AN APPLICATION OF LOGISTIC CAPITAL MANAGEMENT THEORY MODEL TO THE ECONOMIC GROWTH CYCLE IN LITHUANIA

Dalia Štreimikienė[1], Neringa Barakauskaitė-Jakubauskienė[2]

Vilnius University Kaunas Faculty of Humanities, Muitinės g. 8, LT-44280 Kaunas, Lithuania
E-mails: [1]dalia@mail.lei.lt (corresponding author); [2]neringabj@gmail.com

Abstract. The article analyses one of the most recent theories of economic growth prof. Girdzijauskas (2002, 2006, 2008, 2009, 2010) created logistic growth theory, whose main idea is based on market saturation and the concept of limitation. The essential claims of the theory are being tried to adjust analysing the economic growth cycle of Lithuania in 1995–2009 period. Performed logistic analysis of Lithuania's GDP (Loglet Lab2), macro–economic indicators' and factors' affecting them correlation regression analysis (SPSS15,0). The article concludes of the presentation of the created economic growth cycles and the bubble formation mechanism combining hypothetical Lithuanian economic growth cycle assessment model.

Keywords: economic growth, cycle, logistic theory, bubble, model.

Reference to this paper should be made as follows: Štreimikienė, D.; Barakauskaitė-Jakubauskienė, N. 2011. An application of logistic capital management theory model to the economic growth cycle in Lithuania, *Technological and Economic Development of Economy* 17(2): 352−368.

JEL classification: E27, E32, C41, O52.

1. Introduction

Globally, the ongoing economic crisis and the decline in GDP growth, attract the attention of economists, many of them with various economic theories try to explain the economic imbalances – crisis and economic bubbles causes and mechanism of their formation. One of the newest approaches in the theory of economic growth, Girdzijauskas (2002) works, which gradually evolved into a separate autonomous theory – *the logistic capital management theory* (2002, 2006, 2008). The developed *theory* analysing the economic growth (capital) limitations and its reasons is based on the capital gap, as the capital growth area's concept of finality. The following economic phenomena were revealed by developed logistic theory – "*price bubble*"

(Štreimikienė, Girdzijauskas 2008; Girdzijauskas, Štreimikienė 2008, 2009, 2010; Dubnikovas *et al.* 2009; Girdzijauskas, Dubnikovas 2010; Girdzijauskas *et al.* 2008, 2009a, 2009b, 2009c; Moskaliova, Girdzijauskas 2005, 2006), the causes of its appearance and factors affecting the formation and the "*credit trap*" (Girdzijauskas, Dubnikovas 2010; Dubnikovas *et al.* 2009; Girdzijauskas, Štreimikienė 2010) arising under the influence of market niche or gap and the "increasing profitability" paradoxes – the main reason of many economic and financial crisis. Girdzijauskas, Mackevičius (2009) and Girdzijauskas *et al.* (2009a) applied the classic "bubble" definition to the economic growth cycle and confirmed that in the cyclical economical fluctuations in some cases forms a bubble effect and applying and introducing to it a fundamentally based production output rate is obtained the economic bubble phenomenon.

Purpose of the article – to examine the economic growth cycle in Lithuania in 1995–2009 period, regarding the statements of the logistical capital management theory.

Objectives: To review the theoretical assumptions of the economic growth cycle; to meet the theoretical principles of the logistic capital management; to carry out the logistic analysis of the economic growth in Lithuania in 1995–2009 to analyse the economic factors affecting economic growth cyclical fluctuations' trends in Lithuania; to present a hypothetical model of the Lithuania's economic growth study.

The article provides an overview of Lithuania's and foreign authors' scientific literature sources, logistic capital management theory. Methods of analysis applied while performing the investigation: *I study* – carried out the logistic analysis of Lithuania's GDP, using "Loglet Lab2" software tool; *II study* – carried out Lithuanian macroeconomic indicators' and factors' affecting them, correlation and regression analysis. Analysed and structured data is processed using SPSS 15.0 software tool. At the end of the article there is presented *a hypothetical Lithuania's economic growth cycle assessment model joining the created economic growth cycles and the bubble formation mechanism*, the model can be applied in practice assessing the economic growth cycle phases' formation and forecasting the changes in the economic balance tendencies.

2. The economic growth cycle theoretical assumptions

In theory the economic growth is associated with changes in a number of economic factors, but in practice to measure it usually is applied a change of the gross national product within a certain period of time (Gronskas *et al.* 2008). 1936 J. Schumpeter (1961) presented a new interpretation of the economic development, stressing the importance of innovations in order to avoid fluctuations in the economy: „fluctuations in economic activity will be avoided if an innovation process will obtain the continuous nature, development innovations increase the business opportunities in the market, creating competitive products", the important observation that in some industrial branches growth is decreasing, while others are growing rapidly and that such structural changes are related to technical novelties and innovations' changes flow. Such industrial branches as electronics, aviation, drugs, science instruments, synthetic materials production have grown very rapidly and rapid growth pace has been closely associated with the flow of new technologies (Freeman 1982, 2008; Freeman, Louca 2001). J. Schumpeter theory's idea is attributed through the entrepreneurship prism is based

on the capabilities and initiative of entrepreneurs who referring to the scientific discoveries, can create entirely new opportunities for investments in economic growth and employment, a crucial factor and an innovator, leading to rapid growth is the profit obtained from innovations provide to the market (Schumpeter 1961). J. Schumpeter theories were developed by the economist Ch. Freeman (1982, 2008). Scientist presented *"The National Innovation System Concept"* (1982) and defined the national innovation system as the network of institutions in both public and private sector, whose activities and interactions initiate, import, modify and disperse new technologies, but also stressed the need to take into account fluctuations of real GDP in the ratio with potential GDP, defined GDP gap indicator and drew attention to the fact that the economic imbalance of the equilibrium is based on the increased inflation, rising unemployment and related factors affecting the market.

In today's economy an important role is played by N. Kondratjev, J. Schumpeter and later Ch. Freeman developed economic cycle interpretations associated with innovations and new technologies' influence on the economic growth and it may be noted that this theoretical approach is very close to *the position of the logistic capital management theory*, however, it must be noticed that economic theory fails to recognize the limitations of economic growth and the factors influencing it. Created *logistic capital management theory* confirms that economic growth can not be infinite – it is limited and sooner or later ends.

