BOOM OR BUBBLE IN THE KYIV RESIDENTIAL REAL ESTATE MARKET

by

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Abstract

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This paper uses econometric techniques to detect the speculative part (bubble) in the Kyiv residential real estate prices. The bubble part is estimated as the difference between actual housing prices and 'fundamental' prices, where fundamental prices are determined as the sum of the discounted future expected dividends (monthly rent payments). We quantitatively estimate bubble part-to-fundamental price ratio for all 10 Kyiv districts.

The results obtained during this paper clearly indicate importance of the speculative factor (bubble factor) in actual price growth in the Kyiv Residential Real Estate Market. Bubble part is a significant driver of current housing prices for all 10 Kyiv districts even if we looked in it either as a homogenous variable or as a function of fundamentals.

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Chapter 1

INTRODUCTION

The housing price in Kyiv has risen dramatically in the last 5 years. The million dollar question now is - what is the main reason for this rise in the house prices in Kyiv. Is it driven by economic fundamental parameters or by speculation? In this paper, we argue that this increasing process could be explained by both arguments but speculation plays a key role.

The reason why house prices are driven by a speculative factor is investors` expectation of future house prices increasing. Asset price speculation has been deeply studied in the literature. See for instance, studies by Case and Shiller (1988, 1989), Flood and Hodrick (1990), Diba and Grossman (1988), Gurkaynak (2005) and many others.

What is actually a bubble? Various definitions exist in the literature. One of them states that one of the factors of bubble is when prices increase faster than it could be explained by fundamentals (Kindlegberger, 1987, p.281). Hence, it is not correct to say that each quick rise in prices on assets or real estate shows a bubble. Another description of bubble suggests it could be provoked by people who are buying the assets causes they believe that price will go up in a future (Meltzer, 2003, p.23).

Levin and Wright (1997b) consider speculation process (bubble) in terms of asset prices growth in previous time periods. The main hypothesis is that historical price growth positively influences the future price increasing process. Thus, when historical prices have no effect on an investor's decision about future benefits from reselling a house, there is no speculation (bubble) in the market.

Very often new buyers have no experience with fundamental price evaluation and they don't understand it because of limited information about the real value of house that they selling or buying. Therefore, public expectations could force prices to rise even further. Thus it attracts new buyers and ends up like Ponzy Game, where the last buyer will have no opportunities to sell it at higher price.

Some research outlines specific aspects of the bubble: Case and Shiller (2003) write about unrealistic expectations of future price rises, or big depreciation in prices after a bubble burst. Another very interesting statement was made by Case and Shiller (2003) about housing bubble: if there is a tendency to use housing as an investment then this situation could be defined as a "housing bubble". This definition looks close to the situation on the Kyiv residential market where a large number of new houses have no light in their windows at night. This suggests these apartments were bought by investors as asset for future benefits. One more intuition was provided by Stiglitz (1990) as a conclusion of all definitions discussed before: "if the reason that the price is high today is only because investors believe that the selling price will be high tomorrow – when "fundamentals" factors do not seem to justify such a price – then a bubble exists". The situations described above could lead to a 'wrong' market decision, in other words, a 'wrong' market price. But the desire to buy more because of an increasing price is diminishing in time and it leads to a bubble. This situation could accompany with reduction of financial activity, decrease in GDP growth and banking crises (Bordo and Jeanne, 2002, p.4).

Most of these papers propose tests, which detect a "rational" or speculative bubble – the price part, which could not be explained by fundamentals. In other words, asset prices grow by a bubble factor in a situation when investors are ready to pay a price that is higher than the sum of discounted dividends because he/she predicts that the future resale price will be even higher.

This paper examines the bubble factor in Kyiv Real Estate Price growth with econometric methods based on present value model of dividends. To evaluate dividends for real estate we will use rent payments. A Literature Review section (Chapter 2) includes description of specific papers based on testing for rational bubble. Some of these are purely theoretical, others focus on empirics. The methodology section (Chapter 4) consists of a number of tests which allow to detect rational bubbles. A first simple test designs the bubble term based on net present value model with constant dividends and discount rate in section A. Integration-cointegration test (Diba and Grossman, 1988a, b) is the second (section B). Section C focuses on intrinsic bubbles. Chapter 5 concludes and summarizes the results and estimations.

Chapter 2

LITERATURE REVIEW

How did bubble increase in Kyiv? The actual housing prices are not corresponding to Ukrainian real income growth. If the real GDP increased by 50% and real income just doubled for last 6 years, but housing prices in Kyiv raised by about 8 times. The current total price of Ukrainian residential real estate is equal to about 400% of real GDP. This is incredible results even for such speculative real estate markets as USA (160% of GDP) and Australia (337% of GDP). (Vinogorodskiy, 2006).

The typical bubble indication in Kyiv is the sharp rise in actual housing price-to-rent payment ratio. Rent index is increased slower then prices by two times. Apartments renting is only consumer service and could not be used as investment, thus it increased only by fundamentals.

One more reason for bubble existence is uncompetitive behavior of real estate construction companies in Kyiv. The rise of demand should provoke the same rise of housing supply. But the residential real estate construction growth in Kyiv is about 5% in average for last 6 years (Vinogradskiy, 2006). The population of density in Kyiv is about 3.2 thousands persons/square km. But for other European cities this parameter is much higher. For instance, in Paris – 24.5 ths persons/square km, in Moscow – 10.3, in London – 4.7.

The most known housing real estate bubble increased in Japan in 90^{th}. Since 1949, it was observed incredible economic growth in Japan for 40 years, which led to assets prices increasing. The Japan Stock Exchange market grew by 500% in 1971-1985. In the beginning of 1990 Japanese real estate

market was more expensive than US real estate market by 400%. Then, it was price correction:
Stock Exchange market has dropped by 30% and housing prices have been decreased by 40% for the last 15 years (Bordo and Jeanne, 2003).

Flood and Hodrick (1990) claimed that there are no satisfactory proofs for bubble existence yet. For every paper that detects a bubble, there is another one that rejects it (Gurkaynak, 2005). Below we describe the main approaches which are used for bubble detection.

Most studies start with dividing actual price level over different components, mostly over two: one, which is driven by market fundamentals and another component, say bubble or speculative component. The difference between these studies is in the ways to decomposing the fundamental price. After determining the fundamental price, they estimated fundamental price of assets and compared results with the current price level in order to evaluate speculative component or "bubble" component:

$$P_{actual} = P_{fundamental} + P_{bubble},$$

where P_{actual} is the actual market price, $P_{fundamental}$ is the fundamental price and P_{bubble} is the speculative part. Thus, $P_{bubble} = P_{actual} - P_{fundamental}$. If $P_{bubble} \succ 0$, then the bubble exists and asset is overvalued.

There are some approaches to estimate the fundamental price and detect bubble. The simplest one the "net present pricing model" was used by Chan (2001), when he tested the rational bubble in the Hong Kong housing market. He estimated the fundamental part as a discounted value of discounted future dividends:

$$P_t^f = \sum_{i=1}^{\infty}\left(\frac{1}{1+r}\right)^i E_t(d_{t+i})$$

with discount rate r greater than the expected dividends growth rate. With this condition he estimated the market fundamental price and by given actual market price obtained bubble term. He used rent payments as dividends.

Another methodology estimated the fundamental price by using macroeconomic and geographic variables. For instance, Levin and Wright (1997a, 1998b) constructed the fundamental price based on real income and real interest rate.

Firstly, as in the other studies, they decompose the actual market price in period, t, P_t^a, on fundamental (P_t^f) and speculative part (P_t^s). They expect that the first component is positively related to real income y_t and negatively related to short-term interest rate, i_t. Thus, it could be rewritten as function of income and interest rate:

$$P_t^f = f(i_t, y_t).$$

The other component of actual market price P_t^s depends on expectations about future price growth. Thus, it associated with gains on asset investment for the last n periods:

$$P_t^s = F(g_{t-1}, \dots, g_{t-n}),$$

where $g_{t-i} = \frac{(P_{t-i} - P_{t-i-1})}{P_{t-i-1}}100$ - growth rate of asset prices for time period from $t-i-1$ to $t-i$ and $i = 1, \dots, n$.

Thus, the asset price by substituting is the following:

$$P_t^a = f(y_t, i_t) + F(g_{t-1}, ..., g_{t-n}).$$

At the no bubble hypothesis, speculative part is insignificantly different from 0. They rejected this hypothesis by getting all coefficients of fundamentals and speculative component significantly different from zero and satisfied these conditions:

$$\frac{\partial P}{\partial y} \succ 0, \ \frac{\partial P}{\partial i} \prec 0, \ \frac{\partial P}{\partial g_{t-i}} \succ 0, \ i = 1,...d.$$

This test is not used in our paper because of the short observed time period and lack of adequate data for Kyiv.

