
ECONOMICS

Sociology

Radosław Trojanek, Dwelling's Price Fluctuations and the Business Cycle,
Economics & Sociology, Vol. 3, No 2, 2010, pp. 67-77.

Radosław Trojanek*Department of Investment and
Real Estate
Poznań University of Economics
r.trojanek@ue.poznan.pl***DWELLING'S PRICE FLUCTUATIONS
AND THE BUSINESS CYCLE***Received:* June, 2010*1st Revision:* September, 2010*Accepted:* October, 2010

ABSTRACT. The main aim of the paper is to identify the influence of business cycle in Poland on dwelling's price fluctuations on the secondary housing market in the years 1996- II q. 2009 in Poznań. The subject scope results from the aim of the paper and includes price fluctuations on the secondary housing market, involving both property rights and cooperative property rights for private accommodation.

JEL Classification: E32, P2**Keywords:** residential market, house price fluctuations, business cycle.**Introduction**

In this research only dwellings located in multifamily buildings are analyzed. The choice depends on two factors. Firstly, majority of dwellings are located just in multifamily buildings (blocks of flats – up to 90% in big Polish cities). Secondly, houses are characterized by a great differentiation regarding both quantitative and qualitative features, which requires that the data base should involve the appropriate information about each property in order to construct house price indexes. On the other hand the secondary housing market is greater than the primary market (approximately up to three times) taking into consideration the number of transactions.

The time scope involves the period of 1996 - II q. 2009 and is connected with the scope of empirical research on flat price level. Spatial scope of the research involves Poznań. The paper is divided into three parts. In the first part the time series components are analyzed. Then the methods of business cycles analysis are applied to house prices fluctuations on the local markets. The third part of the paper contains cooperative analysis of business cycle and fluctuation of flat's prices on local markets in Poznań in the years 1996-II q. 2009.

1. Time series' components

Empirical analyses the aim of which is to differentiate and characterize the changes occurring in macroeconomic variables are based on the assumption that the following elements may be distinguished in the structure of a time series¹:

- trend component,

¹ M.K. Evans, *Practical Business Forecasting*, Blackwell Publishing, Oxford 2003, p. 205.

- seasonal component,
- cyclical component,
- irregular component.

Trend is a long-time regular direction of changes (increase or decrease) of the value of examined variable. Trend can be used for object illustration of growth trend and facilitates retrospective description of examined factor in time. Trend is a result of operation of certain set of factors both objective and subjective ones, affecting examined variable.

Seasonal fluctuations are changes of intensity of economic activity that occur in one year time and which are the result of factors directly or indirectly depending on the year seasons. These fluctuations repeat regularly in one-year time and can be divided into two categories. The first type of seasonal fluctuations occurs in monthly, quarterly or half-year series and illustrates first of all an influence of year seasons and customs on economic activity. The second category of seasonal fluctuations are to be short-time oscillations that occur in one-month series. Their phases are presented within one day, twenty four hours, one week or one month. Main reasons for their occurrence are biological rhythm, customary division of labour, customs. In the majority of time series being subjects of economical analysis this type of fluctuations does not occur because examined series are available as monthly, quarterly, half-year or yearly data.

Irregular fluctuations result from indefinite chance causes that are not connected with the subject of the factor. Moreover, they are irregular when speaking both about their power and direction of activity. Main sources of these fluctuations are random events such as floods, draughts, earthquakes and political events such as wars and strikes.

Cyclical fluctuations are described as quite regularly repeated fluctuations, lasting more than one year and which are caused mainly by business cycle. Cyclical fluctuations result from economic factors, which makes difference between them and seasonal fluctuations.

Market of some goods, as well as the whole economy, fluctuate and mainly happen as consequences of business cycle. The same refers to property market. In time series of variables describing property market it is also possible to find trend, seasonal fluctuations, irregular fluctuations and cyclical fluctuations. These variables are the following: demand, supply and prices. Regarding prices on property market there can be: trend (in most cases trend is positive excluding Germany and Switzerland in 1975-2005 when real prices tended to decrease), seasonal fluctuations (increasing number of transactions during summer holidays), irregular fluctuations (decrease of flats' prices on flooded areas in Wrocław in 1997) and cyclical fluctuations resulting from economic factors that have an influence on behaviours of this market participants.