3. Logistic capital management theory

The term "*logistics*" is associated with any limited population growth. Logistic (marginal) growth does not only characterize the biological populations, but other populations whose growth rate is proportional to their size, particularly as in the economy grows the capital and investments, the *logistic principle* can also describe the economic growth, which' one of the limiting growth factors – is capital. One of the first researchers who tried to adjust the logistic law to the biological population's growth evaluation – P. V. Verhulst (1804–1849), then O. C. Fereira (2002) used the law for exploring Brazil's economic growth and confirmed that logistic growth model better than the exponential allows to evaluate the economic growth, prof. S. Girdzijauskas (2006) pointed out that these models have a drawback – the used growth function is not expressed by a compound percentage, further research of the scientist developed to the new *logistic capital management theory*.

"As a representative logistic growth model in theory is accentuated P. V. Verhulst (1847) model of population growth, where growth limitation is estimated by the multiplier reflecting a level of the completion of the certain system", says S. Girdzijauskas (2006, 2008), formula (1):

$$1 - \frac{K}{K_p}, \tag{1}$$

where K_p – the maximum marginal biological population's value (expressed y the units evaluating the quantity of product); K – existing value of the same population's product.

This ratio shows the percentage part of the population's filling, and the multiplier – the free part of the population that can be filled. These markings are used also in the logistic capital

management theory, while examining the *capital growth consistent pattern* (Girdzijauskas, Štreimikienė 2009, 2010) formula (2):

$$\frac{dK}{dt} = \left(1 - \frac{K}{K_p}\right) \cdot \ln r \cdot K,$$

(2)

where K – the real capital or investment coverage at time moment ($t \leq 0$); K_p – potential capital or maximal value of investments, $\ln r$ –coefficient representing the growth rate of capital ($r < 0$, $r \neq 1$).

The solution of differential equation according real capital (K) and assuming that at the initial moment Real capital *(K)* is equal to K_0, i. e. $K\big|_{t=t_0} = K_0$, time $t = n$, coefficient $r = 1+i$ *and i* – rate of interest measured in the same units as time n, provides the future value of real capital in n periods. Applying the logistic model to the analysis of the economic system and adjusting a similar growth limiting multiplier and the other rates to the differential equation of capital variation, it is obtained a *Logistic capital growth function* (Girdzijauskas, Štreimikienė 2009, 2010) formula (3):

$$K = \frac{K_p \cdot K_0 \cdot (1+i)^n}{(K_p - K_0) + K_0 \cdot (1+i)^n},$$

(3)

where the difference ($K_p - K_0$) – initial capital gap and $K_0 \cdot (1+i)^n$ – real capital for n period evaluated based on compound interests formula.

We see that logistic future value of real capital is expressed through potential capital, initial real capital and compound interests. The future logistic value of real capital (K) further we will call capital and will note by symbol K. Transforming logistic future capital value formula by calculating the $\lim_{p \to \infty} K$ we can make conclusion that compound interest formula is the separate case of logistic growth model when potential capital K_p infinitively large number. In other words when $K_p \to \infty$, logistic future value model turns into compound interest formula: $K = K_0 (1+i)^n$, according to Girdzijauskas and Štreimikienė (2009, 2010). As can be seen from the presented model, capital can not grow in the same pace and the infinite long period of time. The considered logistic model show limited (logistics) capital growth, so is best for long-term process simulations.

"Inherent feature of the capital – growth, similarly grows GDP, however, the growth needs the space", says Girdzijauskas (2006, 2008). Economic growth, according to Štreimikienė, Girdzijauskas (2008) and Girdzijauskas, Štreimikienė (2009, 2010), can best be described as the transformation process. Modern economic growth rates – relative economic indicator's size changes in the comparative periods are closely related to the investments and specific technological changes and cyclical economic development supports the fact that economic growth is limited.

Country's economical capital – a key factor of economic growth: "Analysing the capital growth it is defined that there is a certain marginal size *potential capital (capacity)*. Conse-quently, *the capital* – a key factor of economic growth, and GDP – a key indicator of economic

GDP gap = Potential GDP – real GDP Potential capital = Real capital + capital Gap
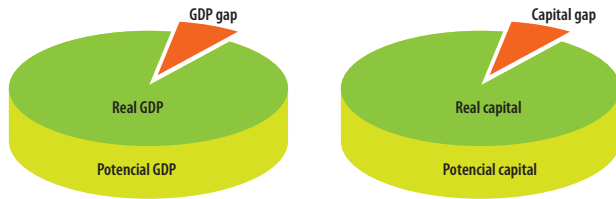

Fig. 1. Logistic capital model variable items
Source: Developed by authors, according to Girdzijauskas, Štreimikienė (2008, 2009, 2010)

growth, in this case the capital corresponds to – *the GDP created in country's economy*" (Girdzijauskas *et al.* 2009a; Girdzijauskas, Mackevičius 2009).

The real capital, in the case of economic cycle corresponds to the active (created) the real GDP in the economy. The residual capacity of the investments is devoted to capital growth and is defined as *a capital niche* similarly to that one can define it (relative value) as a GDP gap. *Potential capital* – is related to the investment environment, which depends on the economic conjuncture. Sometimes it is called tolerant (transporting) country's investment capacity. Based on the equivalent of the GDP gap, the capital difference (the gap) can be expressed by the formula (relative value) (Girdzijauskas, Štreimikienė 2008, 2009, 2010; Girdzijauskas *et al.* 2009a) (Fig. 1):

Source: Developed by authors, according to Girdzijauskas, Štreimikienė (2008, 2009, 2010)

In Fig. 1 "the schematic ratio of potential, real capital (K) and capital gap (K_g) is represented.

Therefore, potential capital (K_p) can be expressed by the following formula" (Girdzijauskas, Štreimikiene 2009 2010) formula (4):

$$K_p = K + K_g. \tag{4}$$

Based on gap GDP analogy the capital gap can be represented by the following formula (5):

$$K_g = 1 - \frac{K_b}{K} = \frac{K_b}{K_b - K}, \tag{5}$$

where K_p – potential capital, the largest productive capital that can be productively invested in the current economic situation (usually equal to 1); K – real invested capital, existing in a potential capital structure K_p (may be equal to GDP); K_g – the capital gap – uninvested part of the potential capital.