Belke and Wiedmann (2005) also used macroeconomic parameters for bubble detection. With time series estimation they explained drivers of the rise of US real estate prices from 1990 till 2003. First they looked through the movement of household debt level in terms of the monetary policy provided by government. It was shown that this policy is associated with low interest rates and that as a consequence the debt level of households increased significantly during that period of time. It created a pre-bubble situation which was caused by excess liquidity. It made the housing market very attractive for investors and pushed them to switch from other equities to real estate.

Belke and Wiedmann found no convergence of real estate prices with inflation rate and rent payments behavior. Thus, they conclude that a bubble component exist in the estimated price growth. Low short-term interest rate which implies low mortgage interest rates were identified as the most important factors for US real estate price growth from 1990 to 2003.

One more test was initiated by West (1987) and therefore it was called West's two-step tests. Under this method West constructed two models. At the first model he took Euler equation:

$$P_t^f = \sum_{i=1}^{\infty} \left(\frac{1}{1+r} \right)^i E_t(d_{t+i}) = \overline{\beta} d_t ,$$

where $\overline{\beta} = \frac{\frac{\phi}{1+r}}{1-\frac{\phi}{1+r}}$.

Parameter ϕ easily could be obtained by an OLS regression:

$$d_{t+1} = \phi d_t + u_t .$$

In this method dividends are exogenous and $|\phi| \prec 1$ (stationary AR(1) process). For the second model West decomposed the actual market price on fundamental and speculative parts again:

$$P_t^f = \beta d_t + P_t^b$$

Under no bubble hypothesis β obtained from the second model should be equal to $\overline{\beta}$ obtained from the first model.

Under next approach Shiller and Case (2003) estimated the ratio of residential real estate price level to income. The idea is very simple. If there is a bubble component, then the average buyer will stop purchasing assets in certain time period causes he cannot pay more money then he has. Because of lack of adequate data most of these methods can not be used in Ukraine.

Tests used in this paper will be described in Methodology (Chapter 4).

Chapter 3

DATA DESCRIPTION

The data set includes calculated average monthly residential real estate price indexes for 10 Kyiv districts: Goloseevskiy (with index go), Darnitskiy (da), Desnyanskiy (de), Dneprovskiy (dn), Obolonskiy (ob), Pecherskiy (pe), Podolskiy (pd), Solomyanskiy (so), Svyatoshynskiy (sv), Shevchenkovskiy (sh). This index represents an average sale price of a square meter of residential housing for whole market supply given in each district for the given period. This index is calculated from 01-2003 to 02-2007 by Ukrainian real estate portal Realt.ua. The calculation is based on the whole market supply that was presented in this portal for each Kyiv district. It is obtained for the given period by the following:

$$P_i^a = \frac{\sum_i P_i}{\sum_i S_i}, \qquad (1)$$

where P_i - is the price of an apartment supplied in the whole sample presented for the given period; S_i - is the total living space of an apartment in the whole sample presented for the given period.

We take this index for each month from January 2003 to February 2007. Thus, this period will cover 50 observations.
For instance, we represent our data set for Goloseevskiy district in Figure 1:

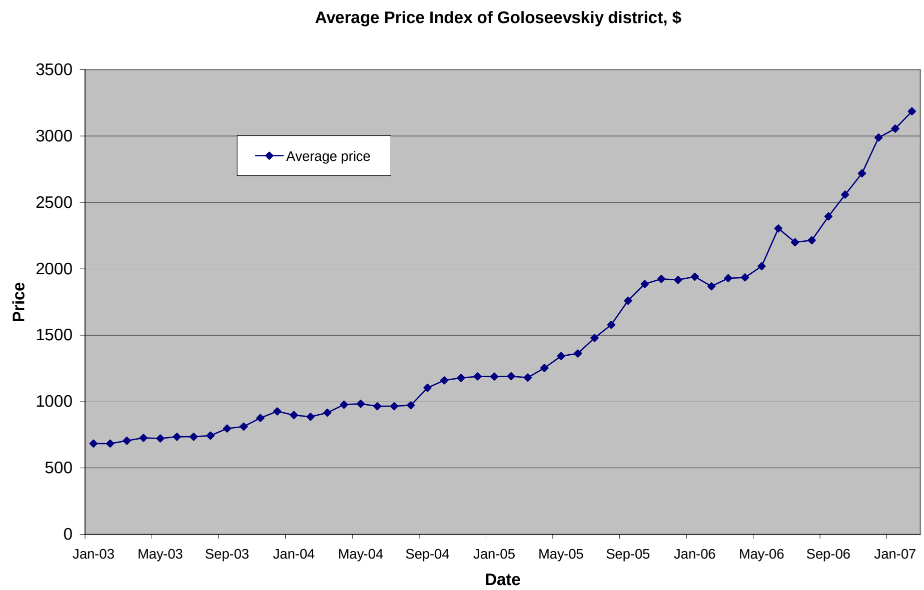

Figure 1

In the next step of this section we describe our explanatory variable on which we based our methodology of bubble detection. This monthly data represents dividends by owning housing as an asset. In other words, this data was constructed as an average rent payment index for the given time period from 01-2003 to 02-2007 that contains also 50 observations and for the same 10 Kyiv districts.

This data set was calculated based on 8894 observations made by D.Sioma for time period from 01-2003 to 12-2005 by the formulas described below and on the average rent index estimated by Realt.ua for time period from 01-2006 to 02-2007. This average rent index is based on the whole rent market supply, and because of the big number of apartments represented in Realt.ua, this index is likely to be the most representative. Calculations of both time periods were based on the same formula, thus together they could be used as single time-series data for our estimations.

Each observation from Sioma's data includes actual monthly rent for the given apartment with some living space valued in square meters. In order to evaluate average rent index for given period we provide calculations by the following formula:

$$d_i^{average} = \frac{\sum_i d_i S_i}{\sum_i S_i}, \qquad (2)$$

where $d_i^{average}$ - is the average monthly rent payment for the specific Kyiv district in the given period; d_i - is the monthly rent payment of an apartment supplied in whole sample of data presented in the given period; S_i - is the total living space of an apartment in the whole sample presented for the given period.

For instance, we represent this calculated data set which presents dividends (rent per average apartment) also for Darnitskiy district:

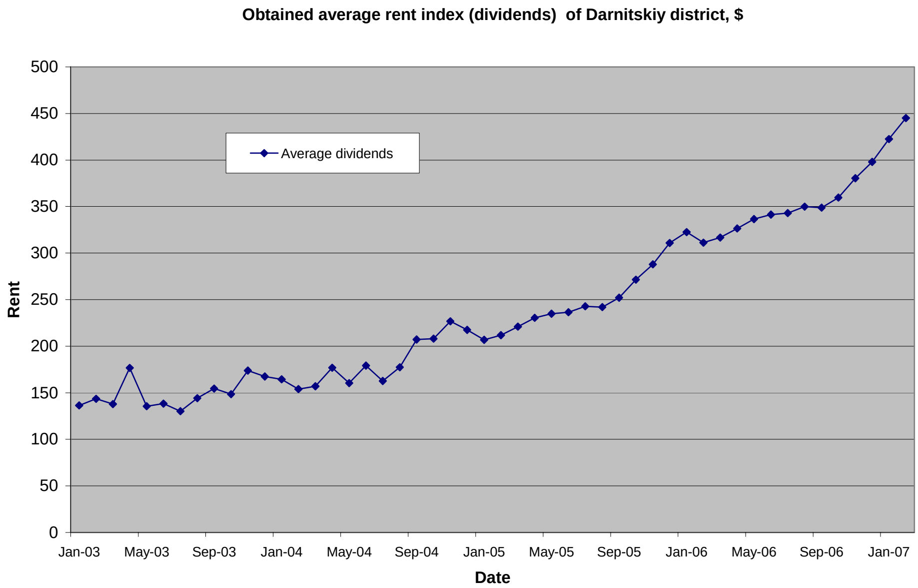

Figure 2

The jumps of the dividends from the figure 2 could be explained by the limited number of observations in Sioma`s data.

C h a p t e r 4

METHODOLOGY

We derive Consumer's maximization problem under three assumptions. We take all apartments as assets, no-arbitrage opportunities and rational expectations (Gurkaynak, 2005). Last two of them are standard for most economic and finance papers by Campbell and Shiller (1988, 1989) and Dida and Grossman (1986) and Cochrane (1992). Let's write expected consumer utility as a function of consumption which is maximized by the following:

$$MaxE_t\left[\sum_{i=0}^{\infty}\beta^i u(c_{t+i})\right] \quad (3)$$

$$\text{s.t. } c_{t+i} = y_{t+i} + (P_{t+i} + d_{t+i})x_{t+i} - P_{t+i}x_{t+i+1}, \quad (4)$$

where y_t - is the endowment; β - is the discount rate of future consumption, x_t - is the asset, P_t - is an after-dividend price on asset, d_t - is the dividends (payoff received from the asset). In our paper P_t is the price of housing and d_t is the rent.

