Original Research Article: full paper

(2017), «EUREKA: Social and Humanities»
Number 5

A NEW APPROACH TO THE NATURE OF ECONOMIC CYCLES AND THEIR ANALYSIS IN THE GLOBAL CONTEXT

Georgiy Revyakin
Department of World Economy and International Economic Relations
V. N. Karazin Kharkiv National University
gevlare@gmail.com

Abstract

The article offers a new product based theory of economic cycles. The theory explains economic activity fluctuations from the point of life-cycle of marketable goods and services.

Based on our assumptions, we have created a model of world GDP and described its dynamics for the period from 1960 till 2015. In this article, we consider long-term growth trend as granted and as an independent variable due to the complexity of factors, which influence economic growth, while defining economic cycles as a recurrent process, which is analyzed by the model. Considering that, we used Hodrick-Prescott filter as an approximated function to the trend component and Fast Fourier Transform (FFT) as the method of spectral analysis of the cyclical component after detrending.

We have also discovered main features of economic cycles in developed and developing countries along with the dependency of economic cycles' amplitudes on the level of financial sector development.

Keywords: economic cycles, business cycles, macroeconomic dynamics, economic crises, world economy fluctuations.

DOI: 10.21303/2504-5571.2017.00425

1. Introduction

The cyclicity of economic development is manifested in economic activity fluctuations around a long-term trend. Positive deviations from the long-term trend are usually called booms and negative are known as crises. While economic booms are considered as a relatively positive phenomenon, crises usually lead to lower standards of living, a higher level of bankruptcies and other negative consequences. It explains the scientific interest in the phenomenon of economic cycles and in economic crises in particular.

Regardless of the fact that the capitalistic system is over three centuries old and almost every known economic school has its own view on the origin, development and functional patterns of economic cycles, there is no unanimity in this field. The major dispute about the periodicity of economic processes stems from the nature of economic fluctuations around the long-term trend. According to this criterion, all theories can be divided into two types: theories based on exogenous factors that cause economic fluctuations, and theories based on endogenous factors. A similar classification divides factors causing economic fluctuations into those that influence aggregate supply (changes in productivity ratio: technology, resources, business processes) and into those that influence aggregate demand (nature of consumption, interest rates etc.).

The main endogenous theory of economic cycles is Paul Samuelson's multiplier-accelerator model [1], which describes economic cycles using the Keynesian multiplier and investment accelerator. According to this theory, the amplitude of economic cycles depends on the level of the investment, which determines the level of aggregate output. The growth of investments may increase the national income by a greater amount due to the multiplier effect. Increased income, in turn, will cause a faster growth in investments due to the accelerator effect. The main critique of Samuelson's model is connected to its simplicity, which cannot explain economic agent expectations during the cycle.

The dominant exogenous theory of economic cycles is Real Business Cycle Theory (RBCT), which explains the recurrence of economic processes as the result of exogenous factors that influence economic activity. Initially discussed by Robert Lucas [2], who mentioned that economic fluctuations happen due to imperfect information and misperception of real wages value by economic agents during the cycle. Further development the theory takes from the work of Finn Kydland and Edward Prescott "Time to Build and Aggregate Fluctuations" [3], where they stated that the main

cause of business cycle is random fluctuation in the level of productivity. This floating nature of the productivity is explained by technological shocks, changes in monetary policy, or shocks in labor supply ("baby booms"). The main assumption of RBCT is spontaneous nature of technological shocks that directly influence labor efficiency and capital. In turn, changes in labor efficiency and capital influence the decision making of economic agents, whether to decrease or increase the consumption or production of goods and services, which has an effect on macroeconomic indicators in the long run. Lawrence Summers has outlined the main shortcoming of the theory and stated that Kydland and Prescott are unable to juxtapose fluctuation of economic activity with specific technological shock and challenge the assumption that economic productivity can fluctuate in a certain extent [4].

There is also a vast number of alternative theories that describe economic cycles from different standpoints:

– Austrian Business Cycle Theory (ABCT), which emphasizes the role of the financial sector and fractional reserve banking system in the origin of economic cycles [5, 6];

– Debt-deflation theory of Irving Fisher, which identifies the main cause of economic cycles to be originated from the credit cycle [7];

– Kiyotaki-Moore model of credit cycles, which shows how small shocks can lead to a business cycle formation due to the capital depreciation in case of collateralization [8];

– Politically based economic cycles theory of Michał Kalecki, which explains economic fluctuations by periodical elections of different parties with different policy regimes [9];

– Reflexivity theory of George Soros, which describes economic cycles by positive and negative feedback loops (self-reinforcing patterns) [10];

– Financial Instability Hypothesis of Hyman Minsky, which explains economic cycles by the existence of different types of borrowers [11].