GDP gap shows the recession or boom of economy. If this calculation yields a positive number it is called an expansionary gap and indicates an economy in expansion; if the calculation yields a negative number it is called a recessionary gap and indicates an economy in recession. The economic cycles can be expressed by such fluctuations of real GDP also S. Girdzijauskas and D. Štreimikienė (2009, 2010) state that the main attention in the created GDP growth model is given to the capital accumulation difference, in other words, the capital gap (niche). Capital gap by its nature is a very important factor in the economic system development, evaluating and analysing economic expansion, but this phenomenon is

neglected. With the decreasing capital gap, real capital accumulation dynamics could change significantly; it is necessary analysing the economic system development, to take into account the growth of the limited resources (Girdzijauskas, Mackevičius 2009; Girdzijauskas *et al.* 2009a).

Girdzijauskas, Mackevičius (2009) and Girdzijauskas *et.al.* (2009a) state that economic "bubble" is characterized by the phases: bubble formation / rapid growth → price peak / boom → bubble explosion / price decline → stagnation of the sector / depression. The authors argue that economic cycles' and economic phases' essence coincides – there are growth, peak, fall and decline phases. When economic growth is of the exceptionally high rates and is fallowed by significant amounts of economic loss – in the opinion of authors it is the classic country's or region's economic bubble growth example.

The *definition of a bubble* tells that the bubble – it's very significant increase in an asset price, when the price is well above the fundamental property (assets) value (Smith *et al.* 1988). Bubble formation size depends on market expectations, which may affect consumption, investment and improve labor productivity (Martin, Ventura 2010). Dubnikovas *et al.* (2009), Moskaliova (2009) and Girdzijauskas *et al.* (2008, 2009b) states, that "the bubble formation is characterized by two conditions – fundamental and psychological. The first condition is related with the exhaustion of the growth area, the second condition – with the desire to earn and get profit. Bubble formation passes two stages: first fundamental, when the market because of the growth stock exhaustion starts to increase capital return (gives a signal to market participants about increasing profitability); the second psychological – when there is a willingness to invest profitably and earn well. The first condition ensures bubble formation, the second condition decides its size".

The economic cycle processes performing in the highest stage – sudden price jumps in the real estate market, the unemployment rate decrease (up to 4 percent.), money supply and credit growth, high inflation, increased production – the authors provide as the equivalent of bubble formation, thus identifying the economic cycle and the price bubble cycles, because of this the main conclusion follows that in the cyclical economical variations in certain cases forms a bubble effect and applying and introducing to it the fundamentally based production output rate there is obtained an economic bubble phenomenon (Girdzijauskas, Mackevičius 2009; Girdzijauskas *et al.* 2009b).

The definition of a bubble applied to the economic cycles, according to Girdzijauskas *et al.* (2009b) and Girdzijauskas, Mackevičius (2009) could be formulated as follows: "the country's (regional) economic bubble – a situation in which it is recorded a significant economic growth, when the economical value (GDP) far exceeds fundamentally based production extent". Here the authors propose to evaluate fundamentally based country's production volumes through the loaned capital influence and the individual economic sectors' influence on the country's GDP growth. When the economic growth is based on borrowed capital also if the level of the real GDP is distorted by the price bubbles formed in the market, the authors state that it can then signal the coming of the country's economy overheating and its sudden descent and following it – economic crisis.

The main causes of crisis origin, according to S. Girdzijauskas and M. Dubnikovas (2010) is now characterized by two now unidentified economic (market) paradoxes: I. Increasing

profitability paradox – which states that investing capital in a closed economy (market) while the investment environment declines, the profitability of invested capital increases. II. The paradox of credit(dept) traps – states that the loaned capital development, surpassing the own capital, appears after the capital niche shrinkage. According to S. Girdzijauskas, D. Štreimikienė (2008, 2010) and S. Girdzijauskas, M. Dubnikovas (2010) logistic model highlights the specific behaviour of loaned capital: loaned capital dynamics is much faster than own capital.

Consequently, more investments in the economy, more the economy is saturated with the invested capital, the lower decrease GDP niche's part and less space remains for the GDP development and growth. Here between the GDP niche and the capital invested into the economy reveals a close inverse linear relation of dependence – decreasing residual capacity part of the investment, increases investment efficiency. According to the scientists: "in terms of wide–scale economy, capital gap shrinkage and the accompanying bubble – is a key factor deciding the crisis or the ending of the economic cycle (business)" (Girdzijauskas, Štreimikienė 2010, Girdzijauskas *et al.* 2009c, 2009a). The authors of the theory state that "the maximal capital limits at which a bubble is formed, are possible to extend by these methods expanding the investment capacity: either by expanding the system itself needed for space growth or developing new technologies. In practice, these suggestions can be applied – to the producers or extending product markets, or postponing the maximal potential GDP limit while developing the technologies, expanding the production markets, thereby increasing the potential country's GDP, all of which delays the future capital niche contraction. However, because of the great loaned capital role in the economic growth the invested capital may grow in higher than the balanced rates and approach the marginal capital value more rapidly and accelerated than in the mentioned course of balanced growth, thus accelerating the formation of a bubble" (Girdzijauskas, Mackevičius 2009, 2009a; Girdzijauskas, Štreimikienė 2009, 2010).

Logistic capital management theory can be applied by analysing the country's economic growth and economic growth cycles. Theory accentuates that growth cannot be infinite and distinguishes itself assessing the capital limitations, the theory states, that there is a finite capacity of capital, representing the maximal amount of capital that can be effectively absorbed in the environment.

3.1. Logistical Lithuania's economic growth cycle analysis in 1995–2009

Logistic growth foundation „"S" shaped curve. V. Moskaliova (2009: 84) according: "*Logistic function's* has its limits, and changes only in a defined range: from zero up to a maximum limit value". The economy is cyclical, when it reaches saturation, begins to collapse, as well as the marginal efficiency of capital investment, as it reaches the saturation point, starts to decrease (Girdzijauskas, Dubnikovas 2010; Girdzijauskas *et al.* 2009c).

Classic expression of the logistic function describes such capital (GDP) growth tendency, which allows accurately identify the upper and lower capital growth limits (Girdzijauskas 2002, 2006, 2008). In this case it is considered that the original line growth – exponential, but when it is noticed "capital" outer and inner resistance – occur the signs of a slowdown, then it is assumed that there appears a logistic growth (Girdzijauskas *et al.* 2009c, 2009b). With the Loglet Lab 2 software tool one can predict the maximal population growth values.