FOC of this consumer's optimization problem is equal to

$$E_t\{\beta u'(c_{t+i})[P_{t+i} + d_{t+i}]\} = E_t\{u'(c_{t+i-1})P_{t+i-1}\} \quad (5)$$

With assumption that utility is a linear function, we have constant marginal utility and risk neutrality (Gurkaynak, 2005). Thus, we could rewrite equation (5) to

$$\beta E_t\left(P_{t+i} + d_{t+i}\right) = E_t(P_{t+i-1}) \tag{6}$$

Under assumption the existence of a riskless bond available with one period net interest rate, r and assuming no-arbitrage (Gurkaynak 2005) implies

$$E_t\left(P_{t+i-1}\right) = \frac{1}{1+r} E_t(P_{t+i} + d_{t+i}) \tag{7}$$

Equation (7) is a beginning of most empirical asset pricing papers. By solving this difference equation we get

$$P_t = \sum_{i=1}^{\infty}\left(\frac{1}{1+r}\right)^i E_t(d_{t+i}) + B_t \tag{8}$$

with $E_t(B_{t+1}) = (1+r)B_t$ (9)

By equation (8) asset price consists of two parts: fundamental part, which obtained by discounting of future dividends and speculative part (bubble) (Gurkaynak, 2005).

A. "NET PRESENT VALUE MODEL"

Under market fundamental model price of the asset is equal to the sum of discounted future dividends, in other words, net present value of dividends, and expected future sale price (Campbell and Shiller, 1988):

$$P_t^f = \sum_{i=1}^{\infty}\left(\frac{1}{1+r}\right)^i E_t(d_{t+i}) + \lim_{i\to\infty}\left(\frac{1}{1+r}\right)^i P_{t+i}\,. \tag{10}$$

But with transversality condition the second term of right side is equal to zero ($\lim_{i\to\infty}\left(\frac{1}{1+r}\right)^i P_{t+i} = 0$). Thus, if dividends grow slower than discount rate, then the fundamental price converges in infinity and it could be obtained by the equation (10) (Gurkaynak, 2005). In our estimation we take r and d_t are constant over time for given Kyiv district. In other words, we assume that investor expect the same level of dividends (in net present value terms) from buying asset all over the time:

$$E_t(d_{t+i}) = d_t,$$

where d_t - is the current average rent payment calculated for the specific Kyiv district. It means that dividends growth equals zero much smaller than discount rate.

$$P_t^{\,f} = \sum_{i=1}^{\infty}\left(\frac{1}{1+r}\right)^i d_t \qquad (11)$$

Then, we could identify bubble part by the difference between actual housing prices and obtained fundamental prices

$$B_t = P_t^{\,a} - P_t^{\,f} \qquad (12)$$

Firstly, under assumption the existence of a riskless bond available with one period net interest rate, r, for Ukraine we take this net interest rate is about $1.01^{12} \approx 12\%$ based on the IMF and World Bank empirical evidence for Ukraine.

With second step of this method we obtain such a net interest rate, $\bar{r}$, by which actual price would be equal to fundamental price with no bubble part by the following:

$\bar{r}_t = \frac{d_t}{P_t - d_t}$ for all 10 Kyiv districts.

Then, we compare these results with interest rate assumed for Ukraine.

B. INTEGRATION - COINTEGRATION MODEL.

The bubble element is the part in prices but not the part in fundamentals, like discount rate and dividends. In the absence of bubble, asset prices and dividends must change with the same rate (Gurkaynak, 2005). Intuitively, this means that if dividends grow slower than prices, under the assumption of a constant discount rate, prices should be driven by bubble factor $(B_t \succ 0)$. Econometrically these intuitive statements could be estimated by tests based on unit roots and cointegration.

Thus, if both P_t and d_t have a unit root but first differences in prices ΔP_t and in dividends Δd_t are stationary and P_t and d_t are cointegrated, then there is no bubble (Diba and Grossman, 1987, 1988a). They assume dividends behavior as follows:

$$d_{t+1} = d_t + \varepsilon_{t+1}, \tag{13}$$

thus, by taking the first difference, we get Δd_t ,which is stationary series:

$$\Delta d_t = \varepsilon_{t+1} \tag{14}$$

and the dividends are integrated of order one I(1). Under assumption that discount rate is constant asset price P_t should follow with the same trend as asset dividends d_t causes dividend is only one fundamental by which price could be driven. Thus, we could write price behavior as:

$$P_t = \beta d_t + \eta_t, \tag{15}$$

where d_t is follows as in equation (13) implies P_t also must follow this way and ΔP_t is also stationary.

Thus, error term η_t: $\eta_t = P_t - \beta d_t$ is stationary and P_t and d_t are cointegrated with a parameter β.

With null hypothesis of no bubble, we construct the regression $P_t = \beta d_t + \eta_t$, and then check the parameter $\eta_t = P_t - \beta d_t$ is stationary or not by Dickey-Fuller test.

C. INTRINSIC BUBBLE MODEL

In the previous two sections we look at the bubble factor as a homogenous variable, which doesn't depend on fundamentals, such as dividends. But in this section we suggest another type of bubble, an intrinsic bubble. First, this definition was used by Flood and Obstfeld (1991). They constructed bubble term as a non-linear function of dividends. First, we present the asset price equation:

$$P_t = \frac{1}{1+r} E_t\left(d_t + P_{t+1}\right), \quad (16)$$

where its fundamental part presents in Section 4.1. by equation (11) and its bubble part is presented in Section 4. by equation (9).

Flood and Obstfeld constructed intrinsic bubble by the form:

$$B(d_t) = c d_t^{\lambda}, \quad (17)$$

where B_t is non-linear function of d_t and satisfies equation (9), $c \succ 0, \lambda \succ 1$. Also they suggest that if log dividends random work behavior is

$$\ln d_t = \mu + \ln d_{t-1} + \xi_t, \quad (18)$$

where $\xi_t \in N\left(0, \sigma^2\right)$. Given fundamental part by equation (11), assuming that d_t is known at the beginning of the period, could be simplified:

$$P_t^f = kD_t, \quad (19)$$

where $k = \frac{1}{(1+r) - e^{\mu + \sigma^2/2}}$.

Such expression for k was easily obtained by simple calculations. Let's present the fundamental part as following:

$$P_t^f = \frac{1}{1+r} E(d_t) + \frac{1}{(1+r)^2} E(d_{t+1}) + \frac{1}{(1+r)^3} E(d_{t+2}) + \ldots.$$

By dividends behavior described in equation (18) Flood and Obstfeld wrote the expression for dividends in period $t+1$ in terms of dividends in period t as:

$$d_{t+1} = d_t \exp(\varepsilon_{t+1}) \tag{20}$$

By taking expectation of equation (20) we get:

$$E(d_{t+1} | d_t) = d_t E(\exp(\varepsilon_{t+1})) \tag{21}$$

Under log-normal distribution assumption for error term, we could write $E(\exp(\varepsilon_{t+1}))$ is equal to $\exp(\mu + \sigma^2 / 2)$, where ε_{t+1} is distributed as independent normal with mean μ and variance σ^2. Then we could present all expected dividends by the following:

$$E(d_t) = d_t$$

$$E(d_{t+1}) = d_t e^{(\mu+\sigma^2/2)}$$

$$E(d_{t+2}) = d_t e^{2(\mu+\sigma^2/2)}$$

and for the period it looks like $E(d_{t+n}) = d_t e^{n(\mu+\sigma^2/2)}$.

Thus, if we replace all expected dividends in our fundamental price equation then it changes to

$$P_t^f = \frac{1}{1+r} d_t + \frac{1}{(1+r)^2} d_t e^{(\mu+\sigma^2/2)}) + \frac{1}{(1+r)^3} d_t e^{2(\mu+\sigma^2/2)} + \ldots$$

or

$$P_t^f = d_t\left(\frac{1}{1+r} + \frac{e^{(\mu+\sigma^2/2)}}{(1+r)^2} + \frac{e^{2(\mu+\sigma^2/2)}}{(1+r)^3} + \ldots\right). \tag{22}$$

The equation in brackets is a geometric progression with first member $\frac{1}{1+r}$ and period equals $\frac{e^{(\mu+\sigma^2/2)}}{1+r}$. Finally, equation of the fundamental price P_t^f is equal to

$$P_t^f = d_t \frac{\frac{1}{1+r}}{1-\frac{e^{(\mu+\sigma^2/2)}}{1+r}} = d_t \frac{1}{(1+r)-e^{(\mu+\sigma^2/2)}} = kd_t$$

as in equation (19).

Then we could rewrite equation for asset price as

$$P_t = P_t^f + B(d_t) = \beta d_t + c d_t^{\lambda} \tag{23}$$

To test the existence of intrinsic bubble Flood and Obstfeld constructed simple regression from equation (23) by dividing both sides on d_t:

$$\frac{P_t}{d_t} = \beta + c d_t^{\lambda-1} + \eta_t , \tag{24}$$

where with no bubble hypothesis: β is significant coefficient ($\beta \neq 0$) and c is insignificant ($c = 0$).