2. Methodology of isolation of business cycle and cyclical price fluctuations on the housing market

In this paper the methods of business cycles analysis were applied to house prices fluctuations on the local markets. Plurality of methods of business cycle measurement makes it difficult to determine the turning points and cycle phases. According to accepted procedure external image of the cycle, locations of turning points as well as the duration of phases will vary. In this paper there have been imposed some methods of business cycle measurement that have their theoretical background in new classic macroeconomic concepts. According to R. E. Lucas², business fluctuations are the set of moves around the trend determined by real GDP of the specific country. Such interpretation enables to measure the cycle as deviations from

² R. E. Lucas, *Understanding Business Cycles*, w *Business Cycle Theory*, red. F. E. Kydland, Edward Elgar Publishing Company, UK 1995, p. 85.

the trend. It is obvious that it refers only to business cycle. However, there are no obstacles to measure the subject of cyclical fluctuations for other economic variables identically. Then the trend will be searched within the series of variables other than GDP³.

Method of the cycle's measurement as deviations from the trend is used very often but it isn't the single one. Other basic methods of business cycle isolation are as follows: cycle of levels, cycle of growth, and cycle of deviations of growth rate from trend. The first method abuts on estimations of fluctuations on the basis of absolute quantities of selected measuring instruments referring to the level of economic activity. The second method is based on growth dynamic. The last concept composes growth rates with long-time trend.

The first step to isolate cyclical fluctuations is to delete from the prime series seasonal and irregular fluctuations. The most popular and most often used methods of time series smoothing are X-12 ARIMA⁴ and TRAMO-SEATS. The first method was worked out by the U.S. Bureau of the Census and the other one by V. Gomez and A. Marvall⁵. These tools join classic decomposition of time series to components connected with trend, seasoning and irregular factor with modeling of time series with the use of ARIMA models. Smoothing of time series by using these methods enables to eliminate seasonal fluctuations and irregular factors from the series.

In the concept of deviations from the trend an essential element is the way of determining the trend itself because a course of received fluctuations of market conditions is conditioned by the trend. Identification of cyclical oscillations with the use of this method is doubtful because of arbitrary choice of its function which may have an influence on final results. It has to be pointed out that this problem is connected with deterministic trend only⁶. According to easiness of calculations and clear economic interpretation linear function is used most often. Using such deterministic trend amounts formally to finding the following equation:

$$\hat{y}_t = \alpha_0 + \alpha_1 * t + \varepsilon_t; \quad (1)$$

where:

\hat{y}_t – theoretical trend values for variable y in the time t,

α_0 – estimator of parameter of trend's linear function defining a level of effects in the time t=0,

α_1 – estimator of parameter of trend's linear function defining an average increase of the value of effect in question,

ε_t – summand of remainder.

Assumption of linearity of trend's function causes that any element disturbing formation of real property prices is of short-time character. It is assumed, however, that after some time an influence of disturbing factor will be neutralized and prices return to permanent growth line resulting from long-time linear trend. The most important factor of long-time changes of real estate's prices are certainly changes in demand for property services. They depend mainly on economic situation of the economy thus tickling directly households – mainly their incomes and access to financing which is connected with mortgage loans rates. If we use linear function to describe trend of prices on real estate market, α_1 estimator informs about an average price increase. Considering the fact that GDP cannot be recognized as permanent

³ M. Kruszka, *Wyodrębnianie wahań cyklicznych*, Warsztaty Makroekonometryczne, AE Poznań 2002, p.2.

⁴ D.F. Findley, B.C. Monsell, W.R. Bell, M.C. Otto i B. Chen, *New Capabilities and Methods of the X-12 ARIMA Seasonal Adjustment Program*, Journal of Business and Economic Statistics 1998, vol. 16, pp. 127-152.

⁵ V. Gomez, A. Marvall, *Programs TRAMO (Time series Regression with Arima noise, Missing observations, and Outliers) and SEATS (Signal Extraction in Arima Time Series). Instructions for the User*, Banco de Espana, Working Paper 1996, nr 9628.

