ANALYSIS OF ECONOMIC ACTIVITY MOVEMENTS IN THE CZECH REPUBLIC – FREQUENCY APPROACH

Poměnková Jitka
Wydział Finansów, MUAF
e-mail: pomenka@mendelu.cz

Abstract The primary purpose of this work is to identify the business cycle types in the Czech Republic. In the light of business cycles problematic, and viewed from the frequency analysis perspective, harmonic analysis will be used. From the range of de-trending techniques, the first order difference, linear filtering, unobserved component model and Hodrick-Prescott filter are used. In the case of Hodrick-Prescott filter, a cyclical fluctuation estimate with the derivation of smoothing parameter designed specially for the Czech Republic case is investigated. The aim is to distinguish types of cyclical fluctuations in the Czech Republic. A consequent analysis of potential sources of cyclical movement is done.

Keywords: harmonic analysis, deterministic trends, stochastic cycles, economic activity, business cycle

INTRODUCTION

In many studies, the economic activity of a country is discussed in respect to the business cycle theory. Recall for example Canova (1998, 1999) business cycle study from de-trending and dating turning-points points of view; also King and Rebelo (1993) using the Hodrick – Prescott (HP) filter in time and frequency domain or Harding and Pagan (2006) with the description of different measuring ways of business cycle. There is a variety of approaches to de-trending methods, approximations between filtering methods and effects of used techniques on obtained results. Nevertheless, the empirical analysis results are different from the data approach results. The correctness of the business cycle identification consists of stabilization function of monetary and fiscal policy.

Most of these studies work with advanced market economy, like the US economy having at disposal a large data sample size. The case of the Czech Republic is different. The type of economy in this country is denoted as transition because the economy was transformed from a central planned economy into a

market economy with shocks, structural breaks and with a small sample size of available data.

Notice that a series of works are motivated by the European Union enlargement when countries study their transition economies, separately or in comparison with Euroarea, comovement as well as aspects of evolution of domestic economy. Recall for example the work of Artis & all (2004) or Szapáry and Darvas (2008). The work of Wozniak and Paczinski (2007) using the finite order AR model for the calculation of time series spectra belongs to the topical (contemporary) pieces. Furthermore, Hallet and Richter (2004) examined the time-frequency framework in a way which allows to accommodate structural breaks and non-stationary variables.

Thus, this paper focuses on the business cycle in the Czech Republic from the frequency domain point of view using harmonic analysis for identifying possible types of cycles. Available data are the quarterly values of Gross Domestic Product (GDP) 1996/Q1 – 2008/Q3. Consequently, the analysis of potential sources of cyclical movement is done. The identification of sources of cyclical movements can significantly contribute to the effectiveness of economic policy during the economic activity stabilization.

EXPERIMENTAL PROCEDURES

The standard theory of Burns and Mitchel (1946) business cycle is used: "Business cycles are a type of fluctuations found in the aggregate economic activity of nations that organise their work mainly in business enterprises: a cycle consists of expansion occurring at the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; in duration business cycles vary from more than one year to ten to twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own." There exist two approaches to the business cycle. The first one is called the classical business cycle and is based on a fluctuation in the level. The second one is known as the growth cycle and is based on a fluctuation around a trend. The dating of cycles is usually done by identifying turning-points. The time period is usually too short; full of structural breaks and shocks. On the other hand, the growth cycle, where turning-points are characterized by changes relative to the trend, represents a more promising version of the business cycles (Artis & col, 2004). And, the dating procedure of the growth cycle is less sensitive to the growth trend than that of the classical cycle.