Chapter 5

ESTIMATION

In Chapter 5 we will discuss the estimated results. By our methodology, we estimate the existence of a rational bubble factor in section B, the existence of an intrinsic bubble factor in section C, and calculate dynamics of bubble term and bubble part-to-fundamental price ratio in section A. for all 10 Kyiv districts.

A. "NET PRESENT VALUE MODEL"

Under two assumptions of constant net interest rate equals $1{,}01^{12} \approx 1{,}12$ or 12% and constant dividends we obtained fundamental price for housing. Then, we identify bubble term by difference between actual housing prices and obtained fundamental prices. The bubble factor is presented (Figure 3 – 12) by bubble factor – fundamental part ratio for all 10 Kyiv districts. The biggest bubble factor is in actual housing prices of Shevchenkovskiy district (127.47%). The smallest is in actual housing prices of Goloseevskiy district (69.59%).

At the second step of this method we obtained net present interest rate by which bubble factor is equal to 0 ($B_t = 0$) and fundamental prices are equal to actual prices. All calculated net interest rates lie in range from 5.37% (Shevchenkovskiy district) to 7.28% (Goloseevskiy district) (Figure 13 - 22). In comparison with assumed Ukrainian net interest rate these results are twice lower in average. It proves bubble existence in all 10 Kyiv districts.

B. INTEGRATION - COINTEGRATION MODEL.

With no-bubble hypothesis H_0: term η_t ($\eta_t = P_t - \beta d_t$) is stationary, which means that P_t and d_t are cointegrated with a parameter β. First, by using Dickey-Fuller test we check the stationarity of variables P_t and d_t under null hypothesis that we have a unit root problem (variables are not stationary) and we get following results (p-values) in Table 1:

Variable	p-value	Variable	p-value
pa_sh	1.0000	d_sh	0.7879
pa_so	1.0000	d_so	0.9338
pa_sv	1.0000	d_sv	0.9703
pa_pe	1.0000	d_pe	0.9648
pa_pd	0.9990	d_pd	0.9921
pa_ob	1.0000	d_ob	0.9043
pa_dn	1.0000	d_dn	0.9980
pa_de	1.0000	d_de	0.9582
pa_da	1.0000	d_da	0.9973
pa_go	1.0000	d_go	0.9708

Table 1. Dickey-Fuller test of variables P_t and d_t

As it is seen from these results, p-value for both dividends and actual prices are close to 1, thus, we could accept null hypothesis and variables P_t and d_t have unit root. Prices and dividends are not stationary for all 10 Kyiv districts.

Then, according to our methodology, we take first differences of variables P_t and d_t, which are ΔP_t and Δd_t, respectively. And check for unit root with Dickey-Fuller test again. Obtained results (p-values) for these variables are present in Table 2:

Variable	p-value	Variable	p-value
d.pa_sh	0.0003	d.d_sh	0.0000
d.pa_so	0.0035	d.d_so	0.0000
d.pa_sv	0.0010	d.d_sv	0.0000
d.pa_pe	0.0001	d.d_pe	0.0000
d.pa_pd	0.0000	d.d_pd	0.0000
d.pa_ob	0.0102	d.d_ob	0.0000
d.pa_dn	0.0000	d.d_dn	0.0000
d.pa_de	0.3151	d.d_de	0.0000
d.pa_da	0.0698	d.d_da	0.0000
d.pa_go	0.0000	d.d_go	0.0000

Table 2 Dickey-Fuller test of variables ΔP_t and Δd_t

With these results, we could see that almost all p-values are close to 0. This means that we reject null hypothesis for unit root process and ΔP_t and Δd_t are stationary, exclude variable d.pa_de. Its p-value is 0.3151. Because of p-value for variable d.pa_de there is an intuitive bubble factor for Desnyanskiy district with this methodology. In the absence of the bubble, if dividends are stationary in first differences and asset prices are equal to its fundamental part, asset prices should also be stationary in first differences. With given results for Desnyanskiy district, we have seen that null hypothesis of unit root process is rejected by p-value = 0.0000 for d.d_de variable. This means that it is stationary and the price series should also be stationary in the first differences. However, p-value = 0.3151 for d.pa_de variable and price series in first differences have a unit root, thus, they are not stationary.

We obtained that both prices and dividends are integrated in order one. The next step is to test cointegration between P_t and d_t. In other words, we should check no-bubble hypothesis H_0: term $\eta_t\,(\eta_t = P_t - \beta d_t)$ is stationary or not. Results are the following in the Table 3:

Variable	p-value
res_sh	0.8748
res_so	0.3104
res_sv	0.9551
res_pe	0.1740
res_pd	0.1525
res_ob	0.6587
res_dn	0.7692
res_da	0.7667
res_go	0.1108

Table 3. Dickey-Fuller test of error term η_t

As we could see from Table 5 even with 10% - significance level we cannot reject null of unit root which means that there is evidence for the presence of a bubble for all 10 Kyiv districts. (p-values are greater than 0.1)

Using the above methodology we wanted to check the absence or existence of a bubble factor in actual real estate price level. With obtained results we could clearly conclude the bubble existence in all 10 Kyiv districts.

C. INTRINSIC BUBBLE MODEL

According to our methodology, we consider the presence of intrinsic bubble based on the regression: $\frac{P_t}{d_t} = \beta + cd_t^{\lambda-1} + \eta_t$ with no-bubble hypothesis: β is significant coefficient ($\beta \neq 0$) and c is insignificant ($c = 0$). As it is seen from the results below, we reject this hypothesis, because both constant coefficient β and coefficient c are significant with t-statistics and p-value. These results are present in Table 4 :

Goloseevskiy

COEFFICIENT	go1
d_go	0.216***
	(-0.035)
Constant	71.78***
	(-12.2)
Observations	49
R-squared	0.44

Darnitskiy

COEFFICIENT	da1
D_da	0.195***
	(-0.023)
Constant	96.48***
	(-5.76)
Observations	49
R-squared	0.61

Desnyanskiy

COEFFICIENT	de1
d_de	0.328***
	(-0.033)
Constant	78.32***
	(-7.36)
Observations	49
R-squared	0.67

Dneprovskiy

COEFFICIENT	dn1
D_dn	0.280***
	(-0.02)
Constant	75.93***
	(-5.25)
Observations	49
R-squared	0.81

Obolonskiy

COEFFICIENT	ob1
d_ob	0.308***
	(-0.024)
Constant	67.95***
	(-6.78)
Observations	49
R-squared	0.77

Pecherskiy

COEFFICIENT	pe1
D_pe	0.148***
	(-0.017)
Constant	92.84***
	(-8.07)
Observations	49
R-squared	0.61

Podolskiy

COEFFICIENT	pd1
d_pd	0.200***
	(-0.025)
Constant	99.60***
	(-7.46)
Observations	49
R-squared	0.57

Svyatoshynskiy

COEFFICIENT	sv1
D_sv	0.280***
	(-0.023)
Constant	83.92***
	(-5.63)
Observations	49
R-squared	0.76

Solomenskiy			Shevchenkovskiy	
COEFFICIENT	so1		COEFFICIENT	sh1
d_so	0.166***		D_sh	0.353***
	(-0.022)			(-0.038)
Constant	95.37***		Constant	24.06*
	(-6.51)			(-14.1)
Observations	49		Observations	49
R-squared	0.54		R-squared	0.65
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table 4. The results of OLS regression $\frac{P_t}{d_t} = \beta + c d_t^{\lambda-1} + \eta_t$

By given methodology we want to check the absence or existence of bubble factor that depends on dividends in actual real estate price level. As we could see from obtained results that coefficient c is significant for all 10 Kyiv districts. Thus, our results prove the existence of bubble for these districts.

SUMMARY and CONCLUSION

The current thesis was aimed to detect the bubble factor in actual housing prices growth and also estimate this bubble term using bubble-fundamental part ratio for all 10 Kyiv districts. We present bubble factor by different ways, thus we used three different methods in order to compare obtained results and provide correct conclusions.

All the estimations were presented with important assumptions. First, for all our models we assume dividends (rent payments) as only one fundamental driver for actual housing prices. This is very strong assumption and only one of other possible fundamental price specifications. Other specifications based on macroeconomic and geographic variables were not used in this paper because of lack of adequate data. But the model with dividends is the most understandable because it is presented and learned by most bubble detection studies. In our estimations we also assume no-arbitrage opportunities and rational expectations. Under these assumptions we use econometric models of bubble detection for bubble factor as homogenous variable and as a variable depends on fundamentals (dividends). In the first method the bubble element is the part of actual housing prices but is not explained by the fundamentals, like discount rate and dividends. In the second method bubble term was constructed as a non-linear function of dividends.

The results obtained during this methodology clearly indicate importance of speculative factor (bubble factor) in actual price growth in the Kyiv Residential Real Estate Market. Bubble part is a significant driver of current housing prices for all 10 Kyiv districts even if we looked in it either as a homogenous variable or as a function of fundamentals.

