FACTOR ANALYSIS OF REAL ESTATE PRICES

by

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Abstract

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The thesis analyzes the main determinants of real estate prices. Investigation of Kiev real estate market confirms the influence of different macro and micro factors on real estate market. In the study the effect of changes in GDP, income level, population in interest rate is examined. The analysis inferred the direct relationship between GDP, income level, population and housing prices. While changes in interest rate negatively affect price level. Estimation results also provide the evidence of the relationship between micro factors and housing prices. Location and qualitative attributes appear to have significant effect on real estate prices.

TABLE OF CONTENTS

LIST OF TABLES

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Chapter 1

INTRODUCTION

This thesis analyzes the core determinants of the real estate prices. Real estate prices are influenced by many different macro and micro factors. The goal of the analysis is to define the main factors which affect real estate market and to measure their influence on housing prices. For this purpose Kiev real estate market is examined.

The real estate market is a very important part of an economy. It is a rather interesting field of research both at macro and micro levels. On the macro level the real estate market is closely connected with financial and real sector. Moreover, the trend of real estate cycle coincides with that of economic development. Real estate prices can be considered to be a leading indicator of general business cycle (Wang (2003); Grissom and De Lisle (1999)). Therefore investigation of real estate market is a significant part of the country's economic situation analysis.

On micro level real estate market can be viewed in the framework of consumer behavior analysis. Real estate purchases constitute a considerable part of consumption expenditures; real estate serves as a store of value and a source of income for households. In developed economies real estate is also used for portfolio diversification, since real estate market is closely connected with the stock market. However, in Ukraine this field is not developed yet. So information about real estate market conditions makes important contribution to the micro analysis.

The paper analyzes Kiev real estate market. The market for real estate in Kiev differs considerably from that of other regions of Ukraine. The trend of market's

development is common, but Kiev market has a number of specific features. These characteristics arise due to Kiev's status of the capital of Ukraine and some economic peculiarities such as higher level of business activity and higher income level. The demand for real estate in Kiev is much higher than in other cities, therefore, the price level on Kiev market is above that for the rest of Ukraine. Recently, Kiev real estate market can be considered to experience the price bubble and its further development is rather unpredictable. This thesis attempts to determine main factors that influence real estate prices and stipulate the market development.

Real estate market has been widely studied in the literature and different papers which pointed out various factors influencing real estate prices. In the thesis the following macro variables are supposed to affect real estate prices: economic growth (Wit and Dijk (2003), Case at all (2000)), population growth (Hilbers at al (2001), Bardhan at al (2004), Huang and Wang (2004)), income level and interest rate (Glascock at al (2002), Hilbers at al (2001)). To analyze the real estate market I am going to regress real estate (offered) price on the following factors: real GDP, population level in Kiev, CPI, average wages and interest rate. Some of these factors can be determined for Kiev, but some of them are aggregated for Ukraine since macro factors influence the situation in Kiev as well. The relationship will be estimated with regression analysis using OLS estimation. The model defines the relationship between explanatory variables and real estate prices and measures the influence of determinants on the dependent variable. The analysis is conducted for the period 2000-2004 years.

The next stage of the analysis includes investigation of different micro factors that determine real estate prices. These factors include location and different qualitative attributes that may influence price level. This part of the analysis will be conducted using OLS regression with dummy variables for different quality characteristics.

The rest of the paper is organized as follows. Chapter 2 gives the review of the literature that study real estate market and regard issues of the thesis. Chapter 3 contains methodology and data description. In Chapter 4 empirical results and their interpretation are given. Chapter 5 introduces conclusions on the work done in the thesis.

Chapter 2

LITERATURE REVIEW

Real estate is a rather popular area of research. Many studies were conducted in the field of modeling real estate price pattern, analyzing the relationship between real estate market and other economic sectors and estimating return on real estate assets. In developed economies the real estate market is rather efficient way of investing money and portfolio diversification. On the other hand, the market is closely connected with general economic cycles (Wang (2003); Case et al. (2000); Hilbers et al. (2001)). Therefore there is a necessity to analyze the market and to find tools for predicting its development. The articles relevant to the subject of my thesis can be grouped in two main categories. One includes studies, which analyze macro factors that affect real estate market. Summarizing the findings of these studies several main factors can be singled out: GDP, inflation rate, population level, level of unemployment, taxation, income level, vacancy rate etc. The second contains papers which examine micro determinants of housing prices. Micro analysis uses mainly different spatio-temporal methods and hedonic price models. There are also several pure empirical studies that develop different techniques for analyzing and modeling real estate market.

There are various viewpoints concerning determinants of real estate price, different factors are highlighted as the most important. None of the studies includes all factors mentioned above. Each paper is concentrated on some main factors chosen for the analysis.

Glascock et al (2002) examine the relationship between REIT (Real Estate Investment Trust) returns and inflation by testing for the causal relationships among REIT returns, real activity, monetary policy, and inflation through a vector error correction model. REIT returns appear to be sensitive to interest rate

changes, changes in monetary policy and real sector activities. There is no evidence of causality between inflation and REIT returns. The relation between these indicators can be explained by interaction of monetary policy and inflation, since REIT returns are affected by changes in monetary policy. The results indicate that REIT return anticipates changes in expected and unexpected inflation, so there is reverse relationship. Since the REIT returns are highly correlated with real estate prices, the similar relationship between real estate prices and analyzed factors can be expected.

Hilbers et al (2001) focus on the relationships between the real estate market and financial sector. In the analysis expected growth in income, anticipated real interest rate, taxes, demographic situation, availability of credit resources are emphasized as main determinants of real estate prices. The analysis of real estate market cycle and financial cycle reveal close relation between them. Analysis concludes that unbalanced real estate price developments often cause financial sector distress and that trends in real estate market should be monitored closely in the context of the financial sector analysis. The other finding of the paper is that price changes in real estate markets may be used as indicator for financial system.

Wit and Dijk (2003) investigate the determinants of direct office real estate returns by analyzing rents, capital appraisals, and total returns. It was explored that gross domestic product, inflation, unemployment, vacancy rate, and the available stock all have an effect on real estate returns. The change in vacancy rate and change in unemployment rate influence the real estate returns the most. These factors can be considered the determinants of real estate cycle development as well.

Case et al (2000) discuss the correlation of cross country real estate cycles and define the main determinants of real estate returns movements. It is considered that real estate cycles are defined by fluctuations of main economic variables

which are correlated across countries. The fact that real estate is not portable but differentiated good contributes to the restriction of the competition across markets and countries; therefore the correlation between markets should be low. Despite this there is empirical evidence of the cross country co-movements in international property returns. The conclusion of the research is that cross country correlation of real estate markets is due to the influence of the global GDP movements. Real estate markets are considered to be affected by the GDP changes which are highly correlated across countries. GDP is also indicated as an important determinant of the real estate cycle by other researchers, cited below. The other inference of the study is that the real estate market is affected by the mix of global and local economic factors. The same conclusion was made by Renaud (1997).

The study of Wang (2003) examines cycles and common cycles in real estate market and related sectors. It investigates the presence of common cycle characteristics and common patterns in the interaction between real estate market and the real sectors of the economy, including the short, medium and long cycles. Common cycles differ from common trends. Common cycle analysis considers the phase of the market cycle, since usually economic fluctuations and movement are not in the same phase. Thus real estate market reveals cyclical characteristics but may not be in the same phase as aggregate economic fluctuations. Examination of common cycles between real estate market and other economic sectors include the following variables: the aggregate GDP itself and its three major components: construction output, industrial production and the services sector, money supply and unemployment rate. Leading indicators of the long lead, short, coincident and lag indicators are also included. Real estate is represented by the JLW Total Return Index (JLW). Common cycle relationship appeared with the house price, the services sector and the manufacturing sector. The existence of common cycles between real estate market and the money

supply and total production is also confirmed but at less level of significance. There is no common cycle relationship found between real estate and the GDP. This result contradicts the studies mentioned above. Real estate shares no common cycles with the construction sector. It appears that real estate price cycle lag behind unemployment.

Huang and Wang (2004) present the analysis of the Shenzhen real estate market. They model the real estate cycle and create the system of indicators predicting the market development. The model was created as a tool to monitor the market and to form regulatory policy. Paper analyzes factors influencing real estate market. The main factors that are considered as 'warning factors' (indicators that reflect market development) are property sale rate or vacancy rate, property price index, housing price index. The paper single out the following factors affecting real estate market development: CPI, GDP, fixed assets investment, savings, population, completed amount of property investment, total constructing area of commodity houses, total completed area of commodity houses, total sold area of commodity houses, vacancy area of commodity houses, total sold area of residential houses, revenue of developers, related taxes and fees of developers, profits of developers, area of new commodity housing projects, total amount of development loans and individual mortgage loans. The system of indicators that predict the trend of real estate market is developed and it can be used for analysis and forecasting.