This software package developed at Rockefeller University is appointed for the analysis of the data distributed in time, the model handles the logistic "S" function. Analysing the presented Lithuanian economy's logistic function (Fig. 2), it can be noticed that it can fairly accurately represents Lithuania's economic cycle variation tendencies during the exploratory period. Lithuanian economic cycle's curve that has been below the logistic model's curve "S" till 1995 *IV quarter (hereinafter – Q)*. 0–4 Point *(hereinafter – p.)* began to rise up after the expiry of recession and post–Soviet economic decline period, held Russian economic blockade and the transition from centrally planned to a market economy (Lithuanian Annual Strategic Review 2005). The period till 1995 in Lithuania's economic cycle distinguishes by a period of fundamental changes – there were held structural, economical, political and social economy reforms. 1996 *IQ* (point. 5) cycle and S–curve equal – reach a turning–point, from where GDP starts to grow rapidly and becomes detached from the S–curve, the gap between the logistic curve signals that in the economic environment forms the bubble effect, in other words, GDP is close to a maximum investment capacity, which in the country's economy can be effectively absorbed and reached maximal saturation limits: invested capital (GDP) reached the limits, economic growth stopped. 1997 *IVQ* (point. 11) GDP peaked and till 1998 *IIQ* the growth stopped. Since 1998 *IIIQ* GDP began to fall "... followed by the country's economic bubble burst phase, which manifests itself by – the economic crisis" (Štreimikienė, Girdzijauskas 2008; Girdzijauskas, Štreimikienė 2008, 2009, 2010).

Since 1998 *IIIQ* till 1999 *IVQ* (five quarters in a row) the economic cycle falls down sharply, reducing GDP by – 5.7 percentage point, economic cycle gets into the recession phase, which was conditioned by the shrinkage of the investment area. It could be argued that the trade rela-tions with Russia broke, took place Russian financial crisis, greatly decreased export volumes to the WAR countries, also sharply decreased demand in foreign markets because of impair-
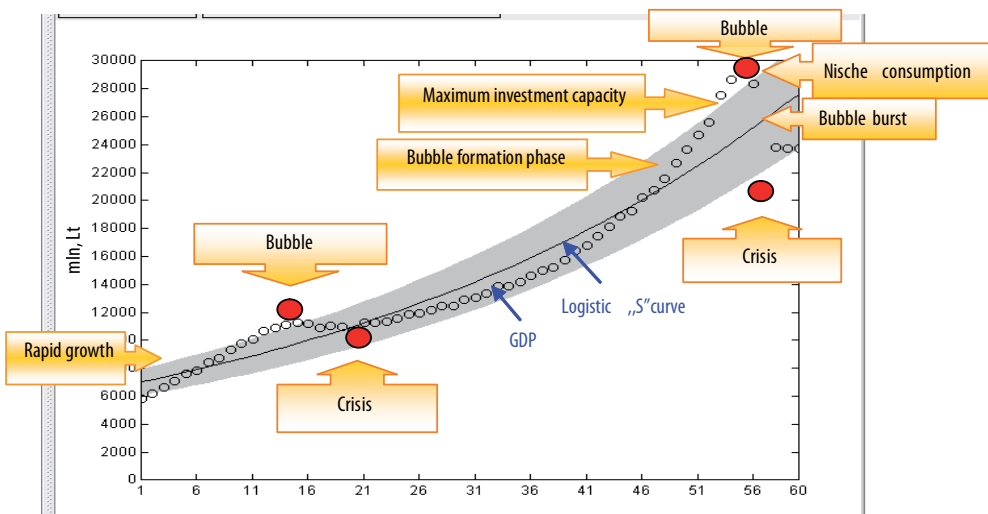

Fig. 2. Lithuanian GDP (quarterly) logistic analysis in the period 1995–2009
Source: The authors' concluded

ment of oil supply. It showed how painful and unforeseen may be external demand shock consequences to the national economy (Lithuanian Annual Strategic Review 2005). After 1999 held short-term economic crisis, since 2000 *IQ* (point 21) in the Lithuanian economy is observed a moderate growth, which runs parallel to the S curve till 2006 *IIQ* (point 46), here growth and S curve identify themselves till the saturation limit of the economy, from this point the curve of GDP growth is growing very quickly and quite strongly breaks away from the logistic curve. The period is defined as accelerating economic growth and market liberalization, structural reforms' conclusion. Lithuania accessed NATO and joined the European Union – financial support was begun to receive. This economic stage is characterized by the new innovations, technologies, bank loans with low interest rates and intensive consumption at the expense of future investment, rapidly growing domestic demand, rising prices followed by the growing inflation (LCB 2005), which growth rate signals about the economic boom formation process. 2007 *IVQ* and 2008 *IQ* (point 51–52) the economic cycle has reached the limits of its rapid growth, significant gap between the S–curve shows that the maximum saturation limit was reached, so in 2008 *IIIQ* (point 55) economic growth has stopped. In this period decreases the investment area, so "...even a little capital additionally invested to the country's economy generates high and fundamentally inexplicable returns, which self–actualise by the country's economic GDP growth therefore it is stated that in the country's economy proceeds a bubble–formation process" (Girdzijauskas *et al.* 2009a, Girdzijauskas, Štreimikienė 2009, 2010). GDP niche shrinkage has attracted more capital investors, who are seeking more and more unreasonably increasing investment returns, so in this case operates – an *increasing profitability paradox.* While investing capital in a closed economy or market and at the same time declining investment environment, increases the profitability of invested capital. Investors because of the ever rising profit expectations result in a rapid GDP niche overspend and thus form the bubbles of prices' and economy, followed by the sudden explosions, it takes a sharp drop in GDP – in the economic growth cycle there is observed a period of crisis, in this case, 2008 *IVQ* and 2009 *IQ* – GDP (point 55–57) fell 29.5 percent. "The main factors that have determined the following changes in the economy were the demand for domestic consumption and investments' negative tendencies. Private consumption growth was particularly slowed by the increased prices of consumer goods and services, rising unemployment, the growth in household debt servicing costs and tighter loan conditions. In 2008 the run–out and deepening financial crisis has undermined both business and consumer confidence, while tightening financial conditions, decreased the consumption and investments, sharply fell international trade volume, further worsened the situation in the housing market, tension in both domestic and international financial markets grew fast" (LCB 2008).

It should be noted that the economy is very dynamic and depends both on internal and on external factors, different sectors of the country's economy and different markets may react differently to the changes in the cyclical fluctuations, Lithuania's as a small country's economic cycle is very sensitive to various changes. Analysing the cyclical Lithuanian economic growth and the process of GDP change in 1995–2009 period can be confirmed that the economic growth is limited and when GDP reaches a maximum saturation limit (gap) – growth stops and the bigger capital coming into the economy over the marginal capital saturation logistic

curve shows that in the economic growth cycle forms an economic "bubble" and then follows the sudden economic cycle drop stage, characterized by an economic crisis.