Besides, we can mention a separate group of scholars studying economic cycles who gave their names to a number of economic cycles with various periodicity:

– Kitchin cycles – 3–4 years; explained by the lag in the information flow that influences the decision-making process of economic agents;

– Juglar cycles – 7–11 years; explained by the fluctuations of investments into the capital assets of an enterprise;

– Kuznets cycles – 15–25 years; treated as technological (infrastructural) cycles, i.e. a large-scale update of key technologies;

– Kondratiev cycles (waves) – 40–60 years; associated with the recurrent global technological breakthroughs.

All the above mentioned theories provide different explanations to the nature of economic cycles and sometimes describe economic cycles with different periodicity.

We also argue that economic cycles cannot be studied separately from the economic growth that is why we stay lean to the practice of decomposition time series into trend and cyclical components.

Considering recurrent nature of economic cycles, we suppose that the models that are based on spectral analysis can have a higher potential of economic activity prediction than different autocorrelation functions. At the same time, few scholars used spectral analysis to build a decent model of economic cycles. Among important predecessors that conducted their research in this field, it is worth mentioning Timothy Cogley and James Nason [12], Fabio Canova [13], William Granger [14], Sharif Raihan and Bing Zeng [15], Makarov and Parovik [16], Korotayev and Tsirel [17], and Luís Aguiar-Conraria [18]. Some of these authors have proved the existence of long and medium term economic cycles in the world GDP dynamics, but none of them provided sufficient GDP dynamics model and corresponding theoretical ground.

2. The aim and tasks of the research

The main goal of the article is to create a new framework for economic cycles analysis. To achieve this goal we set up following tasks:

– provide profound theoretical basis of the research, which combines evidences of exogenous and endogenous theories;

– create a generic model of economic growth dynamics and approbate it using real data;
– analyze economic cycles particularities in developed and developing countries.

3. Methods of the research

Current research is based on the method of system analysis. We threat the world economy as an interdependent system, while economic development cannot be determine in a unique way because of system complexity. We treat the long-term growth trend as granted and as an independent variable due to complexity of factors, which influence economic growth, while defining economic cycles as a recurrent process. Considered that, we used Hodrick-Prescott filter [19] as an approximation function to the economic growth and FFT as the method of analysis of cyclical component of time series.

4. Product based theory of economic cycles and its model

To conceptualize the present research, it is necessary to provide our own understanding of the causes of economic crises as the most prominent phase of an economic cycle.

Typically, the definition of economic crisis is provided through the description of its symptoms: slowdown of GDP growth rate, rising unemployment rate and bankruptcy, drop in the level of investment, deflation etc., revealing the rapid drop in the level of economic activity in general. From our perspective, the drawback of such approach is that it describes the symptoms without showing the essence of the phenomenon itself, i. e. its causes. That is why we treat the economic crisis as a critical level of disproportion between demand and supply, which causes the above mentioned adverse economic effects.

Any market crisis is characterized by product excess (excess supply) that cannot be compensated by aggregate demand. The market can face such situation because of two phenomena: sudden demand contraction or considerable overproduction. Based on this, scholars define two types of economic crises according to their origin:

– crisis of underproduction, which is caused primarily by non-economic factors, correlated with the setbacks in the production process due to force majeure circumstances (wars, natural disasters, political turbulence etc.);

– crisis of overproduction as a market economy crisis, under which the balance between supply and demand is suddenly shifted towards excess supply.

While crisis of underproduction is an unusual circumstance, crisis of overproduction is a salient feature of the capitalistic system. Thus, the source of economic crisis lies in the production of goods in excess to solvent demand, i. e. in the very nature and the laws of economic development, which aims to make a profit.

Profit maximization, together with sustainable production growth inevitably face the problem of limited aggregate demand. An effort to maximize profits and a lack of coordination between economic entities may lead to excess of a certain group of goods. Overproduction of one group of goods may lead to a general overproduction (economic overheating) through the existing mechanism of monetary circulation [20, 21]. The situation is further fueled by existing ways to encourage aggregate demand growth (loans, leasing, special offers, etc.), which eventually gets limited by the demand ceiling, so the disproportion between aggregate salaries and aggregate costs of consumer goods reaches its critical value.