Bardhan, Edelstein and Leung (2004) analyze the influence of globalization and openness of the country on real estate rents. Since rents are highly correlated with the price this study can also be used for the price analysis. The paper considers 46 major world cities and concludes that higher openness increases rents and hence it can be assumed that real estate prices rise as well. In the analysis such variables influencing real estate market are chosen: urban wages and price of services, gross domestic product and gross domestic product per capita, city population,

openness. The estimation results confirm the assumption that openness influence real estate prices positively as well as GDP. Besides, higher wages, higher services' prices and larger city population result in higher rents and it can be expected to lead to higher prices through an increase in demand.

Jin and Zeng (2003) develop a general equilibrium model that investigates the relationship between business cycle and residential investment as well as house prices. The study concludes that monetary policy and nominal interest rate affect real estate prices; taxation is also considered to have an effect on real estate market. Besides, a strong correlation between house prices and GDP was revealed.

Ewing and Payne (2003) examine the relationship between REIT returns and macroeconomic variables such as the real output growth, the inflation, the default risk premium, and the monetary policy. They use generalized impulse response analysis. REIT is highly correlated with real estate prices, therefore the relationship of house price and above mentioned variables should be very similar. As a result of the analysis it was found that shocks to monetary policy, economic growth, and inflation all lead to decline in REIT returns, while a shock to the default risk premium causes an increase in future returns.

Grissom and De Lisle (1999) present the modeling of real estate cycle. The consistency of real estate cycle with business cycles is explored. For this purpose two distinct models were developed: a model based purely on macroeconomic factors and a model based on a combination of macroeconomic and tax factors. The key independent variables in the first model included GNP as proxy of economic productivity, interest rates as an indication of capital markets and unanticipated inflation. The multiple series analysis was conducted. Based on the analysis it was concluded that real estate cycle is not completely consistent with business cycles. Real estate cycle can lead the business cycle and can lag it.

Many different approaches are used for analysis of the real estate market development. All of them have some drawbacks and advantages. The real estate analysis is rather complicated because of distinguishing features of the market. The property is not a portable good so it has specific features that should be taken into account; characteristics of the property are very different that makes any comparison rather problematic; supply of real estate is rather rigid, which hinders the adjustment toward equilibrium. (Hilbers et al. (2001); Case et al (2000))

The major problem that appear from the analysis of housing market is the heterogeneity of housing good. Numerous studies of housing market consider housing commodity in hedonic or characteristic form. They analyze the price of "housing unit" or "dwelling unit", which is defined as a bundle of individual attributes that contributes to the provision of one or more services. Different functional forms of hedonic price model are analyzed.

Cropper et al. (1988) present such analysis. Study examines linear, semi-log, double-log, linear and quadratic functions of Box-Cox transformed variables (for this transformation independent variables are constrained to have the same transformation, which is allowed to differ from the transformation of the dependent variables). (Box and Cox (1964)) Hedonic price functions are used to value housing attributes that is to define marginal attributes' prices. Analysis includes following housing attributes: number of bathrooms, air conditioned, fireplace, garage and neighborhood characteristics.

Cropper et al. concluded that when all housing attributes included in the function are observed linear and quadratic functions of Box-Cox transformed variables provide the most precise estimates of marginal attribute prices. When some variables are not observed a simple linear hedonic price function outperforms the Box-Cox function. It also provides the smallest maximum bias. However a linear

Box-Cox function provides accurate estimates in the presence of specification error as well as under perfect information. Therefore, this functional form is considered the best for estimating marginal attribute prices.

Noland (1979) also provide the estimation of housing attribute prices. He constructs the housing indexes, which present a cardinal measure for comparing heterogeneous dwellings. The index is calculated as a weighted sum of observable attributes. The weights are estimated from the regression of housing value on its attributes. The regression coefficients are interpreted as prices for attributes. The analysis contains housing quality characteristics (number of rooms, number of bathrooms, building age, lot size, presence of various items, interior quality ratings etc.), location characteristics (description and evaluation of neighborhoods) and some occupant's characteristics. The analysis concludes that quality characteristics are the most important for evaluating the dwellings value, the space also has significant influence, but location is less important factor.

Kim (1992) presents truncated regression model of housing market with stochastic and unobserved truncation points. Normally certain search process precedes the purchase or rent of the real estate. This search process is difficult to monitor and estimate therefore data on transactions for housing market are truncated. Hence, the standard housing demand model will suffer from truncation bias. The search model based on reservation price and rule of optimal choice allows joint estimation of the hedonic price equation and reservation rent by the ML method. The model provides the joint estimation of the hedonic price equation and the demand function. Hedonic price function includes such housing attributes as number of bedrooms, type of bathroom, existence of the parking, central air-conditioner, fireplace, quality of neighborhood and several buyers' characteristics. Compared to standard hedonic functions this model gives more reliable estimates.

Palmquist (1984) develops the estimation technique for the analysis of the demand for housing characteristics. Hedonic price model are based on observed housing attributes (floor space, year of construction, number of bathrooms, presence of garage, condition of the apartment, type of exterior finish, presence of fireplace, swimming pool, basement, air-conditioner and dishwasher and several neighborhood characteristics) Paper provides the estimates of cross-price elasticities and expenditure elasticities.

Case et al (2004) presents the results of the comparison of modeling spatial and temporal house price patterns. The first model is ordinary least squares proposed by Clapp. He develops standard cross sectional model including spatial characteristics. Model includes following explanatory variables: latitude, longitude, each variable squared and the interaction of latitude and longitude to control for spatial factors; housing attributes (number of rooms, number of bathrooms, fireplaces, age of building etc.); time dummies and several neighborhood characteristics. Case also develops local regression model to produce neighborhood price indices. LRM is also estimated as a standard cross-sectional hedonic model, but flexible function for the value of space and time is included as explanatory variable in the regression.

The next model is maximum likelihood estimation of the hedonic regression introduced by Dubin. He begins with estimation of the standard form of the hedonic function as well, except that the errors are allowed to be correlated. Regression includes age, lot size, number of rooms and bedrooms, fireplaces and half baths; time dummy is also included, spatial effect is controlled by included latitude and longitude. To control for inflation date of sale is included. Maximum likelihood estimation is used in this case.

After that the Case's hedonic price model that includes homogeneous within country districts created on the basis of cluster analysis is analyzed. This

technique allows for differences in the parameters in the hedonic price function across local neighborhoods. A hedonic price model is estimated separately for each district, the model includes available housing characteristics and time dummies. The estimated parameters of this estimated hedonic price model then used to cluster the districts into groups with similar parameter sets. (Case et al. 2004)

Comparing OLS and Case's cluster analysis it is concluded that the latter adds explanatory power and reveals spatial patterns at the expense of the substantial computational efforts required to estimate clusters. But none of the models provide consistent and efficient estimators of model parameters. Durbin's model produces consistent and efficient estimators, but it also rather computationally intensive.

Spatio-temporal analysis is also presented by Pace at al (2000). Paper develops several methods for spatial–temporal forecasting of real estate prices.

Case and Quigley (1991) provide a method of housing price trends estimation, which combines information on repeated sales of unchanged properties, on repeated sales of improved properties and on single sales. This approach takes into consideration the number of transactions and changes in the property value due to changes in some characteristics. Comparing with repeated sales method this method is considered more appropriate for estimating real estate market prices. The methods introduce the estimation of real estate prices based on property characteristics, spatial and temporal components of the price. Constructing the model that analyzes macro determinants these approaches can be used to create the standardized estimator for the real estate prices.

Articles presenting macro analysis of the relationships between real estate cycle and economic sector apply various methods and give different results depending on methodology used and highlighted factors. The common conclusion for all

studies is that real estate cycles are indeed connected with financial sector and real sector development. Factors influencing real estate price movements vary across different studies. There are some contradictions in the results indicated. The main disagreement concerns the effect of GNP and inflation on real estate cycle. These issues can give the field for the following analysis.

Papers that present investigation of micro determinants provide different techniques for analyzing the housing market. Each method has certain advantages and drawbacks. But all of them use data for specific purchases, which include both housing characteristics and certain information about buyer to account for the demand side of the transaction. Such data is very difficult obtain, so there is no way for implementing the methods examined in considered studies. My analysis is limited to the investigation of the supply side.

Chapter 3

METHODOLOGY AND DATA DESCRIPTION

Main purpose of the thesis is to analyze core determinants of the real estate prices. The model estimates the relationship between various macro and micro factors and residential housing prices. Analysis is conducted using OLS estimation, fixed effects regression and OLS including dummy variables.

