APPROACHES TO ECONOMIC CRISES FORECASTING BY MEANS OF EXCHANGE INDICES ON THE EXAMPLE OF FOREIGN EXPERIENCE

Oleksandr Astafiev
Associate Professor, PhD, Kryvyi Rih Economic Institute
of Kyiv National Economic University named after Vadym Hetman,
e-mail: fmek@kneu.dp.ua, orcid.org/0000-0002-2929-3076, Ukraine
Kateryna Astafieva
Associate Professor, PhD, Kryvyi Rih National University,
e-mail: ksantiy@i.ua, orcid.org/0000-0002-3418-7622, Ukraine
Serhii Rtyshchev
Associate Professor, PhD, Kryvyi Rih National University,
e-mail: satian300@meta.ua, orcid.org/0000-0002-7751-542X, Ukraine
Valeriia Astafieva
Master`s student, Moscow Metropolitan Governance University,
e-mail: lerastafeva@mail.ru, orcid.org/0000-0003-4909-2105, Russia

Abstract. The article explores the possibility of financial crises forecasting in the account of stock indexes changes analysis. The subject of the study was the United States of America, and the object was the Dow Jones index, which has been analyzed over the past 47 years. It has been determined that it is highly probable that the value of the Dow Jones index variation coefficient can be predicted in 2018-2020. It has been outlined that the US economic development will be appropriate within the next three years.

Keywords: financial indices, the coefficient of variation, Dow Jones index, standart deviation.

Introduction

The economic crises, which arise at the certain states, as well as at regions and in the world economy in general, are painful, destructive stages in cyclic development of society. Consequently, the questions assume considerable importance, what are connected with a possibility of the crisis phenomena emergence forecasting.

In the economic theory the concept of business cycles is widely used. They are divided into several types depending on duration of a cycle *(Ivashkevsky, 2002)*:
- short-term cycles of Kitchin (2-3 years);
- medium-term cycles of Juglar (5-10 years);
- long waves (cycles) of Kondratiev (30-60 years).

The theory of business cycles was supported by M. I. Tugan-Baranovsky, A. A. Bogdanov and other scholars.

As a forecast basis in traditional methods it is accepted to analyze global demand for energy resources, their prices in the world market, etc.

This paper offers to consider the dynamics of the auction in the world exchanges for the economy state analysis.

The financial indexes are the generalizing indicators of the economy performance of a certain state, region as well as of the world in general.

As an indicator of the USA economy state it is offered to use the Dow Jones index. The index is chosen because of its great popularity. It is often called the industrial index and also considered as a barometer of the American economy. It is the oldest and widespread index among the   indicators of stock market. The index is calculated since July 26, 1896 and represents a simple average value of the movement of share prices of 30 the USA largest industrial corporations and characterizes the country economic situation. The components of the index can change depending on position of corporations in the USA economy. It is the share of his components from 15% to 20% of market value of the stock quoted at the New York exchange.

The purpose of the article is contained in the analysis of the Dow Jones index change within a year, for further forecasting of the crisis phenomena in economy of the USA. The more alternative the index value, the less the economy is stable and is closer to emergence of an economic crisis.

As a variability measure in the classical statistical analysis the variation coefficient is used, which represents the relation of a standard deviation (a mean square deviation) to average size expressed as a percentage. The change of variation coefficient of the Dow Jones index from 1970 to 2017 is presented in Figure 1 (dependence 1).

We should determine the threshold value of variation coefficient of the index at which there are crisis phenomena in economy of the USA. Thus the variation coefficient reached the maximum value in 2008 and was 13,744%. At value of 40% of maximum the strong variation or fluctuations of sign is observed, i.e. it is possible to assume that at value of variation coefficient more than 5,5% (fig. 1, dependence 2) the unstable situations in economy are observed and there can be crisis phenomena.

We should check the made assumptions by the way of comparison of the received values of variations coefficient with the USA economy real state, since 1970.
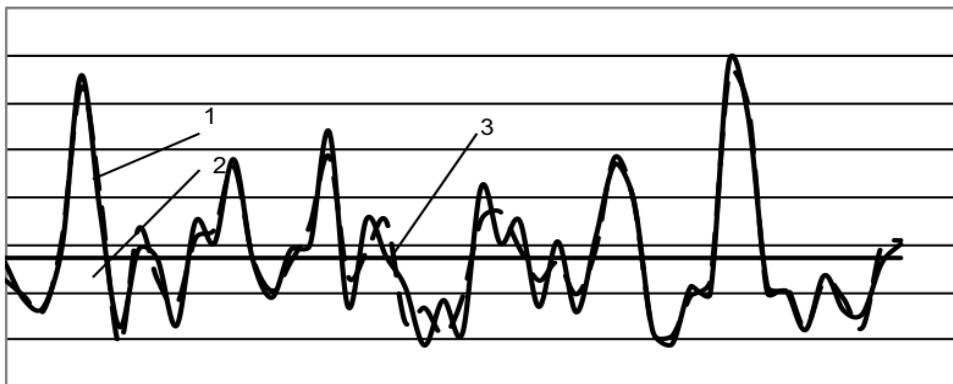
Fig. 1. Value of variation coefficient in 1970 - 2017

So 1973-1975 are known as years of oil crisis during which there was a sudden increase in oil price by almost 4 times.