Detailed calculations from "Net present value model" method prove significance of bubble factor in actual housing prices and demonstrate that Kyiv residential real estate is overvalued by 70% - 127,5%.

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APPENDIX

A. BUBBLE TERM-TO-FUNDAMENTAL PRICE RATIO FOR ALL 10 KYIV DISTRICTS:

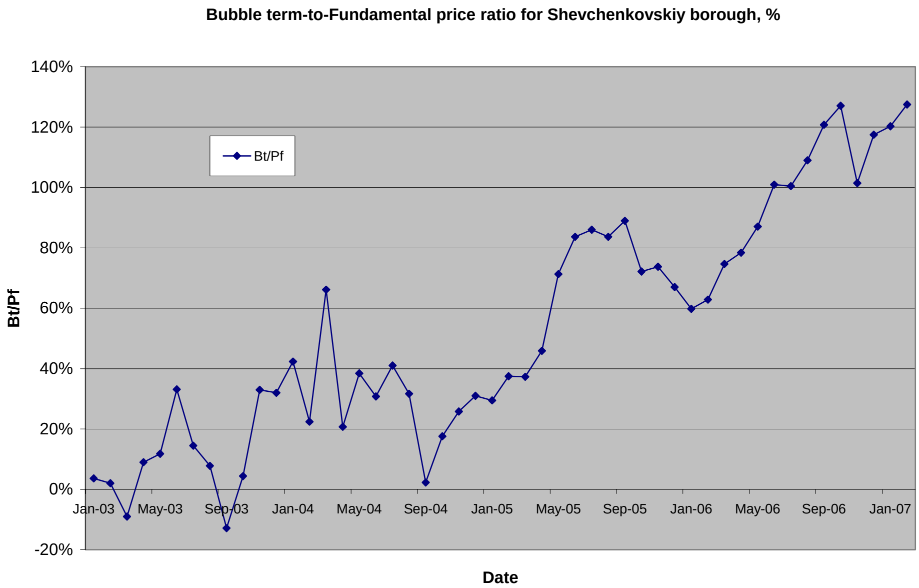
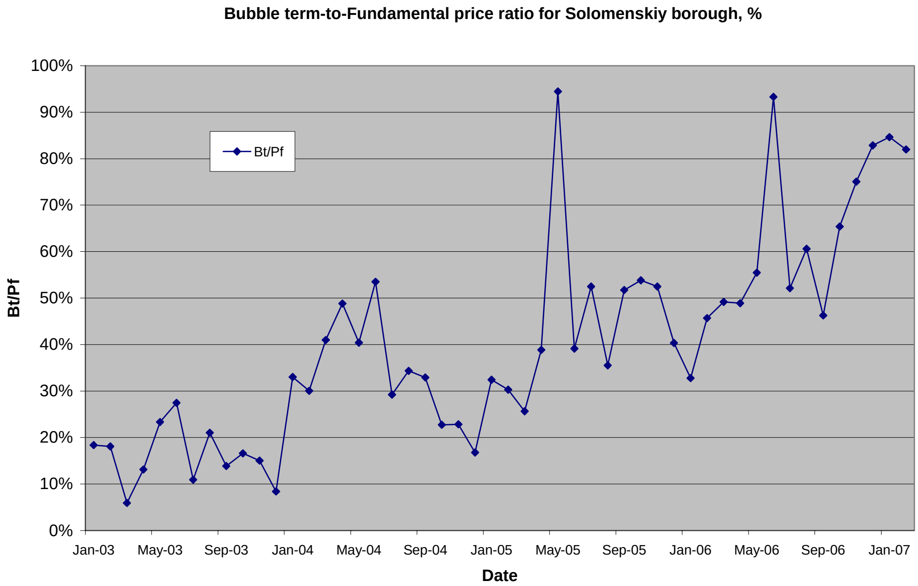


Figure 3



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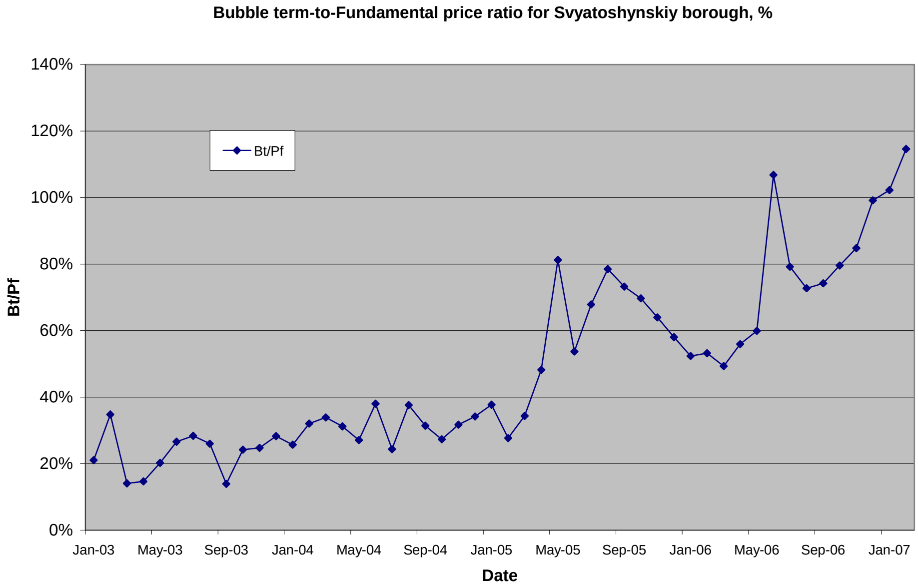

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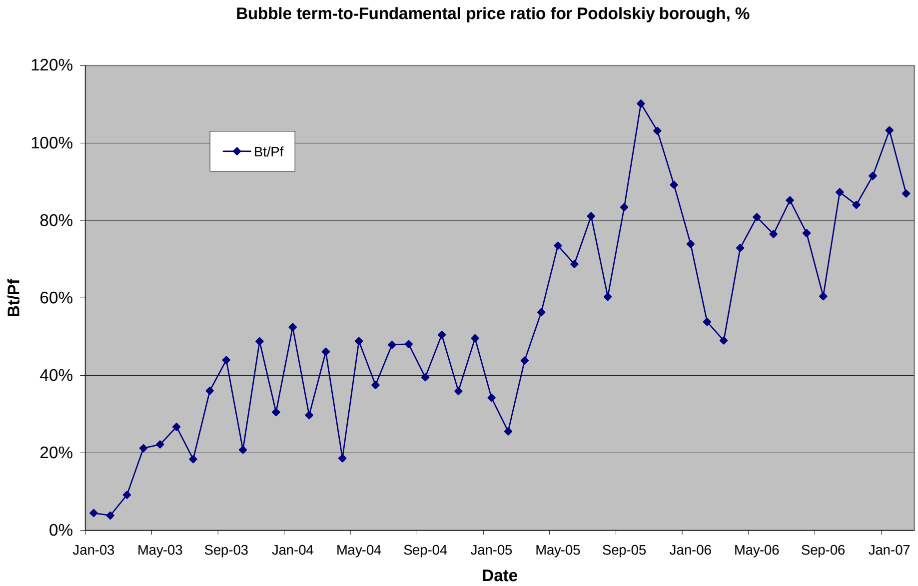

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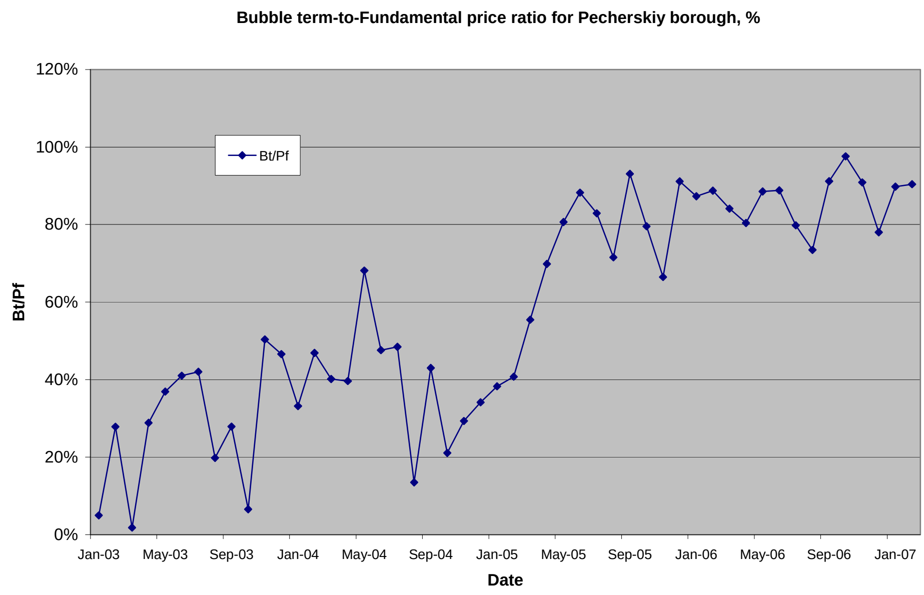