First part of the analysis includes investigation of macro factors. The average residential housing price per square meter is used as dependant variable. Explanatory variables are real GDP, population level in Kiev, average wages, interest rate. GDP is included in the analysis as a proxy for country's economic development and average wage is expected to reflect income level. Economic progress and increase in income level enlarge purchasing capacity that induces demand for real estate and therefore lead to higher price level. Hence, it is expected that there is direct relationship between housing prices and GDP and average wages. Increase in population level also produces increase in demand for real estate; so it is anticipated to have direct relationship as well. Interest rate level affects the availability of credit and as a result influences purchasing capacity. Increase in interest rate restricts availability of financial resources that lead to decrease in demand and hence should cause reduction in prices. Thus inverse dependence of housing prices and interest rate is expected.

Analysis of macro factors includes initial data set that contains statistics for Kiev and Ukraine. Data for macro variables (GDP, average wage, interest rate and population) are given monthly for the period from 1996 to 2004. Statistics for real estate prices are presented in two different data sets. The first includes average prices for Kiev for 1996-2004; the second gives average prices for the neighborhoods of Kiev for 2000-2004. For the purposes of the analysis data are

aggregated for the following districts: Goloseevskiy, Darnitskiy, Desnyanskiy, Dneprovskiy, Obolonskiy, Pecherskiy, Podolskiy, Svyatoshinskiy, Solomenskiy, Shevchenkivskiy. Prices for districts were calculated as the mean for the neighborhoods of the district. There are prices per square meter for 1 room, 2 room and 3 room apartments. Initial data set includes prices per square meter in thousands of dollars. For the purpose of the analysis prices are converted into UAH and corrected on CPI to get real values. Thus the data applied to the analysis contain residential housing price per square meter in UAH.

Data are taken from the Internet site of real estate agency Blagovest. The agency has been operating on Kiev real estate market since 1996 and has completed high volume of sales. The agency has conducted the analyses of the real estate market during last years, so the data provided by them are reliable.

The diagrams for average prices for Kiev and for the districts are given in the Appendix 2. Real estate prices exhibit increasing pattern. It can be seen that prices for 1 room, 2 room and 3 room apartments do not differ much, but prices for one-room apartments are relatively lower, while prices for three room apartments are relatively higher. The descriptive statistics are given in Table 1 and Appendix 1. Considering prices for districts the most expensive apartments are in Pecherskiy district. The descriptive statistics given in Table 2 below and in Appendix 1 show that prices for Pecherskiy district are also more volatile. The Goloseevskiy district is also notable. Since 2003 prices for Goloseevskiy have begun to rise faster than in other districts except Pecherskiy.

Table 1: Average real estate prices per square meter for Kiev, (UAH)

Year	1 room	2 room	3 room
1996	760.45	827.13	862.71
1997	814.25	897.96	940.68
1998	996.31	1112.45	1162.03
1999	1366.61	1597.93	1686.19
2000	1593.60	1701.07	1786.74
2001	1805.61	1845.29	1906.01
2002	2379.55	2450.69	2434.07
2003	3464.30	3502.89	3472.65
2004	4703.31	4753.67	4842.64

Table 2: Average real estate prices per square meter for districts of Kiev, (UAH)

	Goloseevskiy	***Darnitskiy***	***Desnyanskiy***	***Dneprovskiy***	***Obolonskiy***	***Shevchenkivskiy***	***Pecherskiy***	***Podolskiy***	***Svyatoshinskiy***	***Solomenskiy***
2000	1552	1436	1342	1586	1440	1621	2655	1475	1400	1600
2001	1919	1509	1470	1813	1643	1746	2541	1559	1477	1861
2002	2513	2090	2015	2348	2158	2310	3817	2153	2017	2235
2003	3900	3085	3043	3310	3275	3484	5095	3295	3030	3363
2004	4980	4090	3925	4380	4402	4566	7195	4432	4044	4289

The following data are used as explanatory variables:

- real GDP computed as nominal GDP corrected on the inflation level (CPI); data are given in millions UAH.
- loan interest rate officially set by National Bank; data are given in percents.
- average real wage computed as nominal wage corrected on the inflation level (CPI); data are given in UAH. Average wage for Ukraine is used as a proxy for average wage for Kiev, since data for Kiev are available only for 2003-2004. For the available sample both data sets exhibit the same

pattern but wages for Kiev are higher. Besides, average wages for Ukraine are more volatile. Appendix 3.

- population of Kiev.

The descriptive statistics for the variables as well as diagrams are given in the Appendix 4 and 5. All explanatory variables except interest rate exhibit increasing pattern.

Source of the data for GDP, CPI, interest rate and exchange rate are the official web-cite of National Bank of Ukraine. Source of the data for wages and population is the official web-cite of the state statistics committee of Ukraine.

The main problem that is expected from the data is connected with high level of aggregation. Characteristics of residential housing are rather different within districts. Besides, different specific features of districts also affect prices. Therefore aggregation may lead to omitting some factors that influence real estate prices. Real estate market is influenced by many factors; first of all macro analysis omits micro factors that define housing prices. Real estate prices depend much on quality characteristics, location, some specific features such as location in picturesque or quiet surroundings, closeness to some shops or other useful objects. Some of these factors are subjective and it is rather complicated to define them. Among macro factors that also affect real estate prices are state of the building materials market, legislative conditions and political situation.

The other problem with data is correlation between explanatory variables. Some correlation coefficients are given in Table 3. All main economic indicators are closely connected, since all markets in the economy are interrelated and influence each other, so high correlation between explanatory variables can be anticipated.

Table 3: Correlation coefficients for macro variables

	GDP	*Wages*	*Interest rate*	*Population*
GDP	1.00	0.89	-0.76	0.40
Wages	0.89	1.00	-0.83	0.45
Interest rate	-0.76	-0.83	1.00	-0.36
Population	0.40	0.45	-0.36	1.00

First the regression will be run using real estate prices per square meter for Kiev as dependent variable and macro factors as explanatory variables. This analysis will be conducted using OLS regression. Estimation will be done for the prices of one-room, two-room and three-room apartments as explanatory variables. At the next stage of the analysis housing prices are grouped by districts of the city. Prices for different districts vary significantly; such differences in prices can be explained by particular characteristics of the districts such as infrastructure and location relative to the center of the city. So the presence of fixed effects is expected. In this case fixed effects regression is used. Prices per square meter for different districts are used as dependant variable; the same macro variables that were mentioned above are used as explanatory variables.

Second part of the analysis is focused on the examination of micro factors that influence housing prices. Data are taken from real estate sales advertisements from AVISO newspaper. The newspaper has been published since 1994; it issues 100 numbers a year, each number containing few thousand sales advertisements, so it gives representative sample for Kiev real estate market.

Data consist of two samples: attributes and prices per square meter of 300 apartments for April 2004 and attributes and prices of 306 apartments for April 2005. Apartments were chosen randomly with preference given to more detailed advertisements. Data contain prices per square meter in USD. For the purpose of estimation prices are converted in hryvnas.

The main goal of this analysis is to examine the influence of location and quantitative attributes on residential housing prices and to observe how the effects of these characteristics change with time.

For this purpose OLS regression with dummies for different qualitative and location characteristics as explanatory variables will be used. The following attributes are included in the estimation:

- location (district). There are 10 districts: Goloseevskiy, Desnyanskiy, Dneprovskiy, Obolonskiy, Podolskiy, Svyatoshinskiy, Solomenskiy, Shevchenkivskiy, Darnitskiy and Pecherskiy. 10 dummies for 10 districts are included in the regression. Dummy for Darnitskiy district is excluded to avoid multicollinearity problem.
- location relative to the nearest metro station. There are three possible values for this variable: far from metro station, close to metro station, very close to metro station (up to 15 minutes on foot). Regression includes 2 dummies: close to metro and very close to metro.
- number of rooms. There are 3 dummies: for one-room, two-room and three-room apartments. Dummy for 3 rooms is excluded.
- floor space in square meters. The variable is included as number of square meters.
- type of the building (brick or concrete: 1 for brick and 0 for concrete buildings).
- non-standard project of the building (1 if project is nonstandard, 0 if standard).
- new apartment (1 if apartment is new 0 otherwise).
- state of the apartment. There are following possible values: repair is needed, apartments in good conditions, apartments after repair and apartments after modern reconditioning. Estimation includes two dummies: for apartments

after repair and for apartments after modern reconditioning, since "good state" is rather doubtful characteristics.

- type of bathroom (1 if disjoint and 0 if joint).
- height of ceiling in the building (1 if height of ceiling is higher then standard (2.9 meters), 0 if height of ceiling is standard).
- presence of the telephone (1 if telephone is available, 0 if not)
- presence of parquet (1 if parquet is available, 0 if not).
- presence of glazed tile (1 if glazed tile is available, 0 if not).
- presence of built-in furniture in kitchen (1 if there is built-in furniture, 0 if not).
- presence of the furniture in the sold apartment (1 if apartment is sold with furniture 0 otherwise).