The mentioned ways to encourage aggregate demand growth constitute external factors of aggregate utility curve. These factors make the products more generally available, whereas, the income level and welfare of the population remain at the same level. Therefore, the current market equilibrium is tied to the future wellbeing of the population by means of credit, which denotes that the natural balance between supply and demand is broken. Summarizing the work of Peter Ladner and Sergio Rebelo [22] further drop in production can happen due to the slightest changes in estimated and anticipated market conditions (news). Beaudry Paul and Franck Portier share the similar thought [23]. Hence, the economic crisis arises due to the elasticity of economic forecasts of future economic conjuncture, while the production capacity load and the associated infrastructure remain an inelastic factor that reacts to the current market state with a significant delay.

First major crises of this kind happened in England in the XVIII century after the beginning of the industrial revolution. Industrialization of certain industries caused general overproduction – a state in which the technological level of industrial development allows producing goods at a significantly higher pace than their consumption. As a result, when a market is saturated with a certain product, this commodity becomes out of demand and an extensive infrastructure associated with its production is stricken by a large-scale crisis. In this situation, there are three types of suggested solutions:

– finding new distribution markets;

– reallocation of existing production facilities to produce other types of goods, in the production of which similar factors of production are involved;

– decrease of the production level and mass layoffs (depression).

Each of the above choices leads to a significant slowdown in the level of production and eventually causes an economic crisis. Further development of industry and market economy has turned these conditions into a recurrent phase of the economic cycle. Though the cycles have different periodicity determined by a broad list of factors, we presume the possibility of a common cause for all the types. Such cause is assumed to be the product life-cycle.

Each product has its life-cycle, which is defined as a period during which the corresponding products circulate in the market, from their entry into the market till their withdrawal. A typical product life-cycle has four stages (phases):

– Launching. A salient feature of this stage is a small scale of output and sales. This stage of product life-cycle requires a huge amount of investment while there can be no profit at all.

– Growth. This stage is characterized by a rapid growth of production volumes and sales. The product brings profits above market average. The production is growing until the moment when marginal profit is equal to the marginal costs.

– Maturity. The stage represents market saturation, followed by a decrease in the volume of output and sales of the product. At this stage, the enterprise profit does not exceed the market average, while new investments in production do not bring sufficient results.

– Decline (leaving the market). This phase of the product life-cycle is expressed by a significant decline in sales until demand drops entirely. The product becomes obsolete and its production is not efficient anymore.

These stages of product life-cycle correspond to phases of economic cycle: growth, peak (saturation), recession and crisis (depression). In this regard, it seems relevant to suggest that economic cycles acknowledged today have a congruent nature and differ only by the duration of certain product group circulation in the market. Considering this, the duration of any economic cycle depends on three constituents:

1) volume of production per unit of time (P);

2) product consumption per unit of time (C);

3) market size (S).

All these three components indicate the value of the period, during which particular market will be saturated with corresponding products. The peak stage (saturation) in this case represents the economic half-cycle:

$$(P - C)\frac{T}{2} = S. \quad (1)$$

From Formula 1 we can get the equitation, which demonstrates the value of economic cycle frequency:

$$\omega = \frac{2S}{P - C}, \quad (2)$$

where ω – frequency of the economic cycle; T – period of the economic cycle.

With this in mind, economic cycles with different periodicity can be compared to the products with various life-cycles, corresponding to the same periods. In case of Kondratiev waves, such products correlate with fundamental discoveries implemented in production (inventions which form the technological paradigm: Richard Arkwright's machines, steam engines, industrial use of electricity, computer invention, etc.); Kuznets cycles [24] describe such products as infrastructural components (roadways, transport, utilities, etc.); Clément Juglar's cycles may go in parallel with enterprise fixed capital (equipment, machinery, etc.), and Kitchin cycles are characterized by change in the society preferences (tastes) for consumer goods, and time, which is necessary to start the production.

Simultaneous technological updates by all economic agents (as a result, cycle formation) would be determined by highly competitive market conditions: in case if a manufacturing technology at an enterprise does not meet the current technological environment, – such company loses its competitiveness and eventually goes bankrupt. The duration of all the mentioned cycles shrinks with the society's development – that is, the frequency of fundamental economic discoveries increases, requiring less time to implement advanced engineering solutions into the production, which leads to shortened product life-cycles [25, 26]. Furthermore, in certain cases, manufacturers intentionally limit the product life-cycle to prolong the long-term aggregate demand.

To summarize all above, we can conclude that economic cycles start from the stage of exchange, where supply and demand meet. The producers of goods and services aim to maximize their profit and use different ways of demand stimulation. This process is accompanied by the implementation of technological innovations into production, which results in new economic cycles. At the same time, financial sector increases the amplitude and length of economic cycles by enhancing the financial solvency of economic agents, and by artificial increasing of the aggregate demand.