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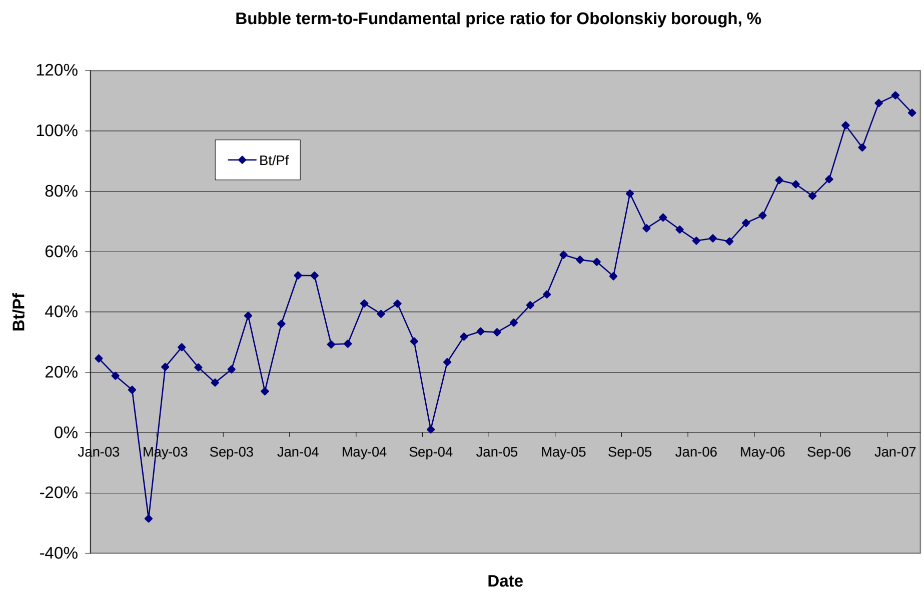

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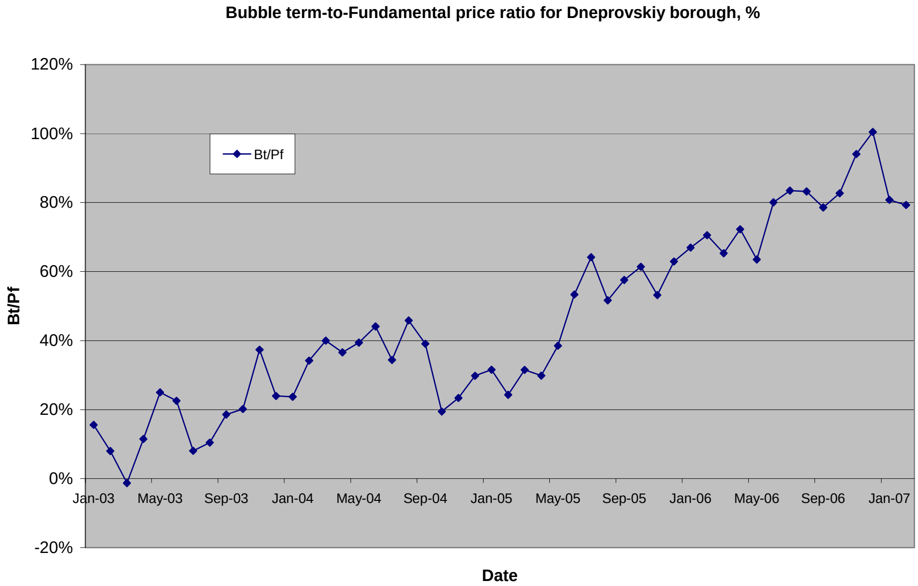

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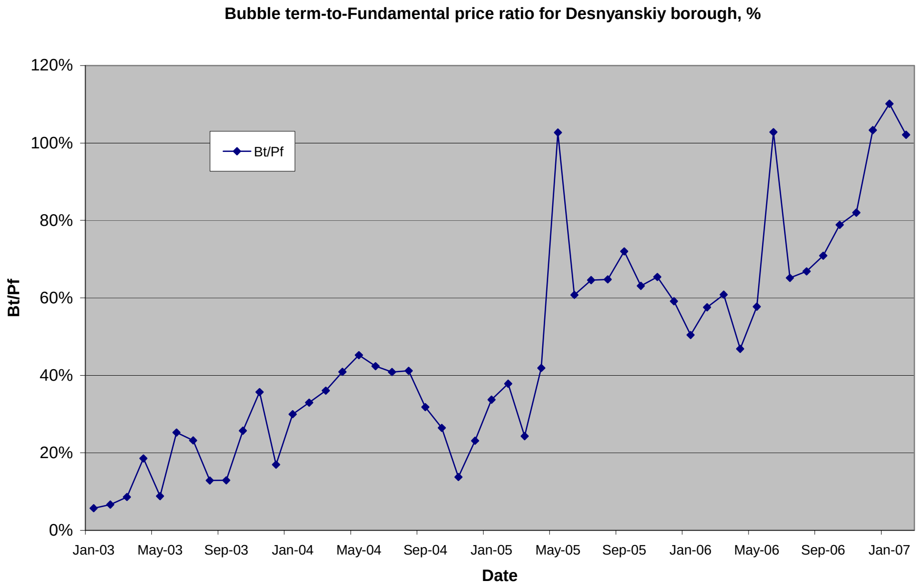

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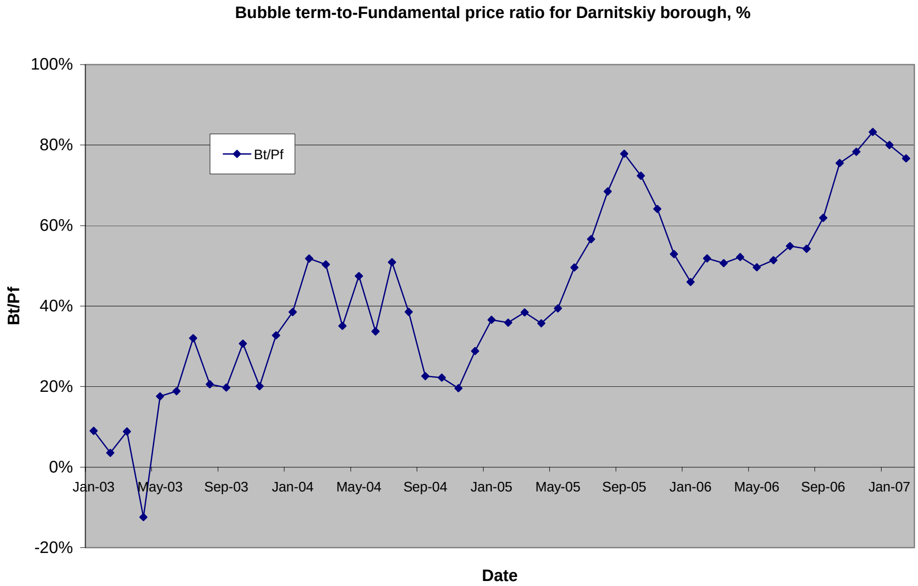

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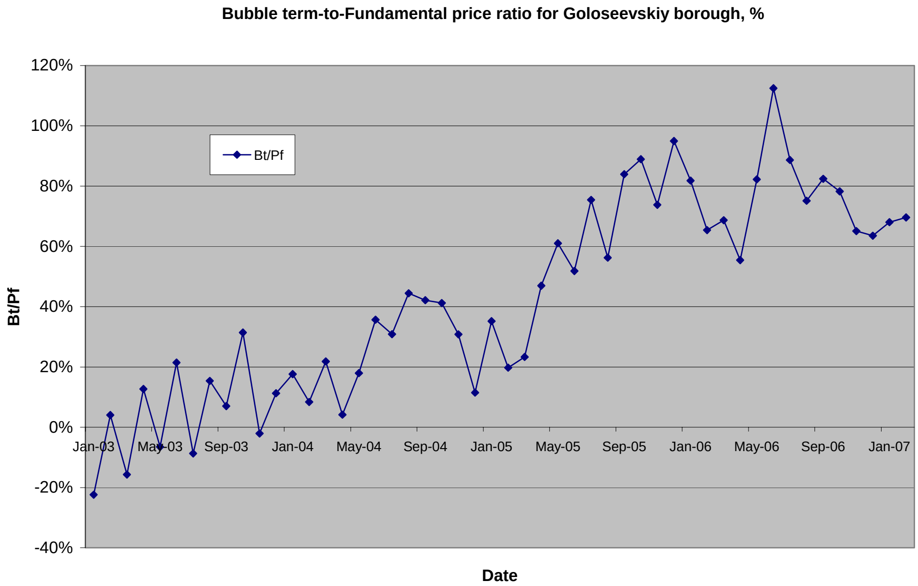