If there is no information about the attribute it is assumed it is absent. The corresponding dummy is given zero value. The descriptive statistics to this data are given in the Appendix 6.

Main problem with these data is the subjectivity of information given in advertisements. It reflects only the information, which seller wants to present to attract potential buyers. Offered price may be higher than actual purchase price, but this difference is not much in general. Besides, some characteristics of the apartment are rather subjective. The most questionable is the state of the apartment, since it is assessed by the seller and can be overestimated. The presence of the parquet, glazed tile and furniture can also have ambiguous effect. These items may be in a very bad condition and need repair, in this case they have no significant value, but presented by the seller to overprice. Unfortunately the information about actual purchases is unavailable and there is no possibility to estimate both demand and supply side of the transactions. But though the analysis of the available data allows estimation the effect of apartment's attributes on the offered price.

Chapter 4

EMPIRICAL RESULTS

4.1 Macro analysis

The first step of the analysis includes running OLS regression with prices per square meter as dependent variable and GDP, wages, interest rate and population as explanatory variables (all variables are given in hryvnas, GDP in millions and population in thousands of men). To compare the response of prices for one-room, two-room and three-room apartments three separate regressions will be run. Since we have time series for all variables, it should be tested for stationarity. For this purpose augmented Dickey-Fuller test can be used. The null hypothesis of the test is the presence of the unit root. Results of the unit root test shows that all time series are non-stationary (Appendix7: Table A8). For the housing prices the null hypothesis can not be rejected at 1% significance level, for the macro variables it can not be rejected at 10% significance level. But the first differences of all the series are stationary that is all series are integrated of order 1. Thus there is the possibility to get spurious results using simple OLS. The next step of the analysis includes testing for the presence of cointegration. OLS regressions for each type of apartment including all macro variables mentioned above as explanatory variables were run. Then the residuals obtained from these regressions were tested for a unit root using the same procedure as for time series. The results of the Dickey-Fuller test show that residuals are non-stationary, the null hypothesis can not be rejected at 5% significance level. (Appendix: Table A9) Hence we can conclude that series are not cointegrated. This result evidences that there is no long run relationship between real estate prices and macro variables. That contradicts the assumptions of the analysis and to the results obtained in different studies of the subject that are mentioned in the literature review.

On the other hand, since there is no cointegration regression in differences can be run. Running OLS in differences gives no significant results: most coefficients are not significant.

Table 4: Results of the OLS in differences for monthly data (for 1996-2004) for one-room, two-room and three room apartments

Variables	Regression 1 for one-room apartments	Regression2 for two-room apartments	Regression3 for three-room apartments
GDP	-0.0013 (0.3570)	0.0007 (0.5889)	-0.0006 (0.6890)
Interest rate	4.79** (0.0185)	3.31* (0.1051)	6.0*** (0.0066)
Wage	0.61 (0.1772)	0.26 (0.5555)	0.75 (0.1256)
Population	3.91 (0.1937)	3.29 (0.2812)	4.19 (0.2010)
Const	44.08*** (0.0000)	43.69*** (0.0000)	43.86*** (0.0000)
$\mathbf{R^2}$	0.08	0.05	0.10

Note: GDP is included in million UAH, wage in UAH, interest rate in % and population in thousands men.
p-values of t-statistics are given in brackets.
*** - coefficient is significant at 1% significance level
** - coefficient is significant at 5% significance level
* - coefficient is significant at 10% significance level

Such results can be explained by the fact that real estate prices hardly can respond to changes in economic environment during one month. Considering all the variables response to changes in GDP is the slowest. To account for this lagging reaction lags of GDP can be included in estimation. The specification includes three lags for GDP. For the regression with prices of one-room apartments as dependant variable all coefficient except the coefficient for population are significant, the coefficient for 1 lag, 2 lags and 3 lags are significant at 5% significance level. For the regression with prices of two-room apartments as dependant variable the only significant coefficient is 2 lags of GDP. For the regression with prices of tree-room apartments as dependant variable the

coefficients for 2 lags of GDP, interest rate and wages are significant. Thus the outcomes obtained for different apartments are very different. But the results obtained from such specification have no explanatory power. The highest R^2 for 1 room apartments is 0.14. Therefore, the results of the estimation hardly can reflect some real relationships.

Table 5: Results of OLS in differences for monthly data including lags (for 1996-2004)

Variables	Regression 1 for one-room apartments	Regression2 for two-room apartments	Regression3 for three-room apartments
GDP(-1)	0.0048** (0.0221)	0.0019 (0.3557)	0.0025 (0.2713)
GDP(-2)	0.0064*** (0.0040)	0.0038* (0.0847)	0.0048** (0.0496)
GDP(-3)	0.0039* (0.0545)	0.0022 (0.2856)	0.0031 (0.1662)
Interest rate	5.05** (0.0168)	3.02 (0.1606)	5.73** (0.0146)
Wage	0.85* (0.0520)	0.64 (0.1565)	0.93* (0.0569)
Population	4.30 (0.1617)	4.31 (0.1732)	5.15 (0.1319)
Const	38.28 (0.0000)	39.74 (0.0000)	39.58 (0.0000)
$\mathbf{R^2}$	0.14	0.07	0.12

Note: GDP is included in million UAH, wage in UAH, interest rate in % and population in thousands men.
p-values of t-statistics are given in brackets.
*** - coefficient is significant at 1% significance level
** - coefficient is significant at 5% significance level
* - coefficient is significant at 10% significance level

Since regression is based on monthly data it is possible that some long run relationships are not reflected by such specification. One way to avoid this problem is to run the regression for quarterly data. To account for slow response of real estate prices on changes in economic growth GDP will be included in the specification with one lag. Because of limited number of observation obtained after converting data in quarterly terms there is no possibility to include more lags.

Table 6: Results of OLS in differences for quarterly data (for 1996-2004)

Variables	Regression 1 for one-room apartments	Regression2 for two-room apartments	Regression3 for three-room apartments
GDP(-1)	0.0236*** (0.0091)	0.0155** (0.0685)	0.0190** (0.0410)
Interest rate	5.78 (0.1790)	4.09 (0.3214)	6.77 (0.1365)
Wage	2.92** (0.0285)	2.43** (0.0568)	2.85** (0.0410)
Population	8.92* (0.0989)	8.93* (0.0878)	8.20 (0.1466)
Const	73.82** (0.0279)	82.35** (0.0123)	82.04** (0.0207)
R^2	0.42	0.32	0.36

Note: GDP is included in million UAH, wage in UAH, interest rate in % and population in thousands men.
p-values of t-statistics are given in brackets.
*** - coefficient is significant at 1% significance level
** - coefficient is significant at 5% significance level
* - coefficient is significant at 10% significance level

The regressions for different apartments give very similar results. All coefficients except the coefficient for interest rate appear to be significant. The only difference is that population coefficient in the regression for three-room apartments are insignificant. The demand for one-room, two-room and three-room apartments is formed by different consumption groups. Three room apartments generally are purchased by families with relatively high income level. According to the data provided by the state statistics committee of Ukraine Kiev population grow due to migration rather than increase in birth rate. People who migrate to Kiev rarely purchase three-room apartments within first few years. They mostly induce the demand for one-room and two-room apartments. This fact can explain insignificance of population coefficient in the regression for three-room apartments. The coefficients for interest rate are insignificant in all regressions. In Ukraine market of banking services and especially mortgages had been developing only during last few years. Since data are taken from 1998 there is no influence during first years of the sample. The loans for housing purchases

are still not very popular because of rather high interest rates, very strict conditions and unstable economic situation. Therefore changes in interest rate may not have significant effect on housing price. The coefficients for GDP are about 0.02 for all apartments. That is increase in GDP by 1 million in previous quarter leads to increase in apartment's price per square meter by 0.02 UAH. For example, GDP growth for the third quarter of 2004 amounts to about 5.5 billions (20%). According to regression results prices in the fourth quarter should rise by 110 UAH due to economic growth. The coefficients for wages are about 3 for 1-room and 3-room apartments and about 2.5 for 2-room apartments, hence increase in average wages by 100 UAH should cause rise in prices by 300 and 250 UAH respectively due to increased demand. The coefficients for population are about 9 for 1-room and 2-room apartments and about 8 for 3-room apartments. That is increase in population by 1 thousand leads to increase in prices by 9-8 UAH. For the last year Kiev population rise by 23,000, hence according to regression result prices should increase by 207-184 UAH. The R^2 of the regressions for 1-room, 2-room and 3-room apartments are 0.42, 0.32 and 0.36 correspondingly, so all the regressions exhibit rather high amount of explanatory power.