The further 1977-1978 years can also be considered to be the crisis years, which are caused by fluctuations of oil price too *(Vasiliev, 1983).*

1980-1982 – are the years to be considered as the most long years of crisis for post-war period, which has captured all industrialized countries, both small, and large including the USA. The decline of industrial production in the USA was 8,2% in 1982. At the first stage the crisis expanded in the branches manufacturing the objects of personal consumption, on the second stage the crisis has captured the heavy industry (including ferrous metallurgy). The symptoms of an energy crisis have also remained *(Polyak, 1983)*.

1985-1987 – at the exchanges of the USA the accelerated increase in share price at sharp delay of industrial production is observed that finally has led to decline of share price and emergence of the crisis phenomena in national economy. The same situation is observed also in other countries, particularly in countries of Western Europe.

The USA turns into the largest debtor. The most admissible public debt raises from 2,3 trillion dollars up to 2,8 trillion dollars under the decree of the president.

In 1985-1986 years the absolute extent of budget deficit of the USA has exceeded 200 billion dollars [1987].

In October, 1987 there is crash of the stock market of the USA after which the stock markets of Canada, Australia, South Korea, Hong Kong and other countries have collapsed.

1989-1990 are the years, which were characterized by the economic downturn in the second economy of that time in Japan. It was reflected in economy of other western countries including the USA.

1995-1997 are the years of the Mexican crisis, further Asian crisis which is a consequence of withdrawal of foreign investors from the countries of Southeast Asia. According to the estimates of economists, Asian crisis has lowered the world GDP by 2 trillion dollars. It has naturally affected economy of other countries including the USA.

2001-2003 are the years of "bubble" crisis of IT – technologies. The countries of Western Europe and the USA have suffered the most. One of the causes of crisis had been the unfairly high level of investments into IT companies at low financial performance of the Internet companies *(Varshavsky, 2010)*.

2008, 2009 are the years of global system financial crisis which has captured the whole world. Its beginning could be attributed to the USA where problems in the market of mortgage lending became the reasons of crisis.

The carried-out analysis allows to draw a conclusion that the variation coefficient can be accepted as the indicator characterizing state of the economy, in particularly the USA. The forecasting of the Dow Jones index variation coefficient allows to give an indication of an emergence of the possible crisis phenomena in economy of the USA.

There are more than 150 methods of economic processes forecasting by estimates of experts. No more than 15 methods have found broad application in practice. The method of trends extrapolation is the most widely used. The dependence is widely used for the analysis of a tendency on the basis of a dynamic number and creation of the forecast taking into account regularities which have occurred during the previous periods. This dependence has the name of the trend equation.

$$Y = f(t) + \xi_t \tag{1}$$

where, $f(t)$ - deterministic component,

ξ_t - stochastic random component.

We will allocate a linear tendency at change of variation coefficient of the Dow Jones index for 1970 - 2017. Using a method of the least squares, we receive parameters of the linear equation:

$$L_c = 0,387554 - 0,0001661 * t \qquad (2)$$

L_c - linear tendency of the variation coefficient change for 1970-2017 years,

t - years of analysis.

We will allocate a constant component from coefficient of variations. The received dependence is presented in fig. 2 (dependence 1). Because the received dependence changes periodically, we extrapolate it with use of Fourier series that also finds its place in the theory of economic cycles.

Fig. 2. A difference between value of coefficient of variations and a constant component.

It is known that any acyclic function can be presented as artificially periodic in the range 2π. It allows to define further Fourier's number for our dependence.

After representation of the received specified dependence as periodic, we are convinced that it will be even function (fig. 3). The graphs of even functions are always symmetric concerning an axis at y (i.e. are specularly reflected). The point -47 on the presented dependence corresponds to value −π, and 47 − +π.

Fig. 3. Artificial periodic correlation of a difference between variation coefficient and constant component

Fourier's number of even periodic function with the period 2π contains terms with cosines (i.e. it doesn't support terms with sine) and can include the constant term. Therefore,

$$K_{var} - L_c = a_0 + \sum_{n=1}^{\infty} a_n \cos nt \tag{3}$$

Where, K_{var} - variation coefficients,

a_0, a_n - coefficients of Fourier's number, which are determined accordingly:

$$a_0 = \frac{1}{2\pi} \int_{-\pi}^{\pi} f(t)dt = \frac{1}{\pi} \int_{0}^{\pi} f(t)dt \tag{4}$$

$$a_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(t) \cos nt dt = \frac{2}{\pi} \int_{0}^{\pi} f(t) \cos nt dt \tag{5}$$

n - number of harmonic.

The result of decomposition in the harmonious number of a difference between the Dow Jones index variation coefficient and a constant component from 1970 for 2017, consisting of 40 harmonicas, allows to receive the correlation presented in fig. 2 (dependence 2).

The correlation coefficient between calculated and reference values is 95,5%. The determination coefficient is according to 91,2%.