In the field of business cycle, cyclical movements of time series which exhibit trends and cycles are studied. If the models are designed to characterize the cyclical behavior, the trends are eliminated prior to the analysis. It is often useful to

build a model where both trend and cyclical behavior are in the model and eliminate the trend from the model and from the actual data in parallel fashion. The specification of the model is subject to the constraint that it must successfully characterize the trend behavior. Having satisfied the constraint, trends are eliminated appropriately and the analysis proceeds with an investigation of cyclical behavior. The isolation of cycles is closely related to the trends removal. Indeed, for time series exhibiting cyclical deviations around a trend, the identification of the trend automatically provides identifying the cyclical deviations as well. Notice that the removal of the trend will leave such fluctuation intact, and its presence can have a detrimental impact on inferences involving business cycle behavior.

In this paper, economic activity is measured by absolute values of GDP transformed to the natural logarithms and denoted as Y_t. For the analysis of business cycle, the additive decomposition method in the form

$$Y_t = g_t + c_t, \ t = 1, \dots, n, \qquad (1)$$

is used. There are three main approaches to removing the time trend from macroeconomic time series. The first two approaches to the trend removal are de-trending and differencing. De-trending is usually accomplished by fitting the linear trend to log input values using the ordinary least square method (OLS). The third approach to de-trending involves the use of filters designed to separate the trend from the cycle, but given admission of slowly evolving trend. We use the Hodrick – Prescott filter, which has proven quite popular in business cycle applications. Thus, the set of chosen de-trending method is the following: the first order difference (FOD), autoregression with/without a constant (AR), regression analysis (linear and quadratic trend) and Hodrick – Prescott filter (HP filter).

In our paper, we are not discussing whether these methods are "the best" for the trend removing, or which one is more or less suitable and why. We just take some of standard methods, for example Canova (1998), Baxter and King (1999), Hodrick and Prescott (1980) or books Mills (2003) or Dejong, Chetan (2007), and search for statistically significant periods. The use of several methods for de-trending provides a robust periodicity analysis in the sense of cyclical movement source identification. As calculating the FOD as well as the estimating process of random walk with/without a drift and regression curve using the OLS are well known, we are not going to discuss it in detail. In the case of resultant deterministic models, a quadratic model and the AR (with or without a constant) were chosen according to the standard statistical techniques for the quality model evaluation

The procedure of HP filter was first introduced by Hodrick and Prescott in 1980 in the context of estimating business cycles. The HP filter decomposes Y_t (macroeconomic time series) into a nonstationary trend g_t (growth component) and a stationary residual component c_t (cyclical component)

$$Y_t = g_t + c_t, \; t=1,...,n,$$

where g_t and c_t are unobservables. The measure of the g_t path smoothness is the sum of the squares of its second difference. The application of HP filter involves minimizing the variance of cyclical component subject to a penalty for the variance in the second difference of growth component

$$\min_{\{g_t\}_{t=1}^{T}} \sum_{t=1}^{T}(Y_t - g_t)^2 + \lambda \sum_{t=1}^{T}\left[(g_{t+1} - g_t) - (g_t - g_{t-1})\right]^2 ,$$

where $c_t = Y_t - g_t$. The parameter λ is a positive number which penalizes variability in the growth component series. As Harvey and Jager (1993) have shown, the infinite sample version of the HP filter can be rationalized as the optimal linear filter of the trend component. King and Rebelo (1993) find that the business cycle component and the second difference of the growth component must have the same moving average representation for the HP filter to be a linear filter which minimizes the mean squares error. That is, this filter minimizes the mean square error

$$MSE = (1/T)\sum_{t=1}^{T}\left(ets(c_t) - c_t\right)^2 ,$$

where c_t is the true cyclical component and $est(c_t)$ is its estimate. Hodrick and Prescot found that if the cyclical component c_t and the second difference of growth component g_t ($\Delta^2 g_t$) are identically and independently distributed normal variables, $c_t \sim N(0, \sigma_c^2)$, $\Delta^2 g_t \sim N(0, \sigma_g^2)$, then the best choice in the sense of MSE for the smoothing parameter is $\lambda = \sigma_c^2 / \sigma_g^2$. In many papers, the recommended lambda value for the quarterly data is $\lambda=1600$, see Ahumada, Garegnani (1990), Guy, St-Amant (1997), Hodrick-Prescott (1980) and others. On the basis of this let us formulate the rule which helps us to find the optimal smoothing parameter.