Housing prices vary much within Kiev, this variation can not be explained by the influence of macro factors. For example, prices are rather different for districts, therefore, fixed effects for districts can be expected. Certain constant district characteristics affect prices of the apartments located in that district. In this case OLS can give inefficient estimators of the coefficients. So next step of the analysis includes running fixed effects regressions. For this purpose data for different districts are used. Prices selected by districts are available only for 2000-2004. Prices per square meter for one-room, two-room and three-room apartments for 10 Kiev districts indicated in data description are used as dependant variable. The same macro factors: GDP, interest rate, average wage

and population are used as explanatory variables. Three separate regressions are run for different types of apartments. The results of the regression are given below.

Table 7: Results of the fixed effects regression for districts (monthly data for 2000-2004)

Variables	Regression 1 for one-room apartments	Regression2 for two-room apartments	Regression3 for three-room apartments
GDP	-0.0027 (0.479)	-0.0023 (0.408)	-0.0017 (0.701)
Interest rate	-30.94*** (0.000)	-32.66*** (0.000)	-25.28*** (0.000)
Wage	5.32*** (0.000)	5.15*** (0.000)	5.57*** (0.000)
Population	26.20*** (0.000)	28.63*** (0.000)	28.61*** (0.000)
R^2 within	0.89	0.90	0.85
R^2 overall	0.75	0.66	0.53
F-statistics	110.00 (0.0000)	251.71 (0.0000)	257.97 (0.0000)

Note: GDP is included in million UAH, wage in UAH, interest rate in % and population in thousands men.
p-values of t-statistics are given in brackets.
*** - coefficient is significant at 1% significance level
** - coefficient is significant at 5% significance level
* - coefficient is significant at 10% significance level

The results of the F-test allow rejecting the null hypothesis that pooled least squares give efficient estimators for all the regressions. So there is clear evidence of the presence of fixed effects, therefore fixed effects regressions give efficient estimators. R^2 for all the regressions are rather high, so the regressions have considerable explanatory power. As before all the regressions give very similar results. All coefficients except that for GDP are highly significant. As it was mentioned before, prices respond to changes in GDP with the lapse of time. So it is reasonable that level of GDP in the same period do not affect housing prices. This estimation is based on data for 2000-2004. In this period banking services as well as crediting has become more popular, so prices appear to respond to changes in interest rate. The coefficients for interest rate show that increase in

interest by 1% leads to corresponding decrease in prices per square meter for one-room, two-room and three-room apartments by 30.94, 32.66 and 25.28 UAH. Prices for three-room apartments exhibit the lowest response to changes in interest rate, while prices for two-room apartments react the most. The possible explanation to this fact is that different apartments are demanded by different groups of consumers, so the demand for them has different structure. Thus demand for three-room apartments as it was mentioned before mostly is formed by families with rather high income level. This category of consumers usually has savings by the time they decide to purchase the apartment. On the other hand, older people are more conservative and they rarely decide to take a loan. Therefore prices for three-room apartments are less sensitive to changes in interest rate. One-room apartments and two-room apartments are the close substitutes. One-room apartments are relatively cheaper, so the demand for them is higher. Consumers who have no enough money to purchase two-room flat may change their decision and buy one-room flat. Therefore, as increase in interest rate makes credit less available demand for two-room apartments decreases. Hence, the prices for two-room apartments are the most sensitive to changes in interest rate. Coefficients for wage are very similar, they mean that increase in average wage by 100 UAH lead to rise in housing prices by about 500 UAH. Coefficients for population show that increase in Kiev population by one thousand causes an increase in housing prices per square meter by about 26-28 UAH.

Based on the results of the analysis of the macro factors it can be concluded that macro factors indeed influence real estate prices. Housing prices are sensitive to changes in income level, population level, changes in population and previous economic growth. The results obtained from the estimation correspond to the initial assumptions of the analysis, but they appear to be sensitive to specification.

The fixed effects for districts was also revealed, hence location have significant influence on prices.

4.2 Micro analysis

Preceding analysis does not account for all the factors that affect housing prices. Real estate prices are influenced not only by macro factors and general economic conditions, but also by many micro factors. Price of each specific apartment depends on many characteristics such as location, state of the apartment and qualitative characteristics. Some of them are rather subjective and reflect consumers' preferences, not the actual value of the specific items. For example, one can prefer top-floor apartments, the other can prefer ground floor; somebody values picturesque surroundings, the other values the infrastructure the most. One likes large windows, the other do not care about that, etc. Fashion for some apartment's characteristics also influences housing prices significantly. It is pretty difficult to account for all the determinants. But there are several common qualitative characteristics that reflect general consumers' preferences and can be somehow measured. The next stage of the analysis is focused on the investigation of different qualitative attributes that determine real estate prices. Initial estimation includes following characteristics as explanatory variables: location (district), location relative to the nearest metro station, number of rooms, floor space, type of building (brick or concrete building), condition of the apartment, presence of parquet, glazed tile, built-in furniture in the kitchen, furniture in the apartment, telephone, height of the ceiling, nonstandard project of the building. Prices per square meter (in UAH) are included as dependant variable. There are two separate estimations: for April 2004 and for April 2005, that allow to compare how influence of the certain characteristics change with time. In this case OLS regression with dummies as explanatory variables is used.

Table 8: Results of the OLS regression including dummies for micro data

Variable	Regression 1 (for April 2004)	P-value	Regression 2 (for April 2005)	P-value
Desnyansliy district	-0.0477	0.2686	0.0874**	0.0153
Dneprovskiy district	0.0554	0.2021	0.1478**	0.0002
Goloseyevskiy district	0.2647***	0.0000	0.3018***	0.0000
Obolonskiy district	0.0649	0.1335	0.1694***	0.0001
Podolskiy district	0.4129***	0.0000	0.4485***	0.0000
Pecherskiy district	0.1272***	0.0033	0.2107***	0.0000
Shevchenkovskiy district	0.2992***	0.0000	0.3789***	0.0000
Solomenskiy district	0.1656***	0.0002	0.2674***	0.0000
Svyatoshinskiy district	0.0140	0.7368	0.1044***	0.0089
Close to metro	0.0741***	0.0033	0.0954***	0.0052
Very close to metro	0.0968***	0.0001	0.0407	0.2894
1 room apartments	0.2778***	0.0000	0.0351	0.6885
2 room apartments	0.1403***	0.0000	0.0413	0.4709
Number of square meters	0.0070***	0.0000	0.0006	0.7652
New apartments	-0.0235	0.7007	-0.0752	0.1033
Building type	-0.0002	0.9946	0.0701**	0.0069
Height of ceiling	0.1341***	0.0001	0.0743**	0.0867
Project	0.0939***	0.0134	-0.0314	0.4767
Repaired	0.0696*	0.0711	0.0183	0.6194
After modern reconditioning	0.0595	0.2404	0.1394***	0.0021
Bathroom	0.0006	0.9780	-0.0036	0.8771
Telephone	0.0177	0.4940	-0.0382	0.2539
Glazed tile	0.0208	0.2960	-0.0100	0.7141
Parquet	-0.0113	0.5937	-0.0671**	0.0164
Kitchen furniture	0.1106***	0.0070	0.1433**	0.0038
Furniture	0.1278***	0.0055	0.0726	0.3078
C	7.5998***	0.0000	8.3455**	0.0000
$\mathbf{R^2}$	0.68		0.42	
Durbin-Watson stat	2.08		2.02	

Note:

*** - coefficient is significant at 1% significance level

** - coefficient is significant at 5% significance level

* - coefficient is significant at 10% significance level

The results obtained from the estimation for 2004 and for 2005 can be compared to examine how influence of the factors changes with time. The estimation provides coefficients for the district dummies that reflect the effect of the location. For 2004 coefficients for Desnyansliy, Dneprovskiy, Obolonskiy, Svyatoshinskiy appear to be insignificant. This can be explained by the fact that these districts are not very popular, therefore, apartments' location in one of these districts adds nothing to the price. For 2005 all the coefficients are significant. For the last year demand for real estate has increased, on the other hand districts' infrastructure has developed, so the effect of location in specific district becomes significant even for "unpopular" districts. All districts' coefficients which are significant have positive signs, therefore, the location in certain district increases price of the apartment. Location in specific districts can increase the valuation of the apartment due to some advantages of the district such as favorable location relatively to the center of the city, infrastructure, developed transport services etc. These results allow to conclude the following: location in Desnyanskiy district do not affect price for 2004 and increase price by 8% for 2005, location in Dneprovskiy district do not affect price for 2004 and increase price by 14% for 2005, in Goloseyecskiy district – by 26% for 2004 and by 30% for 2005, in Obolonskiy district – by 17% for 2005, in Pecherskiy district – by 41% for 2004 and by 45% for 2005, in Podolskiy district – by 13% for 2004 and by 21% for 2005, in Shevchenlovskiy district – by 29% for 2004 and by 37% for 2005, in Solomenskiy district - by 16% for 2004 and by 27% for 2005, in Svyatoshinskiy district – by 10% for 2005. These results coincide with the general distribution of prices between districts. For example, as it can be inferred from the statistics given in Table 2 the most expensive apartments are located in Pecherskiy district and the cheapest apartments are located in Desnyanskiy district. Location near metro significantly influences housing prices. The insignificant coefficient for apartments located very close to metro for 2005 may

be explained by increased demand for real estate. The availability of the metro is still important, but the distance to it matters not as much as before. In 2004 apartments located close to metro were more expensive by 7%, apartments located very close to metro – by almost 10%, in 2005 prices of apartments located close to metro are higher by about 10%.