3.2. Lithuanian macroeconomic indicators' and affecting factors' analysis in the period of 1995–2009

Further the correlation and regression analysis was performed, which was aimed to identify the associations between certain macroeconomic indicators and GDP growth trends in order to establish the macroeconomic factors that mostly affect and most accurately assess the changes in economic cycle's phase. The macroeconomic indicators were drawn from the Lithuanian Department of Statistics (1995–2009) (Table 1).

The correlation coefficient (r, ranging from –1 to +1) is calculated based on statistical function. Strong correlation has high and weak correlation – low absolute values of coefficient. The correlation coefficient was calculated according to Spearman (rank correlation) – when there were less than 30 comparative series (eg. 1996–2009 values) or according to Pearson (linear correlation) – when there were more than 30 comparative series (eg. 1996–2009 quarterly values). Statistical confidence level was set at 95%.

For statistical calculations "SPSS 15.0 for Windows" software package was used. The aim of the analysis was to define, which prognostic indicators strongly correlate ($r > 0.80$) with GDP growth trends and to evaluate in this way, which of the regression models are most suitable for the prognostic calculations. For calculations of correlation coefficient each prognostic indicator was compared with the percentage change in GDP growth, using different regression models and assessing the correlation coefficient between each prognostic indicator and GDP percentage change – r coefficient average is derived.

In Fig. 3 paired correlation analysis showes that the annual change in GDP well correlates not macroeconomic indicators themselves in absolute value terms, but with their annual percentage changes. It was found that the strongest correlation of the change in the GDP
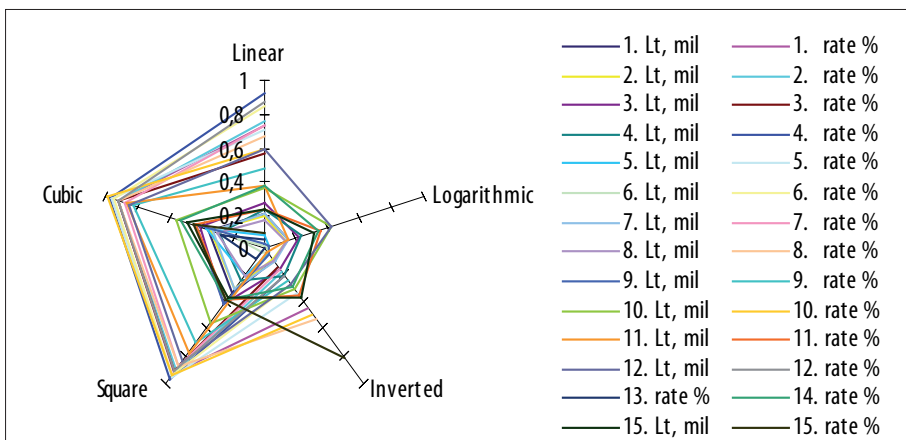

Fig. 3. GDP change and other macroeconomics indicators: paired correlation depending on regression models. *Source:* The authors concluded

Table 1. Macroeconomic indicators in Lithuania during 1995–2009, mil. Lt

Data	GDP mil. Lt	rate %	Final consumpt. expenditure mil. Lt	House-hold consumpt. expenditure mil. Lt	Govern-ment consumpt. expenditure mil. Lt	Gross capital forma-tion mil. Lt	Goods and services exports mil. Lt	Goods and services imports mil. Lt	Salaries and wages mil. Lt	Produc-tion & import taxes mil. Lt	Subsi-dies mil. Lt	ES struc-tural sup-port mil. Lt	Banks loans' portfolio mil. Lt	Govern-ment debt mil. Lt	Infla-tion rate, %	Un-em-ploy-ment rate, %	Banks annual inter-est rate %
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1995	26 924	3.3	23 694	17 069	6593	6096	12 777	15 643	8144	3225	275		11 512	6191	35	11.8	23.9
1996	33 706	4.7	29 734	21 485	8217	7063	16 879	19 969	10 246	3880	396		14 500	7314	13.1	14.1	16.0
1997	40 515	13.1	34 674	24 787	9844	9941	20 911	25 011	12 384	5475	349		21 120	8077	10.3	13.3	11.9
1998	45 016	10.3	39 209	27 461	11 703	10 926	20 316	25 435	14 782	6198	472		55 000	9614	5.4	14.1	12.6
1999	43 885	5.4	38 950	28 444	10 435	9348	16 973	21 385	14 946	5990	457		55 190	12 069	1.5	16.4	13.0
2000	45 737	1.5	39 968	29 448	10 413	8639	20 466	23 336	14 137	5755	361		65 030	12 720	1.1	15.4	11.0
2001	48 637	1.1	41 941	31 424	10 425	9380	24 214	26 898	14 602	5939	412		104 160	12 900	1.6	17.1	8.1
2002	52 070	1.6	44 272	33 231	10 894	10 775	27 444	30 420	15 995	6467	414		116 777	13 160	0.3	10.8	6.1
2003	56 959	0.3	47 817	36 358	11 308	12 461	29 137	32 456	17 849	6674	447		120 999	12 050	–1.1	9.8	5.1
2004	62 698	–1.1	52 902	40 562	12 158	14 234	32 636	37 074	20 142	7052	855	440	168 970	12 160	1.2	11.8	5.7
2005	72 060	1.2	59 958	46 312	13 503	17 228	41 458	46 584	23 331	8213	1335	2530	259 750	13 310	2.7	10.2	5.3
2006	82 793	2.7	69 415	53 269	15 966	21 804	48 917	57 343	28 086	9478	1369	6410	386 410	14 940	3.8	6.4	5.1
2007	98 669	3.8	81 375	63 508	17 638	30 459	53 372	66 537	33 367	11 789	1533	9710	567 460	16 740	5.8	5	6.9
2008	111 190	5.8	93 872	72 141	21 469	30 036	66 975	79 693	38 153	13 276	1506	12190	601 140	17 370	11.1	4.9	8.4
2009	92 450	11.1	82 035	62 596	19 206	11 528	49 237	50 446	32 844	10 828	1273	740	714 410	27 104	5.4	13.8	8.4