Based on the suggested theory, a generic model of economic growth and economic cycles dynamics can be outlined. This model should incorporate a general trend of economic growth and economic cycles with different periodicity (fluctuations around the long-term trend (F)):

$$GDP = Y(x) + F(x), \tag{3}$$

where GDP – gross domestic product, Y(x) – general economic trend, F(x) – aggregate influence of all economic cycles on the current level of production of goods and services.

In order to describe the cumulative effect of all economic cycles on the level of production of goods and services, we need to break the F(x) into economic cycles with different frequencies (see Formula 2). Along with this, the general trend of economic growth Y(x) is exogenous and may be defined by the classical growth model of Robert Solow [27]. Given this, the model of economic growth dynamics is as follows:

$$GDP = f(K, LA) + \sum_1^i a_i \cos\left(2\pi \frac{(P - C)}{2S} x\right), \tag{4}$$

where K – capital; LA – number of workers with permanent labor efficiency; x – the ordinal number of an observation; a_i – amplitude of economic cycles fluctuations; ω_i – frequency of a given economic cycle.

Therefore, the final model combines exogenous (capital, labor, technological advancement) and endogenous (production capacity, market size, consumer preferences) growth factors. In this context, the long-term economic trend becomes an external factor and usually is formed by approximated function (Hodrick-Prescott filter), while economic cycles around this trend are considered regular and make up the subject of a spectral analysis.

5. Model approbation

To define the consistency of product based economic cycles theory and significance of the model, we analyzed the dynamics of world GDP during 1960–2015 (**Fig. 1**).

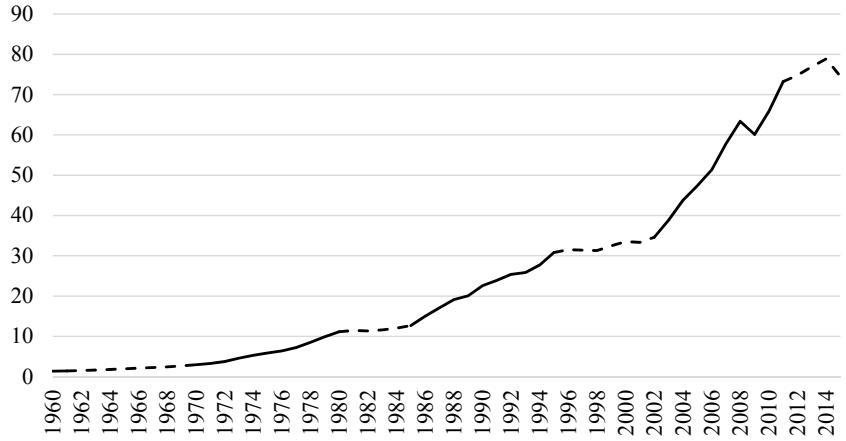

Fig. 1. Dynamics of world GDP in 1960–2015 (trillion USD): [28]

Fig. 1 definitely traces the medium-term economic cycles with a distinctive period duration of approximately 16 years. For further analysis, we have decomposed initial time series into trend and cyclical components using Hodrick-Prescott filter with λ=100 and applied Fast Fourier Transform (FFT) to the cyclical component after detrending (**Table 1**). In accordance with the Kotelnikov-Nyquist theorem, stating that the sample frequency should be at least two times greater than the frequency of the cycle under consideration, only economic cycles with duration of more than 4 years can be analyzed [29]. We set this restriction because only annual world GDP estimations were available at the world level.

Table 1

FFT of the cyclical component of world GDP dynamics in 1960−2015

Period, years	FFT	Amplitude, bn. USD	Phase, radian
64	907,03−1118,97i	45,01	−0,89
32	8568,30−2181,03i	276,30	−0,25
21.3	11142,92+19003,99i	688,43	1,04
16	−31010,84+24976,05i	1244,31	2,46
12.8	−15897,64−15063,37i	684,40	−2,38
10.6	−7220,18−9957,13i	384,36	−2,20
9.1	8065,49−146,60i	252,09	−0,02
8	−16195,45+6403,00i	544,23	2,77
7.1	−7193,074-5747,59i	287,73	−2,47
6.4	−13908,45−7758,06i	497,68	−2,63
5.8	−7893,83−10627,05i	413,69	−2,21
5.3	−2448,15−15731,08i	497,51	−1,73
4.9	1156,19−9299,91i	292,86	−1,45
4.6	775,99−11155,88i	349,46	−1,50
4.3	11408,19−12324,97i	524,82	−0,82

From the results of FFT we can build the periodogram (**Fig. 2**).