The floor space influenced prices in 2004, but the effect appear to be insignificant for 2005. But even significant coefficient gives the evidence of very little effect of the floor space on the price level. So it can be concluded that floor space does not influence price per square meter. The coefficient for new apartments appears to be insignificant, which means that new apartments do not differ in prices with "not-new" ones. The insignificance of the coefficient can be explained by the fact that there are very few observations for new apartments. The estimation gives insignificant coefficient for building type for 2004 and the significant one for 2005 that means that in 2005 prices of apartments in brick buildings are higher by 7%. The most constructions build in the last years are concrete, so the supply of this building type has increased, while consumers prefer to live in brick building because of its higher quality. Therefore apartments in brick building have become more valuable with time. According to the estimation results prices of apartments with higher than standard height of ceiling are higher by 13% for 2004 and for 7% for 2005. The lower valuation of height of ceiling can also be explained by increased demand. Non-standard project of the building appear to be insignificant with time. The sample includes mostly old buildings, since there are much more advertisements about old apartments. The supply of the modern apartments with non-standard projects has increased recently, so apartments in old buildings with non-standard project have become less valuable. Looking at the conditio0ns of the apartment it can be concluded that repair was valuable in 2004, while in 2005 only modern reconditioning has significant influence. This can be explained by the changes in consumers' preferences and in fashion. On

the other hand, increase in consumers' ability to pay due to economic progress and increase in income level induces demand for more expensive and high-quality repair. Coefficients for bathroom, glazed tile and parquet are insignificant, so type of bathroom and the presence of glazed tile and parquet do not affect apartments' prices. But coefficient for parquet is negative and significant for 2005. This can also be explained by changes in consumers' preferences on the one hand. On the other hand, it is possible that parquet in the apartment needs a repair that causes additional expenses for buyer, hence there is negative influence. Insignificance of the availability of the telephone can be accounted for the communications facilities progress. Recent development of communications such as mobile phones and internet makes availability of the telephone in the apartment not so decisive. Presence of built in furniture in kitchen increases apartment's price by 11% for 2004 and by 14% for 2004. Apartments sold with furniture were more expensive in 2004, but in 2005 presence of furniture have no effect. Increase in income level in 2005 give buyers the possibility to buy new furniture, so old furniture in the apartment have no value.

Based on the results of micro analysis it can be concluded that location and qualitative attributes affect housing prices. The estimation also allows to measure these effects.

Chapter 5

CONCLUSIONS

The thesis is devoted to the investigation of the factors that influence real estate prices. The analysis is conducted both on macro and micro levels. There is general trend in real estate market development and there are specific features that determine price of the certain apartment. Main goal of the analysis is to define core factors that affect housing prices. For this purpose Kiev real estate market is examined. Real estate market is closely connected with other economic sectors. Besides, its state also depends on economic development of the county. The study includes investigation of the following factors: GDP, average wage, interest rate and population level. Results of the empirical estimation confirm that macro factors indeed influence real estate market. Increase in GDP, average wage and population level appear to have positive effect on real estate prices, while increase in interest rate has negative influence on the prices. It confirms the assumptions that economic development and increase in income level as well as rise of population induces demand and lead to increase in price level. It was also concluded that real estate market respond to changes in GDP that is to economic progress with the lapse of time. At the same time increase in interest rate restricts the availability of financial recourses that restricts the demand causing reduction in prices.

The second part of the analysis includes examination of micro factors. The estimation results provide the evidence that location and qualitative attributes have significant influence on housing prices. The model constructed in the analysis allows measuring the effect of different characteristics on the price level.

Therefore the results obtained from the analysis coincide with initial assumptions and define core determinants of the real estate prices.

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APPENDIX 1

Table A1: Average real estate prices per square meter for Kiev, (UAH)

Year	1 room apartments	2 room apartments	3 room apartments
1996	760.45	827.13	862.71
1997	814.25	897.96	940.68
1998	996.31	1112.45	1162.03
1999	1366.61	1597.93	1686.19
2000	1593.60	1701.07	1786.74
2001	1805.61	1845.29	1906.01
2002	2379.55	2450.69	2434.07
2003	3464.30	3502.89	3472.65
2004	4703.31	4753.67	4842.64

Table A2: Standard deviations for real estate prices per square meter for Kiev, (UAH)

Year	1 room apartments	2 room apartments	3 room apartments
1996	69.39	59.02	56.26
1997	39.28	40.58	50.67
1998	204.82	226.42	261.41
1999	75.91	99.12	105.82
2000	65.17	61.38	86.86
2001	181.26	129.33	125.66
2002	221.48	219.61	159.92
2003	533.63	475.37	518.11
2004	381.62	375.81	409.00

Table A3: Average real estate prices per square meter for districts of Kiev, (UAH)

	Goloseevskiy	***Darnitskiy***	***Desnyanskiy***	***Dneprovskiy***	***Obolonskiy***	***Shevchenkivskiy***	***Pecherskiy***	***Podolskiy***	***Svyatoshinskiy***	***Solomenskiy***
2000	1552	1436	1342	1586	1440	1621	2655	1475	1400	1600
2001	1919	1509	1470	1813	1643	1746	2541	1559	1477	1861
2002	2513	2090	2015	2348	2158	2310	3817	2153	2017	2235
2003	3900	3085	3043	3310	3275	3484	5095	3295	3030	3363
2004	4980	4090	3925	4380	4402	4566	7195	4432	4044	4289

Table A4: Standard deviations for average real estate prices per square meter for districts of Kiev, (UAH)

	Goloseevskiy	***Darnitskiy***	***Desnyanskiy***	***Dneprovskiy***	***Obolonskiy***	***Shevchenkivskiy***	***Pecherskiy***	***Podolskiy***	***Svyatoshinskiy***	***Solomenskiy***
2000	138	64	31	66	65	118	317	124	68	76
2001	199	104	83	200	181	125	194	157	82	232
2002	291	204	175	255	203	247	628	254	171	174
2003	711	522	493	438	549	571	758	550	496	511
2004	441	286	346	384	369	348	886	409	376	420

APPENDIX 2

Figure A1. Average real estate prices per square meter for Kiev (1996-2004)

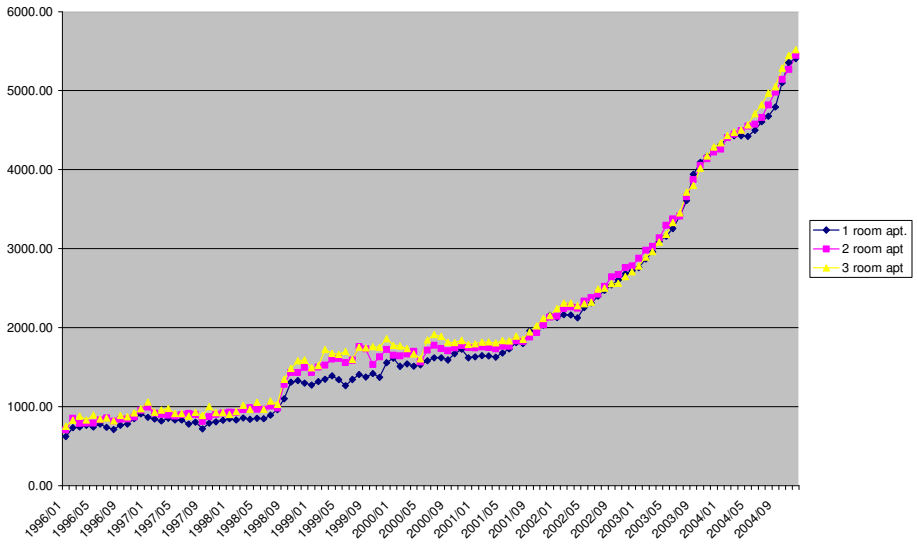


Figure A2. Average real estate prices per square meter for Kiev districts for one-room apartments (2000-2004)