Source: Lithuanian Department of Statistics

and other macroeconomic indicators appears in the cubic model with the square regression model little behind. Based on paired correlation analysis cubic (as optimal) model, only those indicators were selected for the calculations which show strong correlation in the optimal model ($r > 0.8$) – in total 11 prognostic indicators, all of them in terms of annual percentage change: final consumption expenditure ($r > 0.929$), household consumption expenditure ($r > 0.906$), government consumption expenditure ($r > 0.911$), total capital formation ($r > 0.970$), goods and services exports ($r > 0.964$), imports of goods and services ($r > 0.964$), salaries and wages ($r > 0.878$), production and import taxes ($r > 0.904$), subsidies ($r > 0.824$), EU support ($r > 0.983$), the consolidated national debt ($r > 0.912$) (Fig. 4).
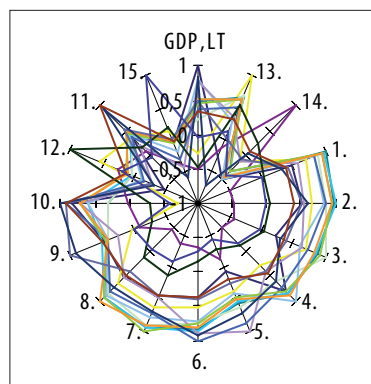

Fig. 4. Prognostic indicators in terms of annual percentage change: correlation analysis in Optimal models. *Source:* The authors concluded

The statistical analysis of macroeconomic data revealed that the GDP percentage growth is mostly appropriately predicted by *3 prognostic indicators – percentage annual EU support, gross capital formation and export of goods and services change*. These macroeconomic indicators were strongly correlating with GDP changes during the cycle, hence they strongly influence the formation of economic growth cycle phases (Fig. 5).

EU structural support element. The correlation coefficient shows a strong direct correlation between the GDP changes ($r > 0.829$) and other economic factors. EU received structural support received indicator correlates with virtually all macro-economic indicators, directly makes impact on the export of goods and services ($r > 0.7$), import ($r > 0.9$), wages and salaries ($r > 0.7$), production and import taxes ($r > 0.7$), the subsidy elements ($r > 0.9$), and strongly influences changes in banks' loans' portfolio ($r > 0.9$) – therefore, strongly affected the increasing money supply. On one hand, because of the EU support, to Lithuania's economy have come new innovations and technologies, many industries have expanded production capabilities. It should be noted also that these cash flows are very important for the country's economic and social development (Fig. 5).

Increased supply of the money amount in the economy forms the supply in the country's economy, encourages the rise of new markets, which are filled with new innovations and technologies, thus creating increasing demand and rising consumption level, which leads to faster growth of the economic growth cycle. On the other hand, in many cases, the EU's financial support cash flows are refinanced, which even more rapidly increases bank loans with low interest rates, intensive consumption and investment at the expense of future change tendencies, related to the rapidly growing domestic demand, rising prices levels and inflation ($r > -0.7$) thus, while the EU's support parameters are growing, i.e. money amount is increasing, consumption grows and raises inflation level and rapid inflation growth rate warns about the economic boom formation process. In summary, the incoming EU support cash flows accelerated economic growth cycle.
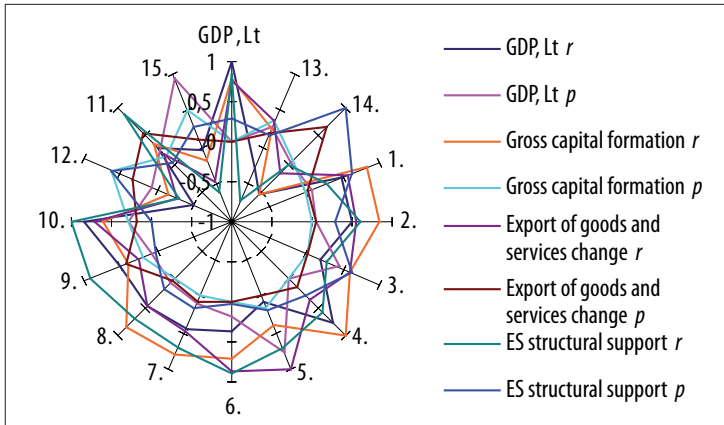
Fig. 5. Impact of prognostic indicators on percentage annual growth of GDP
Source: The authors concluded

Gross capital formation factor. Here exists a strong relation between ($r > 0.802$) and the GDP change. The indicator is related to the country's major investments into fixed asset (buildings, which are investments in housing and there is the cost for new homes' and apartments' construction which are the part of business investment and the cost of buildings (factories, warehouses and office buildings); equipment, machinery and other investments, the cost of vehicles. Negative reverse interdependency relation manifests with unemployment, where $r < -0.495$, while unemployment rate decreases this factor is growing, strongly correlating with the final consumption expenditure ($r > 0.815$), household consumption ($r > 0.833$), production and import taxes ($r > 0.873$), the average strength relation with the goods and services import ($r > 0.719$), salaries and wages ($r > 0.473$), government consumption expenditure ($r > 0.6$), also the support received from the EU ($r > 0.6$) and the direct inverse interdependency weak relation with an annual interest rate ($r < 0.196$), the bank loan portfolio growth tendencies ($r > 0.407$) (Fig. 5).

This factor strongly influences GDP growth and the economic cycle phases' changes, in the period of 1995–1998 the consumption market surged an accumulated savings surplus, an inflation and price spiral spinned, in the economy in a relatively short period of time developed a situation where economic growth has been driven by the growing prices prevailing in the domestic market and excess of domestic consumption growth, also large and rapid investments into the capital. Therefore the closed, small Lithuanian economy was saturated in a very high rate. Very similar tendencies were observed in the period of 2000–2009, when in the economy formed real estate supply and demand imbalances, based on loaned capital growth, which increased investments into the general country's capital and led to the economic boom formation factors and the economic cycle change processes. General capital's formation indicator had a very strong influence on the economic growth cycle, if increasing, this factor directly impacts the formation of a cycle and its change in the cycle reflects the economic growth tendencies.

Goods and services export factor. Here the correlation coefficient $r > 0.771$ indicates a strong direct relation with GDP growth rate changes (this macro–economic figure strongly influences economic growth cycle changes, as already mentioned, namely the decrease in exports severely affected the country's economy, resulting in the 1999 financial crisis and has a strong relation with internal and external, direct and indirect supply and demand factors. Increasing export – a sign that the country is increasing production volumes, reducing the unemployment rate ($r > 0.664$). Also there is observed a moderate correlation with the EU support factors ($r > 0,7$), because it encourages new innovations coming to the country's agricultural sector system creating new added value in the production processes, new jobs and influences external demand factors. Deepening processes of globalisation promote the development of Lithuanian industry and sales in foreign markets, in such a small country as Lithuania the growth of exports has a substantial impact on economic growth cycle. Export is one of the most important factors that enhance economic growth limits and space, also encourage investment growth factors (Fig. 5).