⁶ M. Kruszka, *Synchronizacja wahań koniunkturalnych w gospodarce krajów rozwiniętych*, Wiadomości Statystyczne 2003, nr 6, pp. 1-15.

changing rate process an assumption of linear trend to separate fluctuations of real flat prices would not be proper. Furthermore, negation of linear function as good approximation for trend of macroeconomic variables results also from formal statistical reasons. Nelson and Plosser⁷ made empirical investigations that demonstrated that in the dynamic of the majority of time series exists random walk with drift. Then the formal entry of such course is as follows:

$$y_t = \mu + y_{t-1} + \varepsilon_t; \quad (2)$$

where:

y_t – empiric values y in the time t ,

ε_t – as in the equation ,

μ – constant representing the drift ($\mu > 0$).

Taking into consideration this element it can be stated that single disturbance of previous growth path will cause its permanent distortion. Acceptance of the thesis about formation of time series, as well as flats' prices⁸, according to random walk with drift causes that the description of analyzed phenomenon with the use of linear trend is more and more complicated as it is changeable in time. It is more difficult to differentiate the trend from cyclical fluctuations as random walk causes that trend is also deviated⁹. Authors of the concept of real business cycle proposed statistical methods that can solve this problem. These methods are based on assumption that cyclical summand of variable y is a difference between its current value and a measure showing the value of the trend; the trend is weighted average of past, current and future observations¹⁰:

$$y_t^c = y_t - \tau_t - \sum_{j=-J}^J a_j * y_{t-j}; \quad (3)$$

where:

y_t^c – cyclical summand of variable y in the time t ,

τ_t – stochastic (random) trend value.

This method, named the Hodrick-Prescott (HP) filter, allows calculating value τ_t , which minimize the expression:

$$\sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2; \quad (4)$$

where:

λ – smoothing parameter.

Smoothing parameter exposes various values depending on frequency of the phenomenon. If we have yearly data $\lambda=400$, for quarterly data $\lambda=1600$, and for monthly data $\lambda=14400$ ¹¹. The higher values of λ parameter, the more "flat" is the whole trend. It follows that if λ approaches infinity, using the filter we receive the same values as if we use linear trend¹². The most important limit of the presented filter is demanded minimal length of time serial that is being filtered. In practice minimal number of observations is 32.

⁷ C.R. Nelson, C.I. Plosser, *Trends and Random Walks in Macroeconomic Time Series; Some Evidence and Implications*, Journal of Monetary Economics 1982, vol. 10, p. 139-162.

⁸ M.-C. Chen, Y. Kawaguchi, K. Patel, *An Analysis of the Trends and Cyclical Behaviours of House Prices in the Asian Markets*, Journal of Property Investment & Finance 2004, vol. 22, nr 1, pp. 55-75.

⁹ *Wskaźniki wyprzedzające jako metoda prognozowania koniunktury w Polsce*, red. nauk. M. Rekowski, Wyd. AE w Poznaniu, Poznań 2003r., pp. 100-101.

¹⁰ M. Kruszka, *Synchronizacja wahań koniunkturalnych w gospodarce krajów rozwiniętych*, Wiadomości Statystyczne 2003, nr 6, pp. 1-15.

¹¹ M.K. Evans, *Practical Business Forecasting*, Blackwell Publishing, Oxford 2003, p.v205.

¹² T. Cogley, J.M. Nason, *Effects of the Hodrick-Prescott Filter on Trend and Difference Stationary Time Series: Implications for Business Cycle Research*, Journal of Economic Dynamics and Control 1995, vol. 19, pp. 253 - 278.

The serial received after using the HP filter shows long-time growth tendency of the variable that is not deterministic function but is being changed itself in time. In order to isolate cyclical fluctuations empiric values of the variable should be divided by estimations received by using the HP filter (and multiplied by 100); then we received the serial showed percentage fluctuations from the trend¹³.

3. Data used in the research

Dwellings prices indexes per square metre in Poznań were constructed with a mix-adjustment method. From theoretical point of view the aim of this method is to define the pure change flat price. The data on asking prices used to construct flat price indexes were collected in the years 1996 - II q2009. As a result of methodological processes (repeated sales offers were omitted – this phenomenon of repeated offers was caused by reporting them to more than one agency.) the quantity of base data decreased half as much and amounted to 100000 in Poznań. The number of collected offers satisfies the condition of representative sample. In the Diagram 1 nominal and real flat prices indexes in Poznań in the years 1996- II q 2009 are presented.