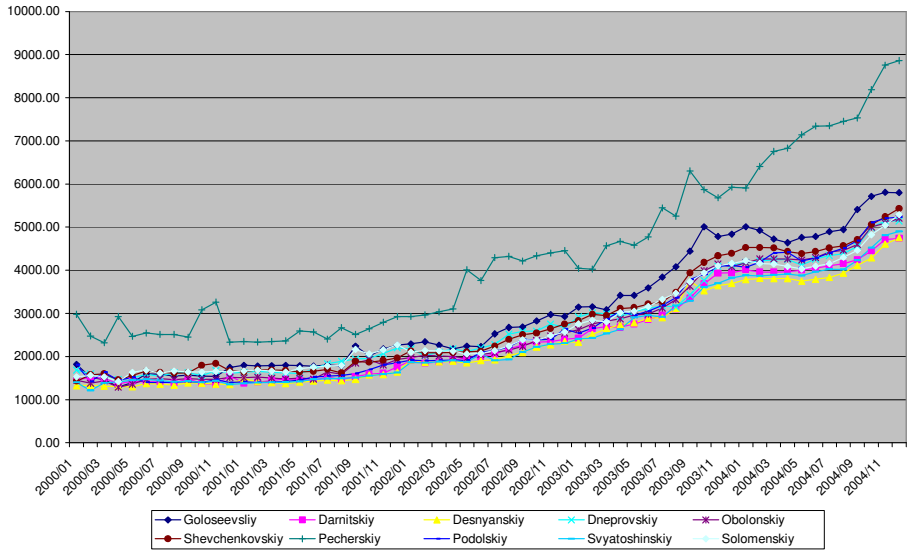


Figure A3. Average real estate prices per square meter for Kiev districts for two-room apartments (2000-2004)

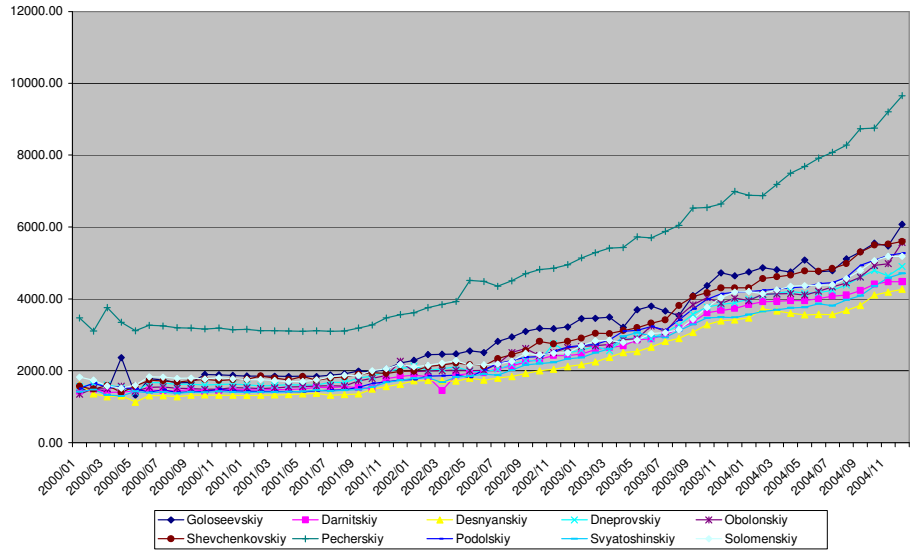
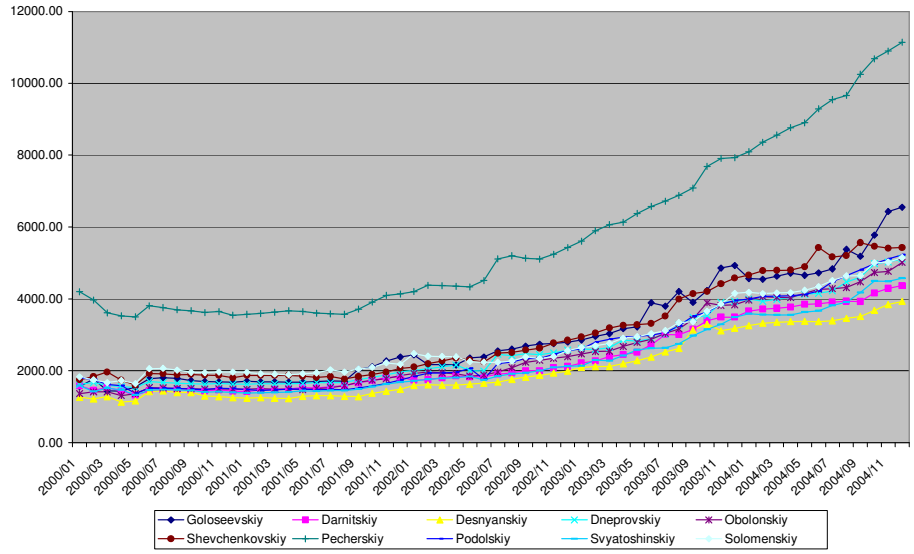


Figure A4. Average real estate prices per square meter for Kiev districts for three-room apartments (2000-2004)



APPENDIX 3

Figure A5. Average wages for Kiev and for Ukraine, (UAH)

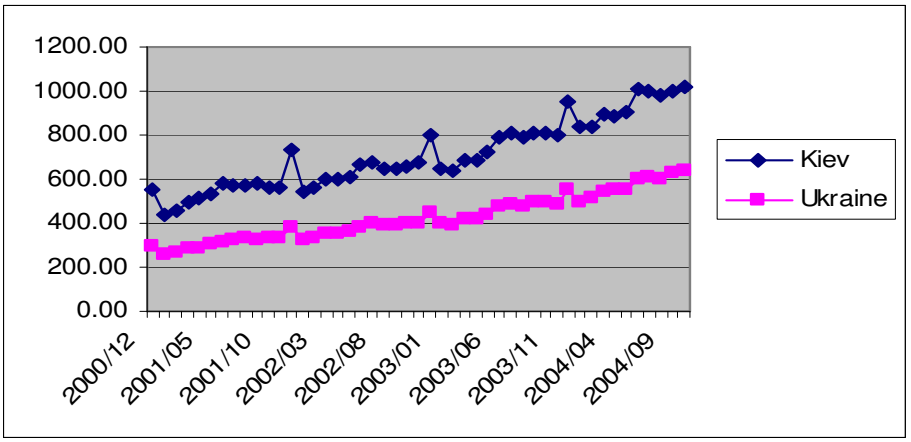
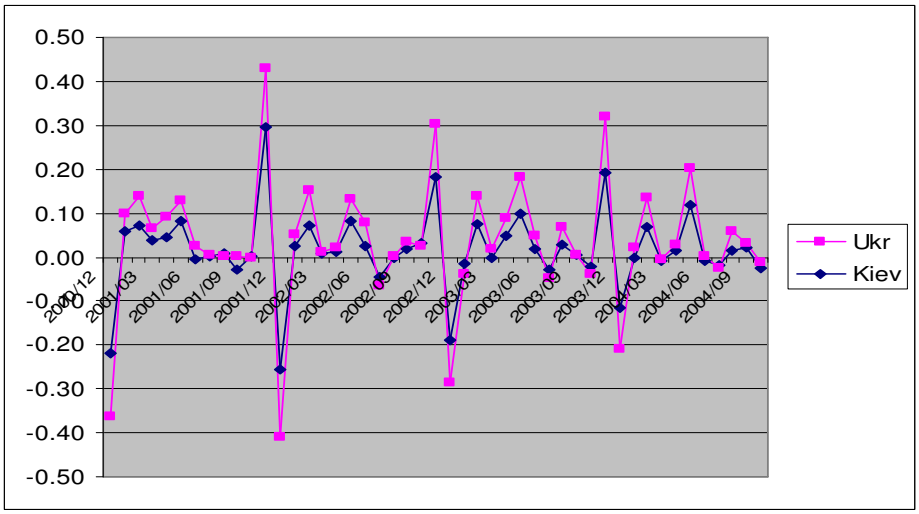


Figure A6. Growth rates of average wages for Kiev and for Ukraine, (UAH)



APPENDIX 4

Table A5: Means for macro variables

Year	***GDP****(mln Uah)*	***Wages*** *(UAH)*	***Interest rate*** *(%)*	***Population*** *(mln)*
1996	6627.53	134.30	77.02	2618.38
1997	7716.07	154.97	48.32	2628.61
1998	8407.37	164.90	52.95	2628.56
1999	10441.14	174.75	53.18	2633.79
2000	13931.72	226.92	39.59	2624.41
2001	16955.72	310.15	31.78	2615.04
2002	18813.81	376.10	32.32	2629.64
2003	21870.42	459.59	17.21	2625.83
2004	27153.71	579.79	16.89	2645.57