Following the analysis of macroeconomic indicators' and factors' affecting them, it can be suggested that all the investigated variables are of crucial importance and particularly relevant and important are the factors affecting the cycle of economic growth.

3.3. Hypothetical Lithuania's economic growth cycle assessment model

According to the analysed logistic capital management theory, the carried out logistic GDP and macroeconomic correlation regression analysis, was formed the hypothetical *Lithuania's economic growth cycle research model* (Fig. 6).

Economic growth cycles' formation process in the literature is often based on increased demand, technological progress and innovation. It can be equated to the Lithuanian economy after the end of Soviet period, when came an extensive new era of innovation, new markets
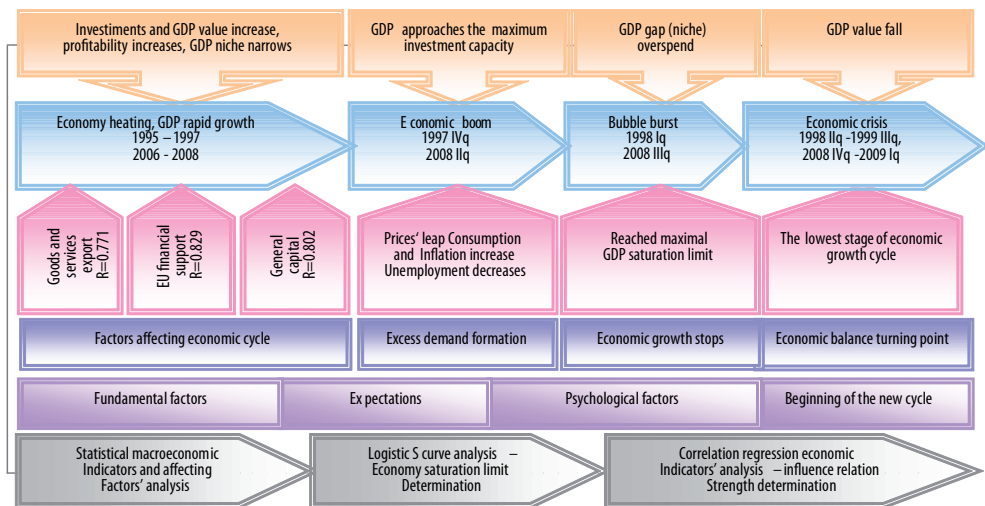

Fig. 6. Lithuanian economic growth cycle research model
Source: The authors concluded

and product assimilation period, which gave a positive impetus to the very rapid economic growth.

On the other hand, at the rise of new technologies, new closed markets and created for the new products, in this case – the economy of Lithuania was filled with extremely high acceleration and with great excitement in a relatively short period of nineteen years, in order to meet the ever–increasing profits and the desire to live better needs. The financial crisis of 2009 – a consequence of a rapid and unbalanced economic development – the large financial capital flows, labor resources have been concentrated in private sectors of the country's economy, although this country's economic disbalance status tends to the economic cycle development, especially considering the global integration and globalization processes, competition–level rise globally, both internal and external demand – supply factors heavily influenced such a small country's like Lithuania economic growth cycle tendencies.

4. Conclusions

Scientists exploring the economic theories do not consider the limitations of the economic growth and the influencing factors. Created *logistic capital management theory* confirms the fact that economic growth can not be infinite – it is limited and sooner or later ends.

After performing the logistic analysis with Loglet Lab 2 software tool and having analysed the cyclical process of GDP change in Lithuania in 1995–2009 period it was confirmed that economic growth is limited and after GDP has reached maximum saturation limit – growth stops. Greater amount of capital coming into the economy over the marginal saturation indicates that in the economic growth cycle forms an economic „bubble" and then the following immediate economic cycle fall stage, characterized by an economic crisis.

After having performed the Lithuanian macroeconomic indicators' and the influencing factors' correlation and regression analysis of 1995–2009 period it showed that Lithuania's GDP growth tendencies and the change of economic growth cycle stages are the strongest formed by the *three economic growth factors*: the EU financial support, the gross capital formation and exports of goods and services.

The created theoretical economic growth cycle assessment model joining the economic growth cycles' and the bubble formation mechanism, can be applied in practice assessing the economic growth cycle stages' formation and allowing the prediction and assessment of the changes of economic balance tendencies'.

References

Dubnikovas, M.; Moskaliova, V.; Girdzijauskas, S. 2009. Analysis of the Share Price Bubbles in the Baltic Countries, *Business Information Systems Workshops.* Book Series: Lecture Notes in Business Information Processing. Poznan, Poland, 27–29 Apr, 2009. Vol. 37: 119–129.

Fereira, O. C. 2002. *Capital Accumulation in the Brazilian economy.* Available from internet: <http://ecen.com/eee9/capacume.htm>.

Freeman, Ch. 1982. *Innovation and long cycles of ecomonic development.* Economics Department, University of Campinas [online] Available from internet: Innovation and long cycles of economic development Professor. <pdf>

Freeman, Ch. 2008. *Systems of Innovation:* Selected Essays in Evolutionary Economics. Cheltenham: Edward Elgar.

Freeman, Ch., Louca, Fr. 2001. *As Time Goes By. From the Industrial Revolutions to the Information Revolution.* Oxford: Oxford UP.

Girdzijauskas, S. 2002. Logistiniai (ribiniai) kaupimo modeliai [Logistic (marginal) accumulation models], *Informacijos mokslai* [Information Sciences] 23: 95–102.

Girdzijauskas, S. 2006. *Logistic Theory of the Capital Management: Deterministic methods.* Vilnius: Vilnius University Publishing House. 232 p. (in Lithuanian).

Girdzijauskas, S. 2008.The logistic theory of capital management: Deterministic methods – Introduction, *Transformations in Business and Economics Suppl. A Published* 7(2): 22–163.

Girdzijauskas, S.; Dubnikovas, M. 2010. Logistic Analysis of Price Bubble and Current Situation in USA Real Estate, in 13*th International Conference on Business Information Systems*. Berlin, Germany, 03–05 May, 2010, Vol. 57: 13–18.