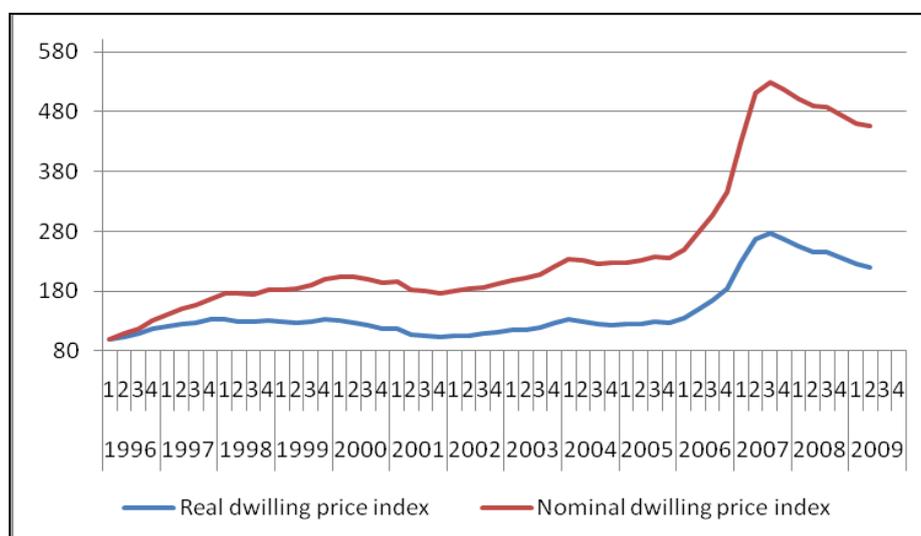


Diagram 1. Nominal and real flat price indexes in Poznań in the years 1996- IIq 2009 (Iq 1996 = 100)

Source: Based on own calculations.

The analysis of chart 1 shows that nominal flat price indexes in Poznań increased by 350%, during the years 1996- IIq 2009. It is worth noticing that real flat price indexes in Poznań increased only by 120%. In Poznań particularly rapid growth took place in the year 2006. The rapid growth resulted from many factors. Firstly, the market was informed about the possibility of increasing V.A.T. (value addend tax) by 22%. Thus only those flats that were built just at that moment were burdened with 7% V.A.T. Secondly, the other important information was that the year 2006 was the last year to use tax relief. Taking into consideration the above mentioned facts it seems that rapid growth of demand met fixed supply and resulted in huge flat price growth in the year 2006. Thirdly, there was a big

¹³ In the situation when variables (free of seasoned fluctuations and any other chances) are logarithmed, in order to isolate cyclical fluctuations we should subtract empiric values of the variable by estimation resulted from use of the HP filter and multiply by 100.

mortgage affordability at that time in Poland. Fourthly, Polish economy was in good condition. Moreover, there was speculative capital doing business on the market and behavior of many buyers was irrational.

In the empirical research on contemporary business fluctuations two macroeconomic indicators are used most frequently: sold production of industry and GDP. In the paper GDP measure was accepted to identify the business conditions processes occurring in the Polish economy in years 1996-IIq. 2009. The basic element of the GDP as regards generation is the sum of gross value added of all sectors of the national economy. The data for the GDP were studied every quarter come from the publications of the Central Statistical Office. The data on dwellings prices and GDP were converted into fixed prices of I q. 1996.

4. Business cycle and fluctuations of dwelling' prices on housing markets in Poznań

Business cycle and cyclical fluctuations of flat prices on the real estate market in Poznań were determined as deviations from the stochastic (random) trend. The very first step in the process of determination of the fluctuation was to make real (for the first quarter of 1996) flat price indexes in the years 1996-IIq 2009. Then the serial of real prices of 1 m² of flat was decomposed into the following components:

- seasonal fluctuations,
- irregular fluctuations,
- fluctuations of both trend and cyclical,
- stochastic (random) trend.

Firstly, seasonal and irregular fluctuations were eliminated using X-12 ARIMA procedure. Basing on the final curve of fluctuations of both trend and cyclical (Henderson curve) there was estimated stochastic trend (with the use of the HP filter). It was the last stage of decomposition of analysed serial that enabled to determine cyclical fluctuations. The serial presenting cyclical fluctuations measured as a deviation cycle was determined by dividing the value of fluctuation of both trend and cyclical by proper values generated by the HP filter. Such serial was multiplied by 100% to receive percentage deviations from the trend curve. Diagram 2 and 3 presents business cycle in Poland and cyclical fluctuations of real prices of 1 m² of flat in Poznań in 1996-II q 2009.