The evidence gathered here suggests the existence of economic cycles with 21.3, 16 and 12.8-year long periods. We suppose that the cycles with such periodicity may refer to the life cycles of durable goods and objects of industrial and social infrastructure (Kuznets cycles).

Based on above results we have built the model of economic cycles, which includes economic cycles with 21.3, 16 and 12.8-year long periods (**Fig. 3**).

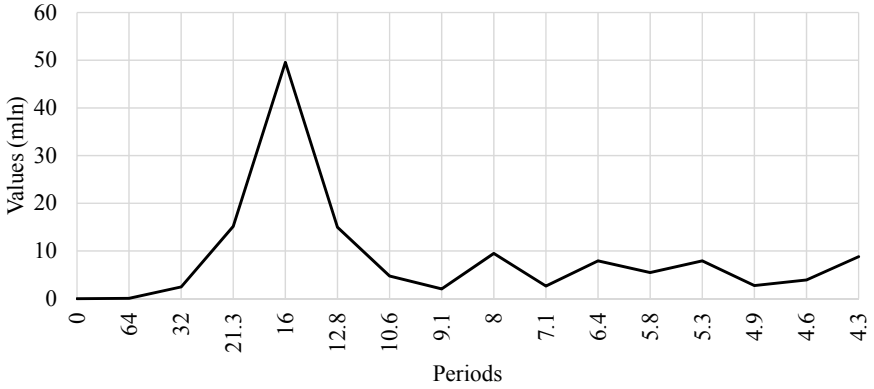

Fig. 2. Periodogram of received harmonics

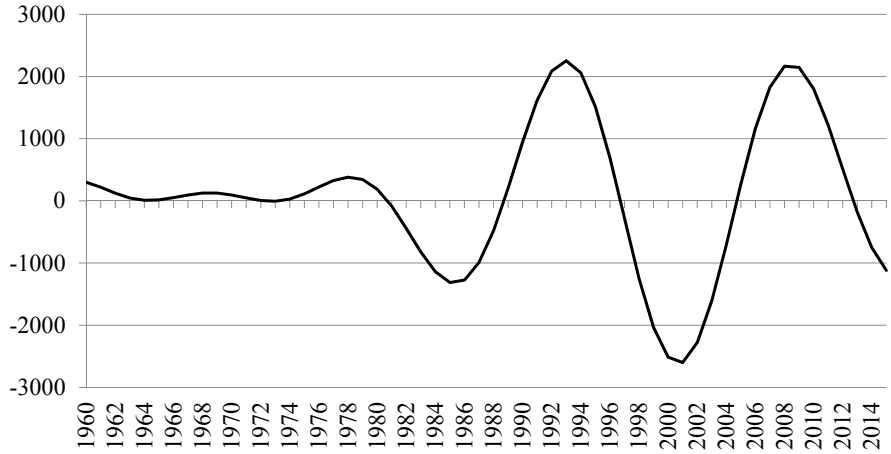

Fig. 3. The model of the dynamics of world GDP oscillations from the long-term trend during 1960–2015 (bn. USD)

We also suppose that the values of the economic cycles amplitudes around the long-term trend depend on the degree of availability of credit means and financial market build-up. The dependency between world GDP volatility and credit availability has strong non-linear dependency (**Fig. 4**).

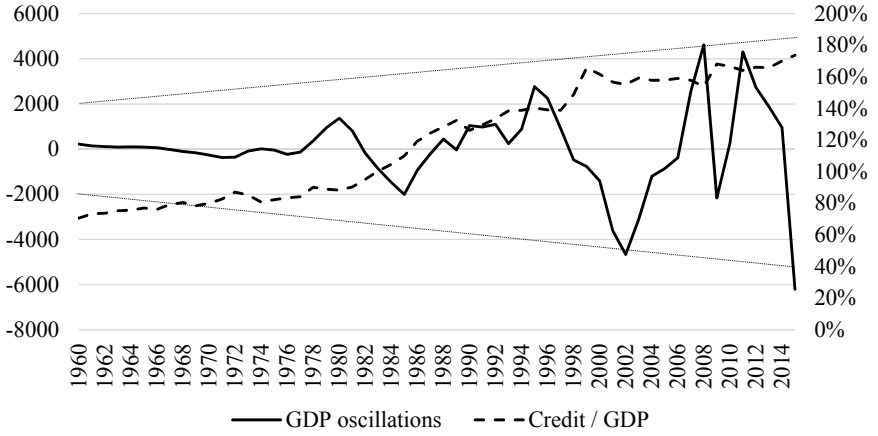

Fig. 4. World GDP oscillations and credit availability during 1960–2015 (bn. USD)

Furthermore, the progress in the information storage, transfer and processing have a significant impact on the parameters of economic cycles (its amplitude and period duration). From this point of view, by using Formula 4 for economic forecasts, it seems viable to use a shorter period (32 years), which will focus on recent economic conjuncture rather than historical dependencies. Describing the economic fluctuations from this standpoint, it should be clear that the research time frame must fully cover at least one full period of the longest of the economic cycles studied, which had a significant input during the studies over longer time frames.