Let us have an input time series of positive values Y_t, $t=1,...,n$, a set of lambdas $L = [100/n; 100 \cdot n]$ and an indexed set $I = [1,..., length(L)]$. Thus, for every $L_i \in L$, $i \in I$ we can calculate the Hodrick – Prescott estimate of growth and cyclical components of Y_t. Let the cyclical component c_t and the second difference of growth component g_t ($\Delta^2 g_t$) be identically and independently distributed normal variables, $c_t \sim N(0, \sigma_c^2)$, $\Delta^2 g_t \sim N(0, \sigma_g^2)$. Thereafter, the optimum value of smoothing parameter λ is such that

$$\lambda_{opt} = \sigma_c^2 / \sigma_g^2 \Leftrightarrow L_i \approx \sigma_c^2 / \sigma_g^2, \quad \text{for any } i \in I$$

where the difference $d = \left| L_i - \sigma_c^2 / \sigma_g^2 \right| \leq 100/n$.

For the periodicity analysis in the time series, the following harmonic analysis was used. After removing the trend T_t, residuals were obtained, i.e.

$$e_t = Y_t - T_t, t = 1,...,n.$$

For the analysis of random sequence in the form

$$e_t = \mu + \sum_{j=1}^{n/2} (a_j \cos(\omega_j t) + b_j \sin(\omega_j t)) + \varepsilon_t, t = 1,...,n,$$

where μ, a_j, b_j and ω_j $(0 < \omega_j \leq \pi)$ are unknown parameters, e_t is stationary process, a periodogram is usually used. In points $\omega_1,..., \omega_r$, the periodogram constructed for a given sequence of realization has relatively big values, and thus makes it possible to find estimates of the parameters $\omega_1,..., \omega_r$ including the value r (the corresponding statistical procedure is called the Fishers test of periodicity and it is discussed later in the text). The coefficients a_j, b_j are estimated using the ordinary least squares method (OLS) in the standard way; they represent a regression parameter for the j-th smoothing sinusoida, resp. cosinusoida, and the following formulas derived on the basis of OLS hold for their calculation

$$a_j = \frac{n}{2} \sum_{t=1}^{n} e_t \sin(\omega_j t), \quad b_j = \frac{n}{2} \sum_{t=1}^{n} e_t \cos(\omega_j t), \quad j = 1,...,n/2.$$

Next, the variability corresponding to the j-th smoothing sinusoida and cosinusoida is calculated according to the formula

$$\text{var}_j = 1/2(a_j^2 + b_j^2).$$

Testing the statistical significance of all possible periods and connected theoretical variance is done by the Fisher test (Anděl, 1976). As it was mentioned above, it is suitable to use some stationary test; therefore we propose the augmented Dickey-Fuller (ADF) test (Wooldridge, 2003).
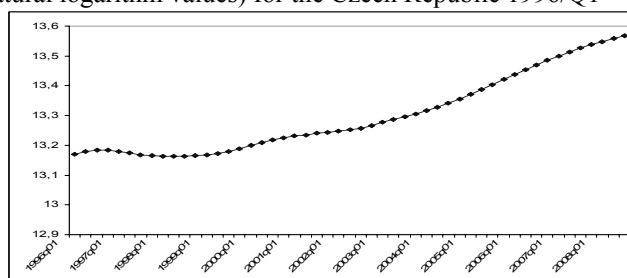
RESULTS

The input data set for the economic activity measurement in this paper are the values of Gross Domestic Product (GDP) in the Czech Republic. The available data are quarterly values 1996/Q1 – 2008/Q3. Notice that the GDP values in absolute form (y_t) had been transformed into natural logarithms and denoted as Y_t (figure 1) before the analysis.