Table A6: Standard deviations for macro variables

Year	***GDP***	***Wages***	***Interest rate***	***Population***
1996	6627.53	134.30	77.02	2618.38
1997	7716.07	154.97	48.32	2628.61
1998	8407.37	164.90	52.95	2628.56
1999	10441.14	174.75	53.18	2633.79
2000	13931.72	226.92	39.59	2624.41
2001	16955.72	310.15	31.78	2615.04
2002	18813.81	376.10	32.32	2629.64
2003	21870.42	459.59	17.21	2625.83
2004	27153.71	579.79	16.89	2645.57

APPENDIX 5

Figure A7. GDP

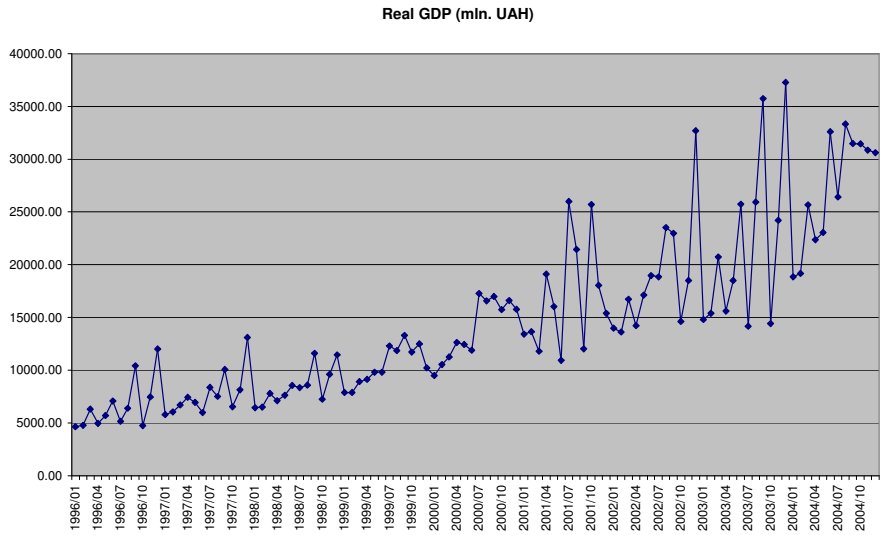


Figure A8. Interest rate, %

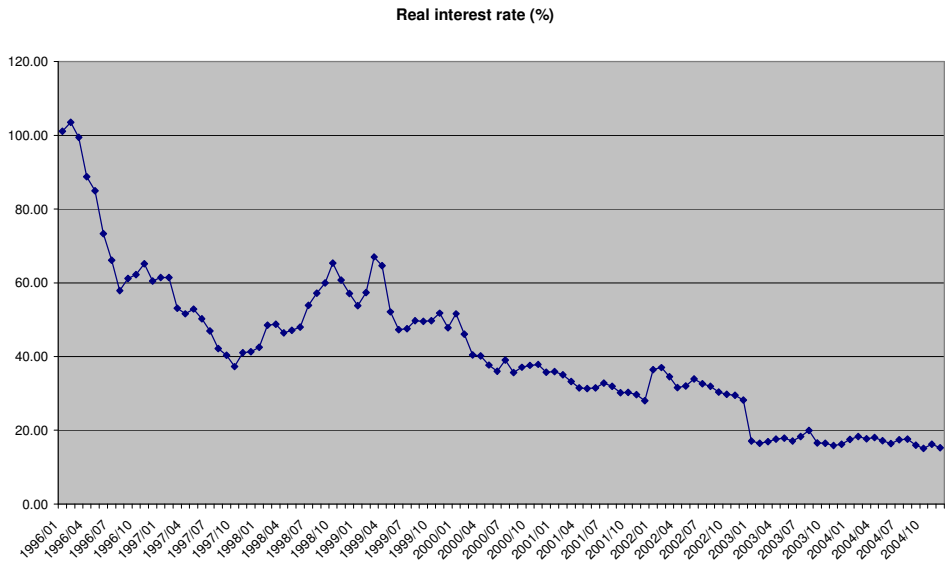
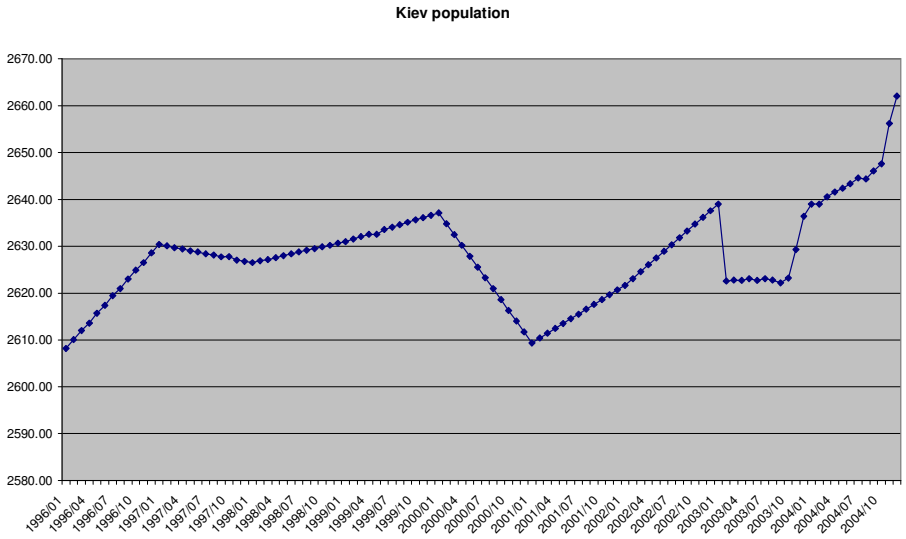


Figure A9. Kiev population, (million men)



APPENDIX 6

Table A7. Descriptive statistics for micro data

Variable	for 2004	for 2005
Darnitskiy district	31	32
Desnyansliy district	30	30
Dneprovskiy district	30	30
Goloseyevskiy district	29	31
Obolonskiy district	30	31
Podolskiy district	30	30
Pecherskiy district	30	31
Shevchenkovskiy district	30	30
Solomenskiy district	30	30
Svyatoshinskiy district	30	30
Close to metro	73	63
Very close to metro	71	77
1 room apartments	100	100
2 room apartments	100	102
3 room apartments	100	103
New apartments	8	24
Apartments in brick building	186	222
Apartments in concrete buildings	114	78
Apartments with higher than standard height of ceiling	31	54
Apartments located in the building with non-standard project	21	59
Repaired	20	28
After modern reconditioning	15	33
Apartments with disjoint bathroom	103	133
Apartments with disjoint bathroom	197	167
Apartments with telephone	243	222
Apartments with glazed tile	122	104
Apartments with parquet	174	169
Apartments with built-in furniture in kitchen	19	24
Apartments with furniture	18	15

APPENDIX 7

Table A8: Results of the augmented Dickey-Fuller test

Variable	ADF test statistics	Critical values	
Prices of 1 room apartments	3.152068	1% Critical value	-3.4946
		5% Critical value	-2.8895
		10% Critical value	-2.5815
Prices of 2 room apartments	3.054753	1% Critical value	-3.4946
		5% Critical value	-2.8895
		10% Critical value	-2.5815
Prices of 3 room apartments	3.034468	1% Critical value	-3.4946
		5% Critical value	-2.8895
		10% Critical value	-2.5815
GDP	-0.049975	1% Critical value	-3.4946
		5% Critical value	-2.8895
		10% Critical value	-2.5815
Wages	2.784953	1% Critical value	-3.4946
		5% Critical value	-2.8895
		10% Critical value	-2.5815
Interest rate	-2.550795	1% Critical value	-3.4946
		5% Critical value	-2.8895
		10% Critical value	-2.5815
Population	-0.657966	1% Critical value	-3.4946
		5% Critical value	-2.8895
		10% Critical value	-2.5815

Table A9: Results of the augmented Dickey-Fuller test (testing for cointegration)

Variable	ADF test statistics	Critical values
Residuals obtained from the regression for prices of 1 room apartments	-2.601193	1% Critical value -3.4946
		5% Critical value -2.8895
		10% Critical value -2.5815
Residuals obtained from the regression for prices of 2 room apartments	-2.275538	1% Critical value -3.4946
		5% Critical value -2.8895
		10% Critical value -2.5815
Residuals obtained from the regression for prices of 3 room apartments	-2.245367	1% Critical value-3.4946
		5% Critical value-2.8895
		10% Critical value -2.5815