6. Economic cycles in developing and developed countries

According to the data received, dynamics of the global economy over the past 56 years (1960–2015) has been cyclical. Such behaviour of the global economy is consistent with the concept of economic cycles described by major economists. In the global GDP dynamics, we have clearly observed 21.3, 16 and 12.8-year long cycles; moreover, we have suggested a hypothesis about the existence of a direct link between the level of development of the financial sector and the value of economic cycle amplitude. In order to confirm this hypothesis, we analyzed the GDP dynamics of the Group of Twenty (G20) from 1960 to 2015. We have devoted all countries into two groups: developed and developing countries to eliminate blurring of the results and to form a relatively homogeneous pattern of economic cycles in developed and developing countries.

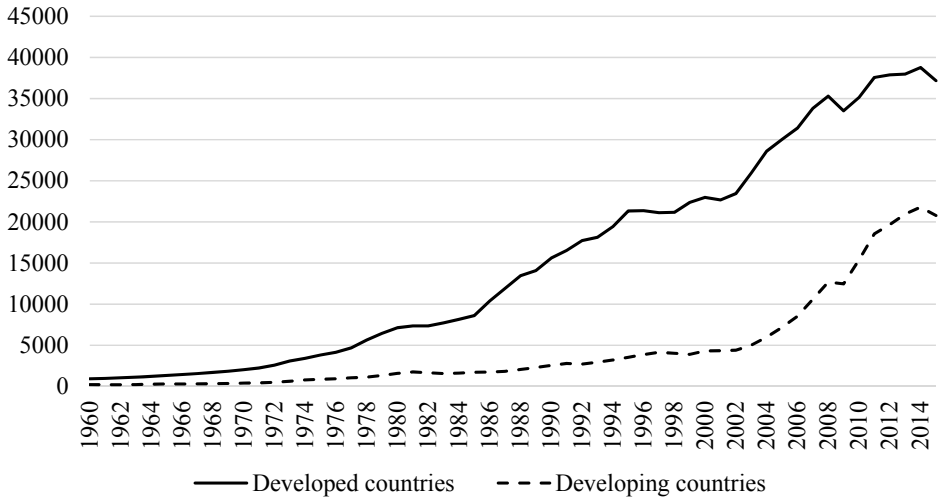

Fig. 5. Dynamics of GDP of developed and developing countries in 1960–2015 (bn. USD): [28]

We have applied FFT to the cyclic component of world GDP after Hodrick-Prescott filter, similarly to the method explained earlier. The results of the conversion are shown in **Table 2, 3**.

Table 2

FFT of the cyclical component of GDP dynamics of the developed countries in 1960−2015

Period, years	FFT	Amplitude, bn. USD	Phase, radian
21.3	2963,95+8366,80i	277,38	1,23
16	−18258,77+6470,28i	605,35	2,80
12.8	−2128,14−12264,91i	389,01	−1,74

Based on above we can illustrate economic dynamic models of developed and developing countries (**Fig. 6**).

The nature and the pattern of economic cycles are different in developed and developing countries not only by the value of their altitude but also by the value of the phases of economic cycles. **Fig. 6** illustrates that economic cycles in developed countries outrun economic cycles in

developing countries. It can be explained by the fact that developed countries take the leading role in the world economy and implement new technologies to their production earlier than developing countries. Furthermore, the amplitude of economic cycles around the long-term trend in developed countries is more than 1.57 times higher than that of the developing countries, which we explain by the fact that high volume and high liquidity of financial systems of developed countries increase economic fluctuations around the long-term trend.