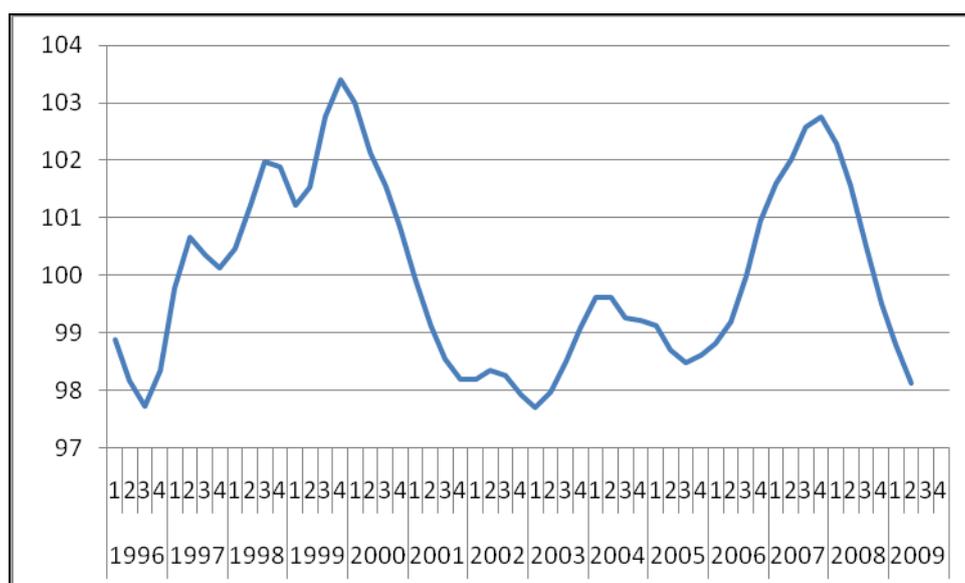


Diagram 2. Business cycle fluctuations in Poland in the years 1996 – IIq 2009 (in %)

Source: Based on own calculations.

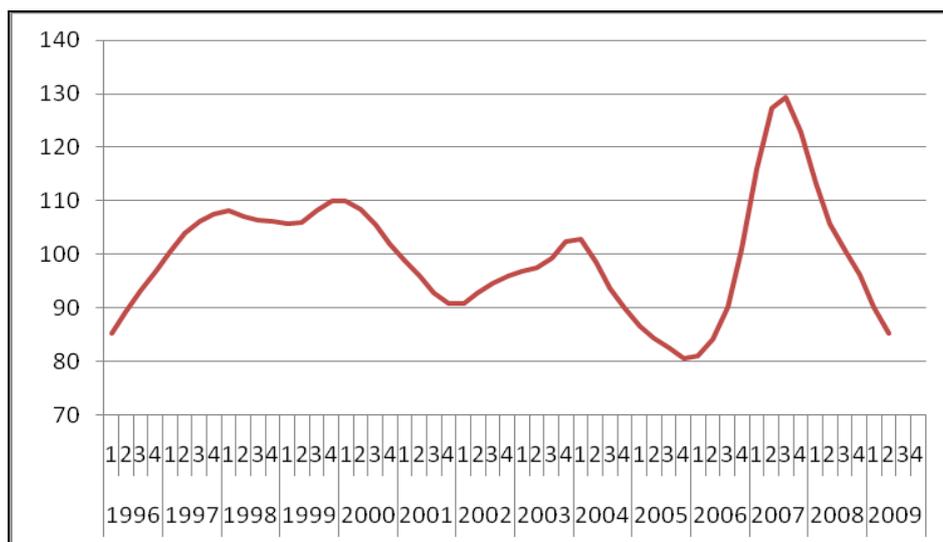


Diagram 3. Cyclical fluctuations of real flat price index in Poznań in the years 1996–IIq 2009 (in %)

Source: Based on own calculations.

Fluctuations mentioned above were the basis for further analyses. The aim was to identify connections between business cycle and dwellings price fluctuations. The achieved results does not allow to compare these fluctuations directly. This stems from the fact that variables are not presented on comparable scales. In order to eliminate this obstacle the variables (BC and DPF) were subject to standardization using formula given by equation:

$$x_i^N = \frac{(x_i - X_i)}{\sigma};$$

where:

x_i – variable value,

X_i – mean average,

σ – standard deviation.