In the first step of empirical analysis, the stationary test of input values was done. According to the ADF test, the logarithmic values of the Czech Republic

GDP are trend stationary on 5% significance level with lag p=2. We can permit that the effects of random disturbance disappear gradually over time because our variable grows along a trend. The chosen methods for de-trending were the first order difference (FOD, e_1), autoregression with/without a constant (AR, e_2; ARc, e_3), regression analysis (linear and quadratic time trend; e_4) and Hodrick – Prescott filter (HP filter, e_5, e_6). Table I describes the OLS estimates of some models. In the case of deterministic model, the quadratic regression gives better results than the linear regression, thus this type of regression is used in the next analysis. The estimates of AR model without a constant as well as AR model with a constant have significant parameters and good statistics. Hence, both cases were involved in the analysis of the periods. The Hodrick – Prescott filter is calculated for two types of smoothing parameter λ. At first $\lambda = 1600$ (e_5) on a regular basis value for the quarterly data is taken. Secondly it is taken as a ratio of variances calculated from values for the Czech Republic $\lambda_{opt} = \sigma_c^2 / \sigma_g^2 = L = 115$ (e_6).

Fig. 1: GDP (natural logarithm values) for the Czech Republic 1996/Q1 – 2008/Q3

Source: Own investigation

Before applying harmonic analysis, the residuals obtained by the application of de-trending methods are tested for the zero mean stationarity (ADF1). Table II shows the results. Figure 2 shows the residuals in correspondence to the used de-trending method. The notation means the "name of detrending method, corresponding residuals", for example "FOD, e_1".

The basic assumption for the FOD procedure applications are that the trend component of the analysed time series is a random walk with no drift and that the cyclical component is stationary and both components are uncorrelated (Canova, 1998). Thus, $g_t = Y_{t-1}$, $t=1,...,T-1$, should be a random walk with no drift in the Czech Republic case. This condition can be taken as satisfied even if we know that a random walk with a drift gives statistically better results. But the stationarity test (ADF1) for the cyclical component (Table II, denotation FOD, e_1) showed a non-stationarity (even in the case of stationarity around a constant). For this reason the FOD cannot be taken as a de-trending method for the Czech Republic. From the

economic point of view, the values of ΔY_t corresponds to the classical business cycle concept more than the growth type of cycle. Even though the FOD does not give stationary residuals, we do the periodicity test to see the results for the classical business cycle.

Table I. Estimate of quadratic regression model, AR model with/without a constant for the Czech Republic

	Parameter estimate	SE	t-value	F-test	p-value	R_{adj}^2	n
Quadratic regression				4609,24	$1,4 \cdot 10^{-55}$	0,9946	51
const.	13,1757	0,0042	3127,1802		$4 \cdot 10^{-129}$		
t	-0,0023	0,0004	-6,0495		$2,1 \cdot 10^{-7}$		
t^2	0,0002	$7 \cdot 10^{-6}$	29,3705		$2,5 \cdot 10^{-32}$		
AR const				4280,1	$1,7 \cdot 10^{-72}$	0,9988	50
const.	-0,4527	0,0665	-6,8089		$1,4 \cdot 10^{-8}$		
Y_{t-1}	1,0346	0,0050	206,8868		$1,7 \cdot 10^{-72}$		
AR				$2,3 \cdot 10^8$	$4 \cdot 10^{-162}$	0,9796	50
Y_{t-1}	1,0006	$6,6 \cdot 10\text{-}5$	15273,9762		$3 \cdot 10^{-165}$		

Statistical significance at the 1% (***), 5% (**), 10% (*)
Source: Own calculation

Table 2. ADF stationarity test results for residuals obtained using corresponding de-trending method

	FOD, e_1	quadratic, e_2	AR cons., e_3	AR, e_4	HP1600, e_5	HP115, e6
ADF1	No	Yes, ***	Yes, ***	Yes,**	Yes, ***	Yes, ***
Lag		2	3	3	2	2