Table 3

FFT of the cyclical component of GDP dynamics of the developing countries in 1960−2015

Period, years	FFT	Amplitude, bn. USD	Phase, radian
21.3	6377,88+4384,07i	241,85	0,60
16	−2682,82+11157,52i	358,61	1,81
12.8	−7403,82+2418,67i	243,422	2,83

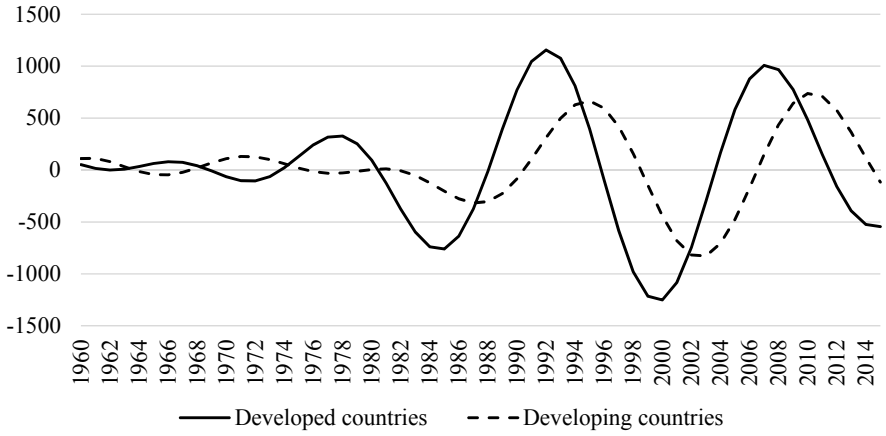

Fig. 6. The model of GDP oscillations of developed and developing countries from the long-term trend in 1960–2015 (bn. USD)

Thus, the frequency of economic cycles is fully consistent with the data presented in all references. We can confirm the existence of economic cycles of different frequency. Meanwhile, the analysis of short-period cycles (less than 4 years) using the FFT method is problematic due to the lack of statistical data (too long sampling period). We also admit the possibility of asynchronous cycles for short economic cycles worldwide. Primarily, this is due to the fact that short economic cycles depend on more individual features of the corresponding economy (national specificity of consumption of short-term goods), rather than global trends.

7. Conclusion

1. We have created a new product based theory of economic cycles, which can possibly fill up the gap of dominant economic cycles theories and provide a new framework for their analysis. We consider different phases of the economic cycles such as growth, peak (saturation), recession and crisis (depression) as a consequence of life-cycle of marketable products. In this case, economic cycles with different periodicity can be compared to the corresponding products with various life-cycles.

2. The resulting model of economic growth dynamics incorporates classical Solow's model of economic growth and economic fluctuations, which are intrinsic to the economic system. As the result it combines exogenous (capital, labor, technological advancement) and endogenous (production capacity, market size, consumer preferences) growth factors.

Applied usage of the model can be achieved with the help of Hodrick-Prescott filter, which decomposes time series into trend and cyclical component and FFT as a method of spectral analysis of cyclical component after detrending.

However, disadvantages of the applied usage of the model should be also pointed out. They are primarily connected with the use of the FFT as a method of spectral analysis. Our model requires input data multiplicity to the power of 2 ($N=2^n$), which limits the range of its applicability to the analysis of economic processes that have a smaller volume of statistical data. In addition, the FFT method can yield ambiguous results in the case of floating period values in the analysed data series. The fact that the cycle frequency measurement depends on the number of observations may also distort the parameters of empirical economic cycles to a certain extent [15, 18].

3. The model of economic growth dynamics describes the main features of economic fluctuations in the world economy as well as at the country level. We have found out that an amplitude of economic cycles in developed countries is 1.57 times higher than in developing countries. We associate this fact with the availability of credit means: the more developed credit market is the higher amplitude of economic cycles in particular country will be. In the same time, it appears that economic cycles in developed countries overrun economic cycles in developing countries. We explain it by the fact that developed countries take the leading role in the world economy and implement new technologies to their production earlier than developing countries.

References

[1] Samuelson, P. A. (1939). Interactions between the Multiplier Analysis and the Principle of Acceleration. The Review of Economics and Statistics, 21 (2), 75–78. doi: 10.2307/1927758

[2] Backus, D., Enders, A., Lucas, R. E. (1983). Studies in Business Cycle Theory. The Canadian Journal of Economics, 16 (4), 736–738. doi: 10.2307/135053

[3] Kydland, F. E., Prescott, E. C. (1982). Time to Build and Aggregate Fluctuations. Econometrica, 50 (6), 1345–1370. doi: 10.2307/1913386

[4] Summers, L. H. (1986). Some Skeptical Observations on the Real Business Cycle Theory. Federal Reserve Bank of Minneapolis Quarterly Review, 10 (4), 23–27.

[5] Sechrest, L. J. (2006). Explaining malinvestment and overinvestment. The Quarterly Journal of Austrian Economics, 9(4), 27–38. doi: 10.1007/s12113-006-1022-0

[6] Von Mises, L. (1953). The theory of money and credit. New Haven: Yale University Press, 512.