The results of this procedure are presented in the Diagram 4.

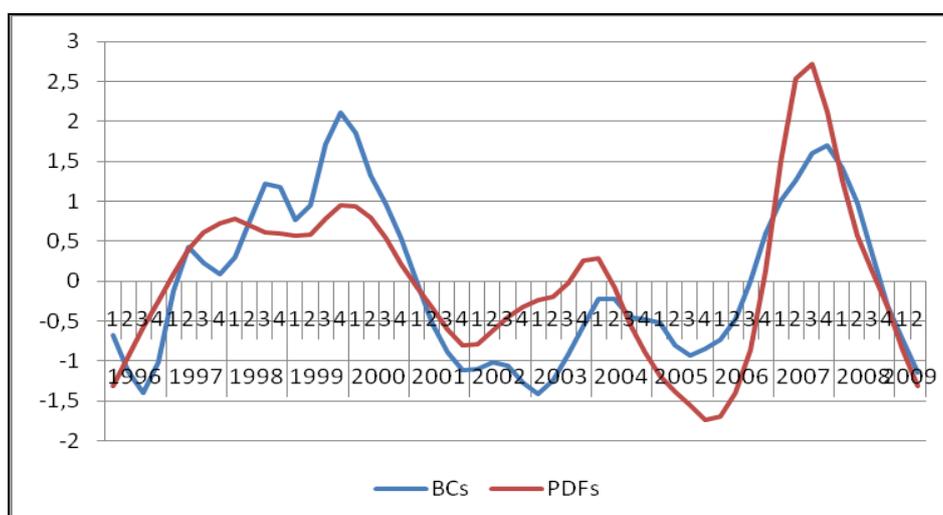


Diagram 4. Business cycle and dwellings price fluctuations after standardization

Source: Based on own calculations.

Fluctuations mentioned above were the basis for further analyses. The aim was to determine morphologic attributes of these fluctuations. It was assumed in the analysis that the upper (lower) turning point appears in the period when the value of the analyzed indicator reaches its maximum (minimum). After establishing the turning points it was possible to differentiate the phases of the business cycles. Therefore, each cycle consists of an increase phase (between the lower and upper turning point) and a decrease phase (between the upper and lower turning point). Restrictions were imposed to ensure that the periods of increases and decreases had a minimum length of four quarters in order to avoid spurious cycles¹⁴. Table 1 presents morphologic of cyclical fluctuations of prices of 1 sq.m of flat attributes in Poznań in 1996-II 2009.

Table 1. Morphologic of cyclical fluctuations of prices of 1m² of flat in Poznań in 1996-2009

Attributes of cycle	Phases of cyclical fluctuations					
	increasing	decreasing	increasing	decreasing	increasing	decreasing
	Within the time					
	up to IV 1999	I 2000-IV 2001	I 2002 - I 2004	II 2004 - IV 2005	I 2006- III 2007	IV 2007 -
Length in quarters						
phases	min. 16	8	9	7	7	min. 7
cycle	min. 24		16		min. 15	

Source: Based on own calculations.

In 1996 -IIq2009 on the secondary housing market in Poznań it was possible to observe two increasing and two decreasing phase. The beginning of increasing phase (it ends in the fourth quarter of 1999) cannot be specified because cyclical fluctuations of prices of 1 sq.m of flat before 1996 are unknown and in the time from the first quarter of 1996 up to the fourth quarter of 1999 the bottom turning point was not found. It can only be assumed, however, that increasing phase lasted minimum 16 quarters and cycle of flat prices on the real estate market in Poznań – that ended in the fourth quarter of 2001 – lasted minimum 24 quarters. In the first quarter of 2002 the next increasing phase began that ended in the first quarter of 2004. After that two phases can be distinguished that lasted 7 quarters each (one decreasing and one increasing). In the fourth quarter of 2007 next decreasing phase begun. Table 2 presents morphologic of business cycle in Poland in 1996-II 2009.