Figure 12

B. OBTAINED NET INTEREST RATES WITH NO-BUBBLE ASSUMPTION FOR ALL 10 KYIV DISTRICTS:

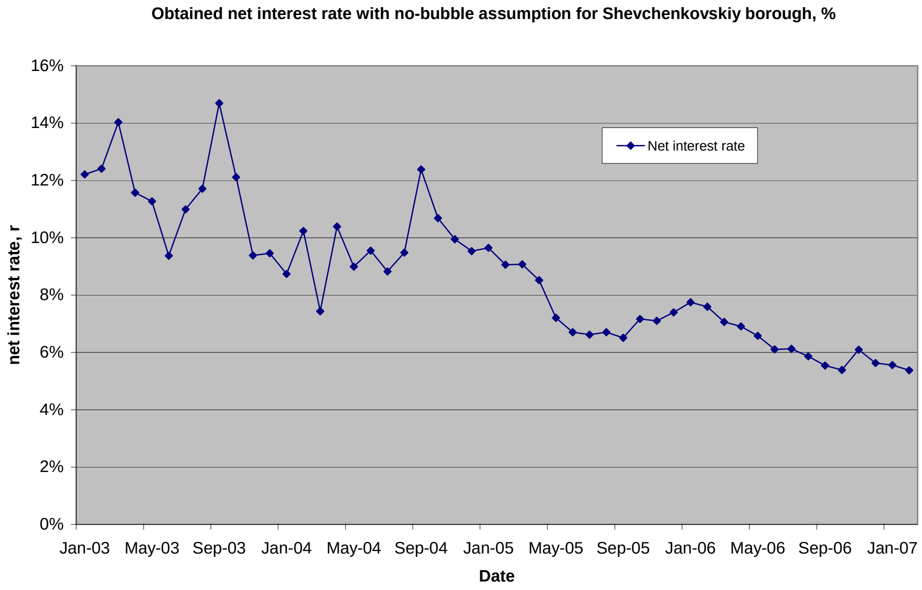
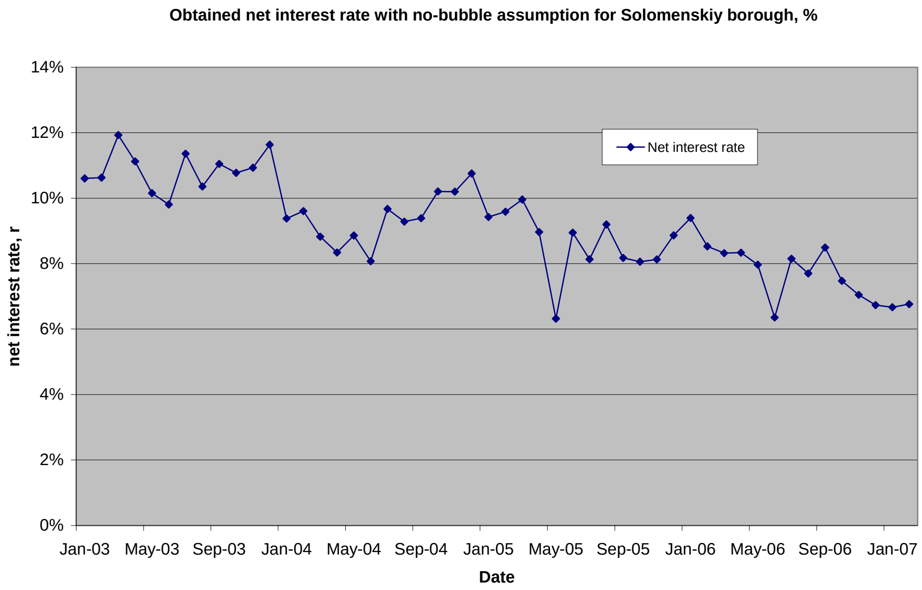


Figure 13



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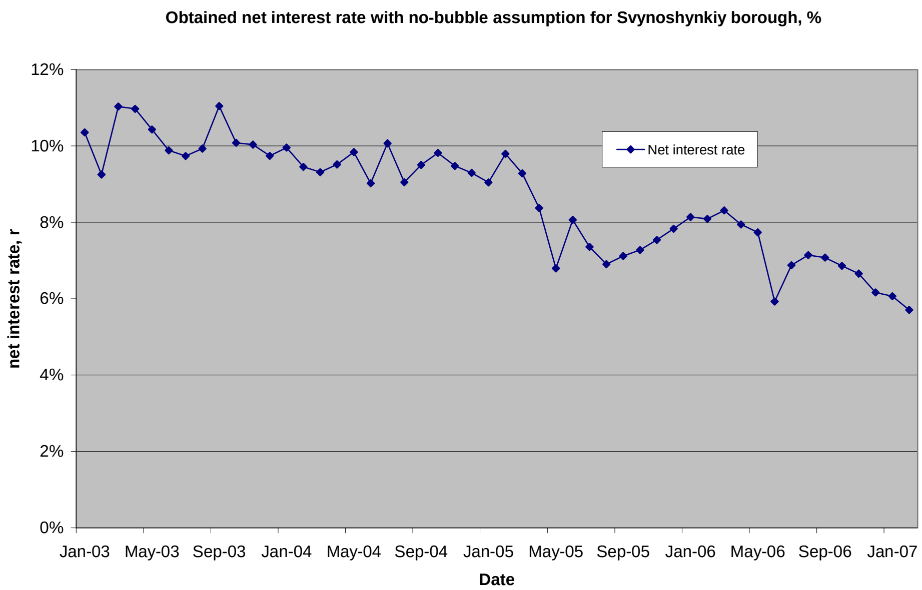

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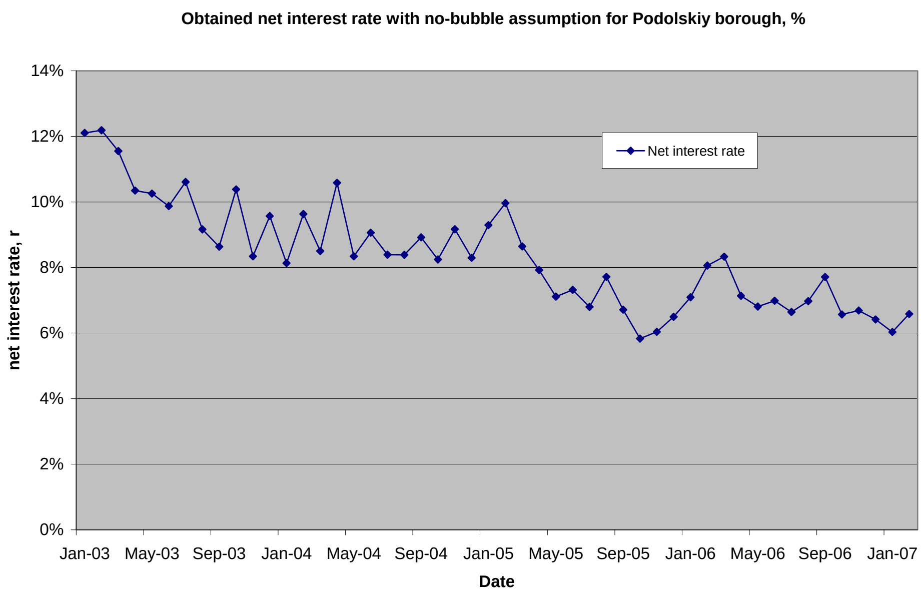