The English statistic Cheddok's scale (table 1) is applied for the estimation of assessment force in the theory of correlation.

Table 1

Cheddok's scale

Quantitative measure of correlation narrowness	Qualitative characteristic of correlation force
1	2
0,1 - 0,3	Weak
0,3 - 0,5	Moderate
0,5 - 0,7	Noticeable
0,7 - 0,9	High
0,9 – 1	Strong

Figure 1 (dependence 3) presents the model of variation coefficient, which is received from the equation:

$$K_{\text{var}} = L_c + a_0 + \sum_{n=1}^{40} a_n \cos nt \tag{6}$$

The coefficient of determination of R^2 for it is defined as follows:

$$R^2 = 1 - \frac{\sum E^2}{\sum (y_t - \bar{y})^2}, \tag{7}$$

Where

$$E^2 = (y_t - y_p)^2 \tag{8}$$

y_t - value of the Dow Jones index variation coefficient by years,

y_p - calculated value of the Dow Jones index variation coefficient,

$\bar{y}$ - average value of the Dow Jones index variation coefficient.

Its value is equal to 91,26%. According to Cheddok's scale (table 1) the value of determination coefficient (R^2) is in the range of 0,9-1,0 and confirms the strong force of correlation between the values.

The relative error or approximation error is determined by the equation:

$$\text{MAPE} = \frac{1}{n} \sum_{t=1}^{n} \frac{\left| y_t - y_p' \right|}{y_t} * 100 \% \tag{9}$$

It makes 15,77% that indicates the sufficient accuracy of a model correcting to reference values *(Prisenko, Ravikovich, 2005)*.

We will check the adequacy of the received model to data of observations:

$$F = \frac{R^2}{1 - R^2}(n - m - 1) = 480,07 \tag{10}$$

where n – the number of observations; m - quantity of factors in the equation of a trend (m=1).

On the Fischer-Snedekor's criterion (F-criterion, F-distribution) at significance value 0,05 we have the following:

$$F_{kp} = 4,052 \tag{11}$$

If F > Fkp, the equation is statistically significant.

The received model allows to forecast the value of the Dow Jones index variation coefficient for the next periods. We will execute the forecast for 2018, 2019 and 2020 years. We have the dot expected values which are equal to 5,951%, 2,458% and 3,642% accordingly.

For the Dow Jones index variation coefficient value forecasting we use interval values of restriction with a confidential interval which borders are defined by the equation.

$$\Delta = \pm t_a \sigma_p \tag{12}$$

where t_a - tabular value, t - Student's criterion for $n-1$ degrees of freedom.

$$\sigma_p = \sigma_y \sqrt{\frac{n+1}{n} + \frac{3(n+2p-1)^2}{n(n^2-1)}} \tag{13}$$

p - forecast period size, which accepts the value 1, 2, 3 at the forecast for three years.

$$\sigma_y = \sqrt{\frac{\sum\limits_{t=1}^{n} (y_t - y_p')^2}{n-1}} \tag{14}$$

t - Student's criterion with number of degrees 47 and probability of 95% (is equal to 2,012).

The table 2 contains the calculations of the Dow Jones index variation coefficient value taking into account a confidence interval.

Table 2

Dow Jones index variation coefficient value taking into account a confidence interval

Forecast period	Years	Pointwise value	Confidence interval	
			minimum value	maximum value
1	2018	5,9507%	7,68988%	4,21145%
2	2019	2,4578%	4,20137%	0,71427%
3	2020	3,6424%	5,39048%	1,89437%

Conclusions and suggestions

It is possible to forecast the Dow Jones index variation coefficient size in 2018 in the range from 4,21% to 7,69% with probability of 95%. It means that instability of the USA

economy will be observed in 2018. The Dow Jones index variation coefficient is predicted to be in the range from 0,71% to 4,20% that assets to stability and lack of any crisis phenomena in the USA economy in 2019. The year 2020 will also be favorable for the USA economy. When carrying out the forecast the different political events which can take place these years weren't considered, and it is essential to influence not only the economy of the USA, but the world economy as a whole.

References

Ivashkevsky, S. N. (2002). Macroeconomics: Textbook. Moscow: Delo Publ. [in Russian].

Polyak, G. B., Markova, A. N. (Eds.). (1983). World History: Textbook for High Schools. Moscow: Culture and Sport, UNITI Publ. [Electronic resource]. Retrieved from http://klbank.ru/birzha-segodnya/prichiny-krizisa-1987-goda.html. [in Russian]

Prisenko, G. V., Ravikovich, E. I. (2005). Forecasting of social economic processes: Manual. Kyiv: KNEU Publ. [in Ukrainian].

Varshavsky, L. E. (2010). The crisis of the financial system and the evolution of commodity markets. Journal "Applied Econometrics", No. 1 (17), University "Synergy". Publ. [Electronic resource]. Retrieved from https://cyberleninka.ru/publisher/n/universitet-sinergiya. [in Russian].

Vasiliev, A.M. (1983). The Persian Gulf at the epicenter of the storm. Moscow: Political literature Publ. [in Russian].