Table 2. Morphologic of business cycle in Poland in 1996-II q.2009

Attributes of cycle	Phases of cyclical fluctuations					
	increasing	decreasing	increasing	decreasing	increasing	decreasing
	Within the time					
	IV 1996- IV 1999	I 2000- I 2003	II 2003 - I 2004	II 2004 - III 2005	IV 2005- IV2007	I 2008 -
Length in quarters						
phases	13	13	4	6	9	min. 6
cycle	26		10		min. 15	

Source: Based on own calculations.

¹⁴ N. Girouard, M. Kennedy, P. van den Noord, Ch. André, *Recent House Price Developments: The Role of Fundamentals*, Economics Department Working Papers No. 475, rok 2008, p. 195.

In 1996 – IIq 2009 in the Polish economy it was possible to observe three increasing and two decreasing phases. The increasing phase lasted 13 quarters and business cycle – that ended in the first quarter of 2003 – lasted minimum 26 quarters. In the second quarter of 2003 the next increasing phase began that ended in the first quarter of 2004. After that two phases can be distinguished that lasted 6 and 9 quarters (one decreasing and one increasing). In the first quarter of 2008 next decreasing phase began.

Comparing cyclical fluctuations of flat prices in Poznań and business cycle fluctuations in Poland in 1996- IIq 2009 we can find some similarities. Both fluctuations had similar course but were not identical.

The next step of analysis was to identify the influence of business cycle in Poland on local housing market in Poznań in 1996-IIq 2009. Considering theoretical point of view every time series is a set of random variable. Organized over time set of random variables is a stochastic process. Important type of stochastic process is stationary stochastic process and linker with it idea of stationary time series¹⁵. In case of using non stationary spurious regression may happen. Spurious regression means that non stationary implies that variables which are not related in the causality terms may seem to be influencing each other if model is estimated on their basis¹⁶. In order to determine stationarity of analyzed time series ADF and KPSS¹⁷ tests were used. In the ADF test zero hypothesis assumes non stationarity (existence of unit root) against alternative hypothesis stating that there's stationarity¹⁸. In case of KPSS test zero hypothesis assumes stationarity while alternative existence of unit root.

In this case both ADF unit root test with intercept KPSS stationarity test with intercept. In the ADF test zero hypothesis assumes non stationarity (existence of unit root) against alternative hypothesis stating that there's stationarity. In case of KPSS test zero hypothesis assumes stationarity while alternative existence of unit root.

Results of ADF test suggests rejection of null hypothesis about existence of unit root at 5 % significance level in case of variables: business cycle and dwellings price fluctuations. Results of KPSS test do not allow to reject hypothesis about stationarity in case of all considered variables at 5 % significance. This allowed to assume that all analyzed time series were stationary. Stationarity of variables made possible development of multiple regression model.

In order to define the influence of business cycle (BC) on dwellings price fluctuations (DPF) in Poznań, first the variables were logarithmed and then the equation was estimated.

$$\text{DPF} = -20,06 + 5,35\text{BC}; \\ R^2=0,63, \bar{R}^2=0,62$$

Diagram 5 presents estimated and empirical fluctuations of prices per 1m² dwelling in Poznań in the period 1996 - IIq 2009.

¹⁵ G.S. Maddala, *Ekonometria*, Wyd. Naukowe PWN, Warszawa 2006, ss. 578-579.

¹⁶ A. Welfe, *Ekonometria*, PWE, Warszawa 2003, ss. 348-349.

¹⁷ D. Kwiatkowski, P. Phillips, P. Schmidt, Y. Shin, *Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root*, Journal of Econometrics 1992, vol. 54, issue 1/2/3, ss. 159-178.

¹⁸ J.B. Gajda, *Ekonometria*, Wyd. C.H. Beck, Warszawa 2004, s. 150.