Statistical significance at the 1% (***), 5% (**), 10% (*) H_0: non-stationarity of e_t, t-stat. > quantil, (No) H_1: stationarity of e_t, t-stat. < quantil, (Yes)
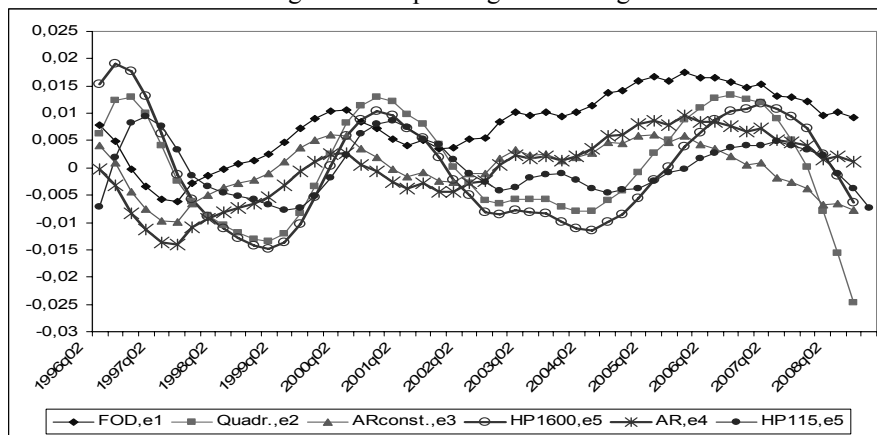Source: Own calculation

The unobserved component (UC) model (Canova, 1998) for de-trending in the Czech Republic case is mentioned above as a random walk process with a drift and with a stationary cyclical component of finite order AR process type. Table I shows statistically significant values for the estimated model, Table II presents stationarity results for the corresponding cyclical components (AR cons., e_3). This method is, therefore, suitable. However, comparing the FOD and AR residuals shape and AR cons. residuals in Figure 2 we can see a similarity in the second half

of the period of the curve shape with the FOD residuals at first sight. Thus, even if the assumptions of UC method are satisfied, it was decided not to recommend this method as de-trending for the Czech Republic case.

In following step, the application of harmonic analysis for the identification of possible types of cycles on all given residuals is done. Notice that one value is lost if we use de-trending by the AR and FOD. The results of calculated periodicity and testing statistical significancy are given in Table III. Two lengths of sample size and two corresponding periods for the used de-trending methods are caused by losing one value in the case of FOD and AR models. This difference is quite small, thus the periods in one column are considered as similar.

Fig. 2: Residuals obtained using the corresponding de-trending method

Source: Own investigation

Table 3. Results of statistical significance of periods for the residuals obtained using the corresponding de-trending method

periods	50	25	16,6667	12,5	10	8,33333	7,14286	6,375
FOD,e1		**						
ARc,e3	***	***	***	***	**			
AR,e4	***	***		**				
periods	51	25,5	17	12,75	10,2	8,5	7,28571	6,375
HP1600,e5	***	***	***	***	**	***	***	
HP115,e6		***	***	***		***	***	***
Quadrat.,e2		***	***	***				

Statistical significance at the 1% (***), 5% (**), 10% (*)
Source: Own calculation

As discussed above, the FOD technique and its residuals do not satisfy assumptions for the application and taking it as a de-trending method does not give a reasonable result. For economic reasons, these values correspond better to the classical type of business cycle theory, thus, we can use the results for considering the periodicity in the classical business cycle. If the analysis of Figure 2 is done, we can see some similarity in the FOD and AR residuals trending. In addition, the FOD residuals are not stationary, unlike the AR residuals. Thereby the periodicity analysis of AR residuals will be taken as confirmative for the FOD residuals.

DISCUSSION OF RESULTS

We can distinguish several types of cycles (Burda, Wyplozs; 2001) known as the Kitchin inventory cycles of 3-5 years, the Juglar fixed investment cycles of middle length 7-11 years and the Kuznets infrastructural investment cycles of 15-25 years. The longest type, the Kondratieff waves of long technological cycle of 45-60 years are not considered as the available sample size for the Czech Republic is small.