[7] Fisher, I. (1933). The Debt-Deflation Theory of Great Depressions. Econometrica, 1 (4), 337–357. doi: 10.2307/1907327

[8] Kiyotaki, N., Moore, J. (1997). Credit Cycles. Journal of Political Economy, 105 (2), 211–248. doi: 10.1086/262072

[9] Kalecki, M. (1943). Political aspects of full employment. The Political Quarterly, 14 (4), 322–330. doi: 10.1111/j.1467-923x.1943.tb01016.x

[10] Soros, G. (2008). The New Paradigm for Financial Markets: The Credit Crisis of 2008 and What it Means. New York: PublicAffairs, 238.

[11] Minsky, H. P. (1999). The Financial Instability Hypothesis. SSRN Electronic Journal, 74. doi: 10.2139/ssrn.161024

[12] Cogley, T., Nason, J. M. (1995). Effects of the Hodrick-Prescott filter on trend and difference stationary time series Implications for business cycle research. Journal of Economic Dynamics and Control, 19 (1-2), 253–278. doi: 10.1016/0165-1889(93)00781-x

[13] Canova, F. (1998). Detrending and business cycle facts. Journal of Monetary Economics, 41 (3), 475–512. doi: 10.1016/s0304-3932(98)00006-3

[14] Granger, C. W. J. (1966). The Typical Spectral Shape of an Economic Variable. Econometrica, 34 (1), 150–161. doi: 10.2307/1909859

[15] Raihan, S. M., Wen, Y., Zeng, B. (2005). Wavelet: A New Tool for Business Cycle Analysis. Federal Reserve Bank of St. Louis, Working Paper 2005-050A, 21.

[16] Makarov, D. V., Parovik, R. I. (2016). Modeling of the economic cycles using the theory of fractional calculus. Journal of Internet Banking and Commerce, 21 (S6), 1–8.

[17] Korotayev, A. V., Tsirel, S. V. (2010). A Spectral Analysis of World GDP Dynamics: Kondratieff Waves, Kuznets Swings, Juglar and Kitchin Cycles in Global Economic Development, and the 2008–2009 Economic Crisis, Structure and Dynamics. Journal of Anthropological and Related Science, 4 (1), 1–55.

[18] Aguiar-Conraria, L., Soares, M. J. (2013). The Continuous Wavelet Transform: Moving Beyond Uni- And Bivariate Analysis. Journal of Economic Surveys, 28 (2), 344–375. doi: 10.1111/joes.12012

[19] Hodrick, R. J., Prescott, E. C. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. Journal of Money, Credit and Banking, 29 (1), 1–16. doi: 10.2307/2953682

[20] Marx, K. (1885). Capital. Vol. 2: A Critique of Political Economy. The Process of Circulation of Capital. Chicago: Charles H. Kerr and Co.

[21] Tugan-Baranovskiy, M. I. (2004). Promyshlennye krizisy. Ocherk iz sotsial'noy istorii Anglii. Kyiv: Naukova dumka, 358.

[22] Jaimovich, N., Rebelo, S. (2009). Can News about the Future Drive the Business Cycle? American Economic Review, 99 (4), 1097–1118. doi: 10.1257/aer.99.4.1097

[23] Beaudry, P., Portier, F. (2007). When can changes in expectations cause business cycle fluctuations in neo-classical settings? Journal of Economic Theory, 135 (1), 458–477. doi: 10.1016/j.jet.2006.06.009

[24] Kuznets, S. (1930). Secular Movements in Production and Prices. Their Nature and their Bearing upon Cyclical Fluctuations. Boston: Houghton Mifflin, 536.

[25] Dosi, G. (1982). Technological paradigms and technological trajectories. Research Policy, 11 (3), 147–162. doi: 10.1016/0048-7333(82)90016-6

[26] Francis, N., Ramey, V. A. (2005). Is the technology-driven real business cycle hypothesis dead? Shocks and aggregate fluctuations revisited. Journal of Monetary Economics, 52 (8), 1379–1399. doi: 10.1016/j.jmoneco.2004.08.009

[27] Solow, R. M. (1957). Technical Change and the Aggregate Production Function. The Review of Economics and Statistics, 39 (3), 312–320. doi: 10.2307/1926047

[28] World bank group: official web site of World Bank. Available at: http://www.worldbank.org

[29] Kotel'nikov, V. A. (1933). O propusknoy sposobnosti efira i provoloki v elektrosvyazi – Vsesoyuznyy energeticheskiy komitet. Materialy k I Vsesoyuznomu s"ezdu po voprosam tekhnicheskoy rekonstruktsii dela svyazi i razvitiya slabotochnoy promyshlennosti.