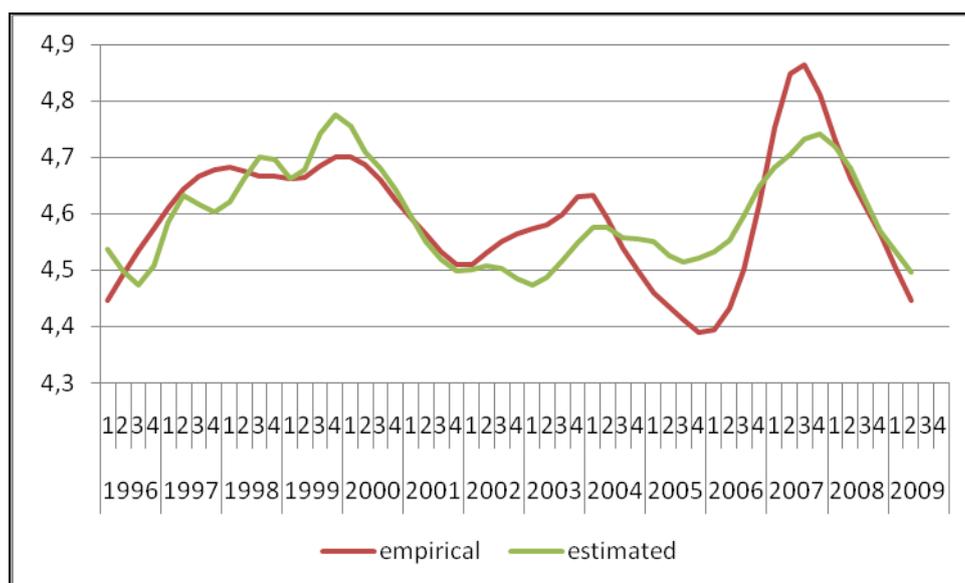


Diagram 5. Estimated and empirical fluctuations of prices per 1m² dwelling in Poznań in the period 1996 - IIq 2009

Source: Based on own calculations.

Adjusted r squared equals to (0,62) which implies that oscillations of prices per 1m² of dwelling in Poznań for the period 1996 – IIq 2009 are explained in 62 % by business cycle. Variable BC and constant are significance at 1% level.

Conclusion

The main aim of the paper was to identify the influence of business cycle in Poland on dwelling's price fluctuations on the secondary housing market in the years 1996- II q. 2009 in Poznań. Comparing cyclical fluctuations of flat prices in Poznań and business cycle fluctuations in Poland in 1996- IIq 2009 we can find some similarities. Both fluctuations had similar course but were not identical. Moreover simple regression equation implies that over 60% of dwellings price fluctuations may be explained by business cycle in Poland. It demonstrates there are persistent forces that link residential local market to business cycle, plus mechanisms internal to residential market, that make the dwelling price cycle more than a simple reflection of that in the economy.

References

- C.R. Nelson, C.I. Plosser, *Trends and Random Walks in Macroeconomic Time Series; Some Evidence and Implications*, Journal of Monetary Economics 1982, vol. 10
- D.F. Findley, B.C. Monsell, W.R. Bell, M.C. Otto i B. Chen, *New Capabilities and Methods of the X-12 ARIMA Seasonal Adjustment Program*, Journal of Business and Economic Statistics 1998, vol. 16
- M. Kruszka, *Synchronizacja wahań koniunkturalnych w gospodarce krajów rozwiniętych*, Wiadomości Statystyczne 2003, nr 6
- M. Kruszka, *Wyodrębnianie wahań cyklicznych*, Warsztaty Makroekonometryczne, AE Poznań 2002
- M. Lubiński, *Analiza koniunktury i badania rynków*, Dom Wydawniczy Elipsa, Warszawa 2002

- M.-C. Chen, Y. Kawaguchi, K. Patel, *An Analysis of the Trends and Cyclical Behaviours of House Prices in the Asian Markets*, *Journal of Property Investment & Finance* 2004, vol. 22, nr 1
- M.K. Evans, *Practical Business Forecasting*, Blackwell Publishing, Oxford 2003
- N. Girouard, M. Kennedy, P. van den Noord, Ch. André, *Recent House Price Developments: The Role of Fundamentals*, Economics Department Working Papers No. 475, rok 2006
- R. E. Lucas, *Understanding Business Cycles*, w *Business Cycle Theory*, red. F. E. Kydland, Edward Elgar Publishing Company, UK 1995
- T. Cogley, J.M. Nason, *Effects of the Hodrick-Prescott Filter on Trend and Difference Stationary Time Series: Implications for Business Cycle Research*, *Journal of Economic Dynamics and Control* 1995, vol. 19
- V. Gomez, A. Marvall, *Programs TRAMO (Time series Regression with Arima noise, Missing observations, and Outliers) and SEATS (Signal Extraction in Arima Time Series). Instructions for the User*, Banco de Espana, Working Paper 1996, nr 9628.