The success of dating growth cycles crucially depends on the quality of the approximation of trend component. In our case of the Hodrick-Prescott filter, a random walk with a drift and quadratic de-trending helped to identify the growth cycle, while the FOD and AR were used for the classical business cycle dating. All residuals time series denoted 6.25 years as a significant period. This cycle duration is of the Juglar type caused by fixed investment.

The periodicity of FOD residuals showed only 25 periods as significant, i.e. 6.25 years periodicity. More significant periods were found when we used the AR residuals. In the other cases the residuals describe the growth business cycle. Comparing all of them, the cycles of length 6.25, 4.25 and 3.19 years were detected. Additional cycles, shorter ones, with the cycle duration of 2,125-1,6 years, were detected when the Hodrick-Prescott filter was used. For the special λ, derived for the Czech Republic, the Hodric-Prescott also identified the longest period of 12,75 years. For the ARc residuals, the results show a similar statistical significance period as the quadratic and Hodrick-Prescott filters. All these three cyclical components agreed on three kinds of periodicity, namely 6.375, 4.25 and 3.18 years. The comparison of classical and growth business cycle concepts validates the fact (Bonenkamp, 2001) that the classical cycle peaks come later in time than the growth cycle peaks also for the Czech Republic case.

Hence, the basic types of cycle can be found in the Czech economy evolution - the shortest Kitchin cycles caused by the inventories as well as the middle one Juglar cycles caused by the fixed investment. On the basis of harmonic analysis, the results completed by the economic research of cycle correlation

analysis were done. For the classical BC as well as for the growth BC, the Kitchin inventory and the Juglar fixed investment cycles were identified, and so were the Kuznets infrastructural cycles. In the case of the growth BC the short type of cycle was identified.

Table IV. Correlation coefficients between residuals and economic factors

Correlation	final consumption expenditure	final consumption expenditure of households	final consumption expenditure of general government	gross capital formation	gross fixed capital formation	changes in inventories	exports of goods and services	imports of goods and services	net exports of goods and services
Quadrat.,e2	0,1687	0,3039 **	-0,0973	0,4655 ***	0,4077 ***	0,1837	0,3444 ***	0,4638 ***	0,0590
ARc,e3	0,1278	0,2204	-0,0581	0,3645 **	0,2440 *	-0,2359	0,2643 *	0,2397	-0,1251
HP1600,e5	0,1945	0,3313 **	-0,0875	0,3981 ***	0,4713 ***	0,2445 *	0,3210 **	0,4283 ***	0,1913
HP115,e6	0,2036	0,2987 **	-0,0233	0,4618 ***	0,4372 **	0,2498 *	0,3351 **	0,5107 ***	0,1072

Statistical significance at the 1% (***), 5% (**), 10% (*)
Source: Own calculation

Hence, the economic factors possibly influencing cyclical fluctuation in the Czech Republic based on the data availability were chosen – the final consumption expenditure, final consumption expenditure of households, final consumption expenditure of general government, gross capital formation, gross fixed capital formation changes in inventories, exports of goods and services, imports of goods and services, net exports of goods and services in the period 1996/Q1 - 2008/Q3 as the percentage changed compared to the corresponding previous period. The aim of the study is to measure the tightness relation, i. e. the correlation coefficients between economic factors and de-trended time series (Table IV). Thereafter the source of cyclical movements in the Kitchin sense caused by the inventory was statistically significant only on 10% level for one de-trending method. This dependence is rather weak for the correlation coefficient result (r = 0,24). In the Czech Republic, the cyclical movements of short type are influenced more by the consumption of households; the correlation showed significant results for several de-trending time series on 5% significance level. Further, the source of cyclical movements in the Juglar sense was highly significant for the gross capital formation (the correlation from 0.36 to 0.46) and the gross fixed capital formation

(the correlation from 0.40 to 0.46) and it can be denoted as the middle one. The question is which type of cyclical movements is influenced by the export and import in the Czech Republic. The results of correlation showed a high statistical significance for the middle level of correlation.