Figure 16

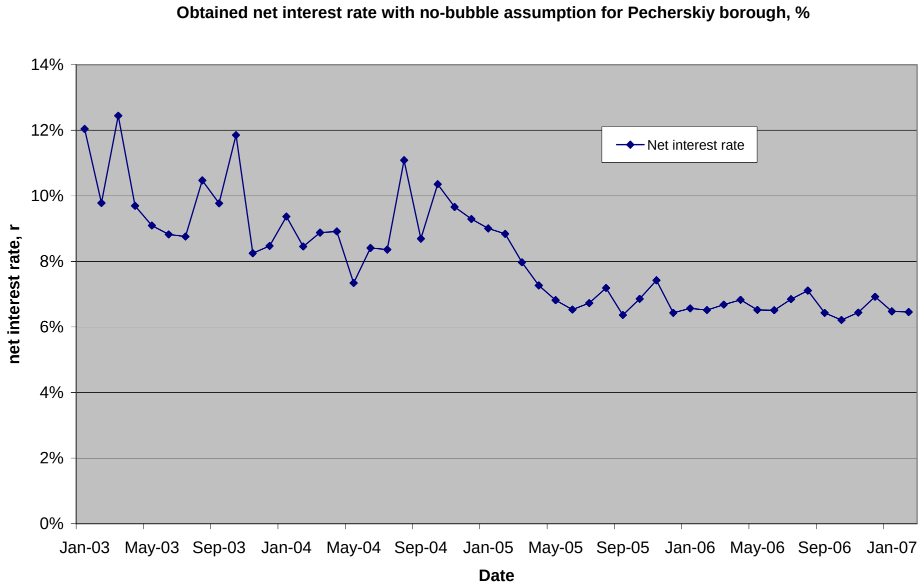


Figure 17

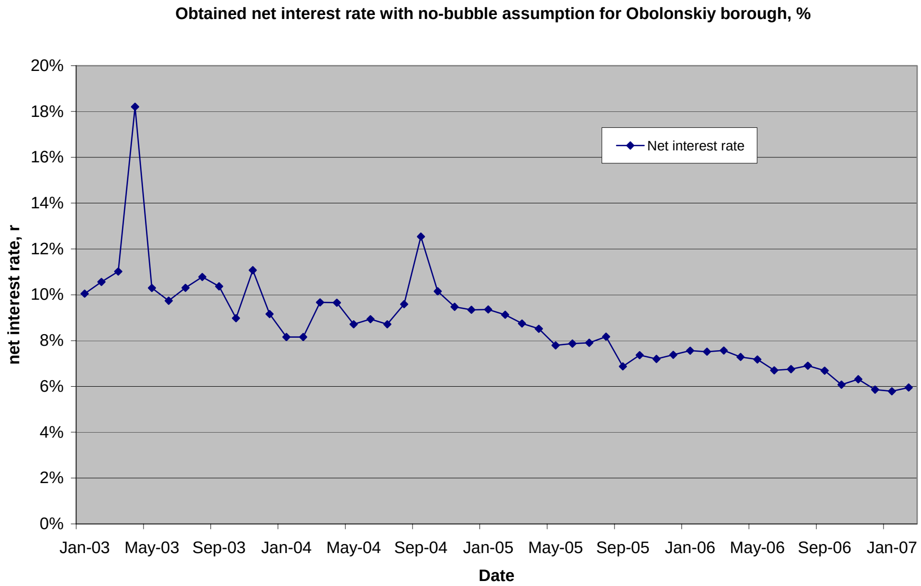
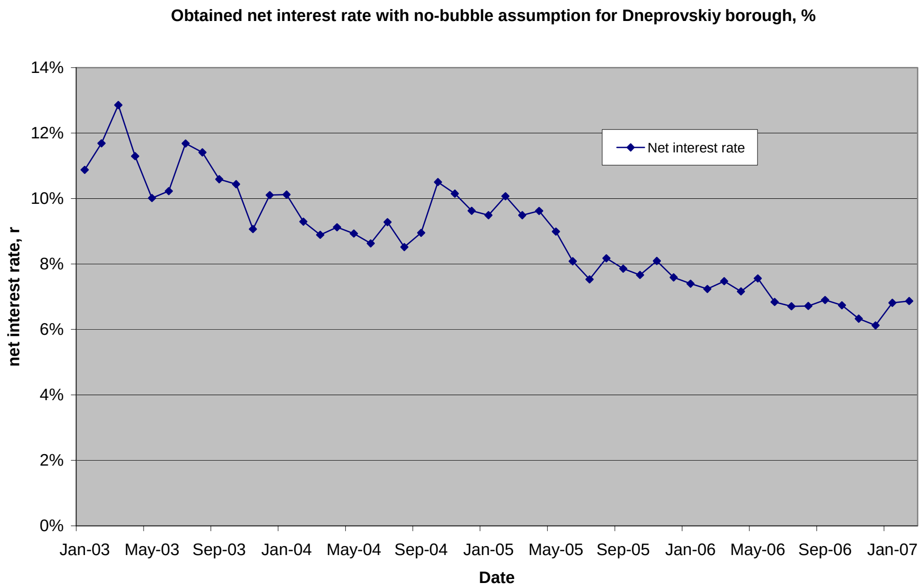


Figure 18



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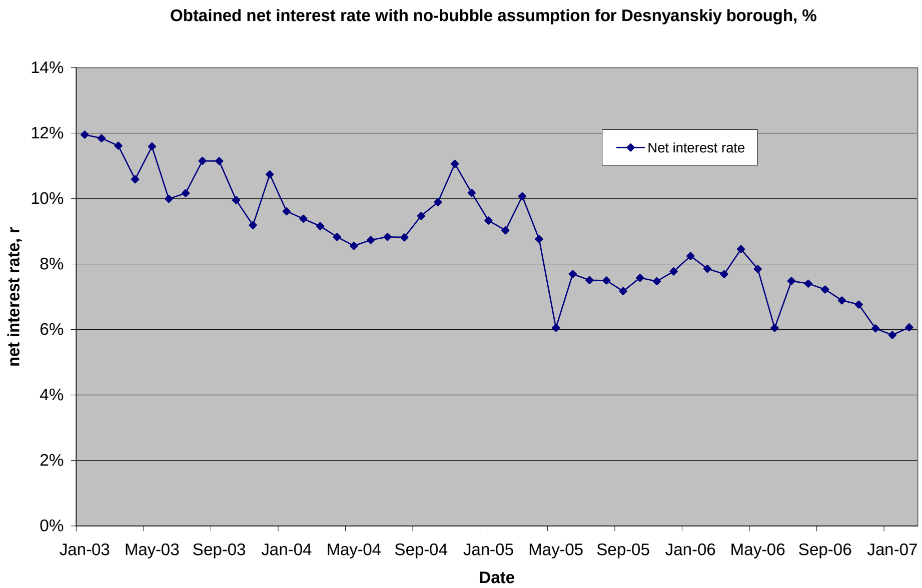

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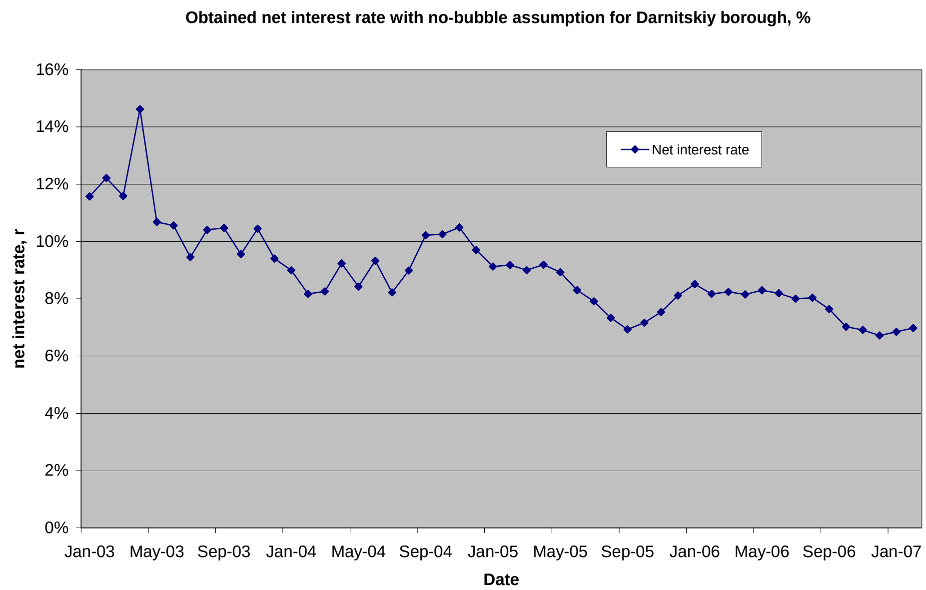

Figure 21

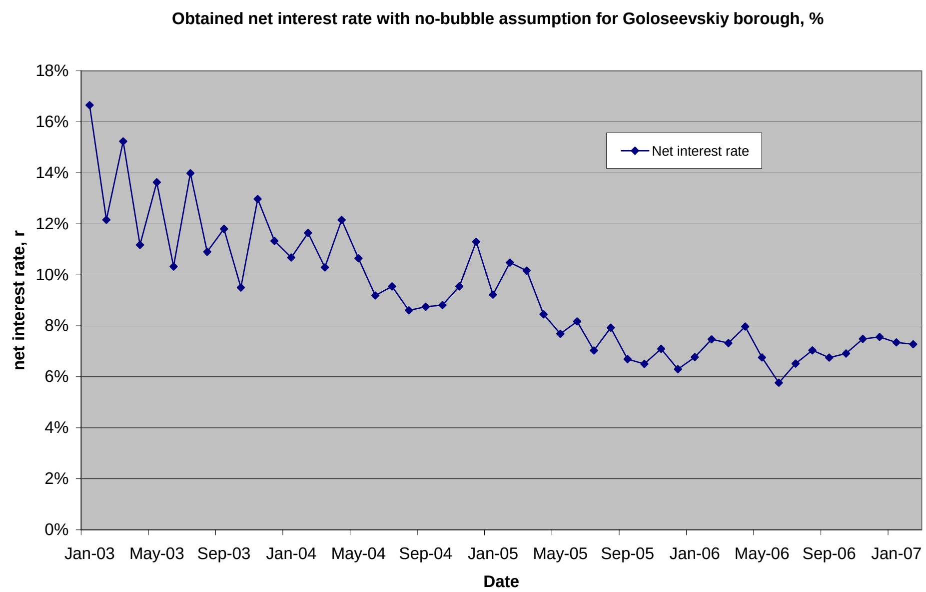

Figure 22