CONCLUSION

This paper has focused on the business cycle in the Czech Republic from the frequency domain point of view using harmonic analysis for the identification of possible types of cycles. Deterministic as well as stochastic methods were applied for obtaining the cyclical fluctuation. According to the empirical results, two approaches to business cycle are discussed, the classical and growth types. Consequently, the analysis of potential sources of cyclical movement is done.

The chosen methods for de-trending were the first order difference, autoregression with/without a constant, quadratic time trend and Hodrick – Prescott filter. In the case of Hodrick – Prescott filter, two types of smoothing parametr were used (λ=1600 and λ=115). The success of dating growth cycles crucially depends on the quality of the approximation of trend component. In our case, the Hodrick-Prescott filter, random walk with a drift and quadratic de-trending helped to identify the growth cycle, while the first order difference and autoregression process without a constant were used for the classical business cycle dating. Next, harmonic analysis for the identification of possible types of cycles in all given residuals (including the first order difference and random walk process residuals) was done. All residuals time series denoted the period of 6.25 years as significant. This cycle duration is of the Juglar type caused by the fixed investment.

As mentioned in the introduction, the Czech Republic post-transforming economy disposes of a limited sample size of available data. Even if we study the classical BC concept, this length gives one possible period with respect to the shocks, structural breaks and development of the country. The growth business cycle reacts to this feature better and is less sensitive to the trend. Thereafter, the application of HP filter, random walk with a drift and quadratic regression detected a wide scale of significant periods. From the longest one (12.5 years), through the medium (around 6 years), to the short one (between 2-4 years). In both cycle concepts, the same effects of nested loops took place.

Thus, the basic type of cycles in the Czech economy evolution were identified, the shortest Kitchin cycle caused by the inventories as well as the middle Juglar cycle caused by the fixed investment. In case of growth BC the short type of cycle was also identified. Hence, the economic factors possibly influencing the cyclical fluctuation in the Czech Republic based on data availability were chosen and the correlation between the cyclical movements and economic factors was investigated.

Thereafter, the source of cyclical movements in Kitchin sense caused by inventory was statistically significant only on 10% level for one de-trending method and this dependence is rather weak. The cyclical movements of the short type cycles are influenced more by the consumption of households; the correlation in this case showed significant results for more de-trending time series. Further, the source of cyclical movements in the Juglar sence was highly significant for the gross capital formation and gross fixed capital formation and it can be denoted as middle one.

ACKNOWLEDGEMENTS

REFERENCES

ANDĚL, J. (1976) Statistická analýza časových řad, SNTL, Praha, 271 pp.

AHUMADA, H., GAREGNANI, M. L. (1999) Hodrick-Prescott Filter in practice, UNLP.

ARTIS, M., MARCELLINO, M., PROIETTI, T. (2004) Characterizing the Business Cycles for Accession countries. CEPR-EABCN Conference of Business Cycle and Acceding Countries, Vienna.

BAXTER, R., KING, R. G. (1999) Measuring Business Cycles: Approximate Band – Pass Filters for Economic Time Series. Review of Economic and Statistics, vol. 81, no. 4, pp. 575-593.

BURDA, M., WYPLOZS, C. (2001) Macroeconomics. A European text. 3rd ed. Oxford: Oxford University Press, 572 pp., , ISBN 0-19-877650-0.

BURNS, A.F., MITCHELL, W.C. (1946) Measuring Business Cycles. New York, National Bureau of Economic Research, pp.590, ISBN: 0-870-14085-3 .

BONENKAMP, J., JACOBS,J., KUPER, G.H., (2001) Measuring Business Cycles in the Netherlands, 1815 – 1913: A comparison of Business Cycle Dating Methods. SOM Research Report, No. 01C25 , Systems, Organisation and Management, Groningen. University of Groningen [online],.

CANOVA, F. (1998) De-trending and business cycle facts, Journal of monetary Economic, vol. 41, pp. 533-540,.

CANOVA, F., (1999) Does De-trending Matter for the Determination of the Reference Cycle nad Selection of Turniny Points?, The Economic Journal, Vol. 109, No. 452 (Jan., 1999), pp. 126-150,.

DEJONG, N. D., CHETAN, D. (2007) Structural Macroeconometrics, Princeton University Press, New Jersey, 338 pp., ISBN-10: 0-691-12648-8 .

GUAY,A. ST-AMANT, P., (1997) Do the Hodrick-Prescott and Baxter-king Filters Provide a Good Approximation of Business Cycles? Université a Québec á Montreál, Working paper No. 53,.

HALLETH, A. H., RICHTER, C. (2004) A Time-frequency Analysis of the Coherences of the US Business Cycle and the European Business Cycle, CEPR Discussion Paper no. 4751, London, Centre for Economic Policy Research.

HALLETH, A. H., RICHTER, C. (2007) Time Varying Cyclical Analysis for Economies in Transition, CASE Studies & Analyses no. 334, Center for Social and Economic Research.

HARDING, D., PAGAN, A. (2006) Measurement of Business Cycles, Research paper number 966, Melbourne, ISSN 0819-2642.

HARVEY, A.C., JAEGER, A. (1993) De-trending, Stylized FActs and the Business Cycle. Journal of Applied Econometrics 8: pp. 231-47.

HODRICK, R.J., PRESCOTT, E.C. (1980) Post-war U.S. Business Cycles: An Empirical Investigation, mimeo, Carnegie-Mellou University, Pitsburgh, PA. , 24 pp.,.

KING, R. G., REBELO, S. T. (1993) Low frequency Filtering and Real Business Cycles. Journal of Economic Dynamics and Control. vol. 17, pp.207-231.

MILL, T. C. (2003): Modelling Trends and Cycles in Economic Time Series, Palgrave Macmillan, 178 pp., ISBN 1-4039-0209-7.

SZAPÁRY, G., DARVAS, Z. (2008) Business Cycle Synchronization in the Enlarged EU, Open Economies Review, Volume 19, Number 1 / February.

WOOLDRIDGE, J. M. (2003): Introductory Econometrics: A modern approach. Ohio, 863 pp., ISBN 0-324-11364-1.

WOZNIAK, P., PACZYNSKI (2007) Business Cycle Coherence between Euro Area and the EU New Member State: a Time-Frequency Analysis. Center for Economic Research and Graduate Education and the Economics Institute (CERGE-EI), Prague,.

SCHUMPETER, J. A. (1939) Business Cycles. A theoretical, Historical and Statistical Analysis of the Capitalist Process, New York, 461 pp..

Analiza ruchów w zakresie aktywności gospodarczej w Czechach – podejście frekwencyjne

Streszczenie: Głównym celem pracy jest określenie rodzajów cykli koniunkturalnych występujących w Czechach. Mając na uwadze cechy cyklów koniunkturalnych oraz częstotliwość ich występowania, w artykule zastosowano analizę harmoniczną. Spośród technik de-trending wybrano filtr „pierwszych różnic", filtrowanie liniowe, model nieobserwowanych

komponentów oraz filtr Hodricka-Prescotta. Przy użyciu tej ostatniej metody zbadano oszacowanie zmienności cyklicznej z derywacją wygładzonego parametru, które zostało zaprojektowane specjalnie dla Czech. Celem badań jest wyodrębnienie typów cyklicznych fluktuacji w Czechach. W pracy przeprowadzono również analizę potencjalnych źródeł ruchów cyklicznych.

Słowa kluczowe: analiza harmoniczna, trendy deterministyczne, cykle stochastyczne, aktywność ekonomiczna, cykle koniunkturalne JEL.