Girdzijauskas, S.; Mackevičius, R. 2009. Kapitalo augimo modeliai ir logistinė kapitalo valdymo teorija. Naujas požiūris į ekonomines krizes [Capital Growth models and Theory of Logistic capital Management. New approach ti Economical Crises], *Journal of Economics & Management* (14): 757–762.

Girdzijauskas, S.; Štreimikienė, D. 2008. Logistic Growth Models for Analysis of Stocks Markets Burbles, in *The 2008 International Conference of Financial Engineering, Lecture Notes in Engineering and Computer Science,* London, England 02–04 Jul. 2008, Vol. I-II: 1166–1170.

Girdzijauskas, S.; Štreimikienė, D. 2009. Application of logistic models for stock market bubbles analysis, *Journal of Business Economics and Management* 10(1): 45–51. doi:10.3846/1611-1699.2009.10.45-51

Girdzijauskas, S.; Štreimikienė, D. 2010. Logistic Analysis of Business Cycles, Economic Bubbles and Crises, in *Business Intelligence in Economic Forecasting: Technologies and Techniques.* Hershey, New York, 45–64.

Girdzijauskas, S.; Štreimikienė, D.; Mackevičius, S. 2009a. Logistic Analysis of Ekonomic Fluctuations, *Journal of Management* 14(2): 75–81.

Girdzijauskas, S.; Štreimikienė, D.; Čepinskis, J.; Moskaliova, V.; Jurkonytė, E. ; Mackevičius, R. 2009b .Formation of economic bubbles: sauses and possible preventions, *Technological and Economic Development of Economy*, 15(2): 267–280. doi:10.3846/1392-8619.2009.15.267-280

Girdzijauskas, S.; Štreimikienė, D.; Dubnikovas, M. 2009c. Analysing banking capital with Loglet Lab software package, *Transformatios in Business and Economics* 8(2): 48–56.

Girdzijauskas, S.; Pikturna, A.; Ivanauskas, F.; Merkevičius, E.; Moskaliova, V. 2008. Investigation of the elasticity of the price bubble functions, in 20*th International Conference /Euro Mini Conference on Continuous Optimization and Knowledge-Based Technologies (EurOPT 2008).* Neringa, Lithuania, May 20–23, 2008, 131–136.

Gronskas, H. Y.; Štreimikienė, D.; Girdzijauskas, S. 2008. Economy, anti-economy and globalisation, *Transformations in Business and Economics* 7(2): 166–168.

LCB. Finansinio stabilumo apžvalga 2005 [Finacial stability review] [interactive]. Available from Internet: <http://www.lb.lt/fsa_2006_2>.

LCB. Finansinio stabilumo apžvalga 2008 [Finacial stability review] [interactive]. Available from Internet: <http://www.lb.lt/fsa_2008_2>.

Lietuvos metinė strateginė apžvalga 2005 [Lithuanian Annual Strategic Review 2005]. Strateginių tyrimų centras, LKA [Center for Strategic Studies, LKA] Vilnius [interactive]. Available from Internet: <http://www.lka.lt/index.php/lt/148425/ISSN 1648–8016>.

Lietuvos statistikos departamentas 1995–2009 [Lithuanian Department of Statistics 1995–2009] [interactive]. Available from Internet: <http://www.stat.gov.lt>.

Martin, A.; Ventura, J. 2010. *Economic Growth with Bubbles*. NBER.Working Paper 15870. Cambridge, MA 02138.

Moskaliova, V. 2009. *Netvarių ekonominių situacijų logistinė analizė*: mokslo daktaro disertacija [Unsustainable economic situations logistic analysis: PhD thesis].Vilnius: VU. LABT. 156 p.

Moskaliova, V.; Girdzijauskas, S. 2006 The risk of investment: Determinate models, in 7*th International Baltic Conference on Databases and Information Systems (Baltic DB&IS 2006).* Vilnius, Jul 03–06, 2006, 91–100.

Moskaliova, V.; Girdzijauskas, S. 2005. Instability modeling of financial pyramids, in 5*th International Scientific and Practical Conference on Environment, Technology, Resources, Procesing*. Rezekne, Latvia, Jun 16–18, 2005, 26–32.

Schumpeter, J. A. 1961. *The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle.* New York: OUP.

Smith, V. L.; Suchanek, G. L.; Williams, A. W. 1988. Bubbles, Crashes, and Endogenous Expectations in Experimental Spot Asset Markets, *Econometrica* (56):1119–1151. doi:10.2307/1911361

Štreimikienė, D.; Girdzijauskas, S. 2008. Logistic Growth Models for Analysis of Sustainable Growth, *Transformations in Business and Economics* 7(3): 218–235.

LOGISTINĖS KAPITALO VALDYMO TEORIJOS MODELIO TAIKYMAS LIETUVOS EKONOMINIO AUGIMO CIKLUI

D. Štreimikienė, N. Barakauskaitė-Jakubauskienė

Santrauka. Straipsnyje analizuojama viena iš naujausių ekonominio augimo teorijų – prof. S. Girdzijausko (2006, 2008) sukurta logistine kapitalo augimo teorija, kurios pagrindinė idėja remiasi rinkos prisisotinimo ir ribotumo sąvokomis. Teorijos esminius teiginius siekiama pritaikyti, vertinant Lietuvos ekonominio augimo ciklą 1995–2009 metų laikotarpiu. Atliekama Lietuvos BVP logistinė analizė (LogletLab2), makroekonominių rodiklių bei jiems įtaką darančių veiksnių koreliacinė regresinė analizė (SPSS 15,0). Straipsnio pabaigoje pateikimas sukurtas ekonominio augimo ciklus ir burbulo susiformavimo mechanizmą apjungiantis hipotetinis Lietuvos ekonominio augimo ciklo vertinimo modelis.

Reikšminiai žodžiai: ekonominis, augimas, logistinis, kapitalo valdymas, ciklas, burbulas, modelis.

Dalia ŠTREIMIKIENĖ is a professor at Vilnius University Kaunas Faculty of Humanities. She graduated from Kaunas Technological University in 1985 and obtained a PhD (Social Science) in Vilnius Technical University in 1997. Since 1985 up till now she works in Lithuanian energy institute. The main areas of research are energy and environmental economics and policy, development of economic tools for environmental regulation in energy sector seeking to promote use of renewable energy resources. The author of more than 50 scientific publications in foreign and Lithuanian scientific journals.

Neringa BARAKAUSKAITĖ-JAKUBAUSKIENĖ is a lecturer at Vilnius University Kaunas Faculty of Humanities. She graduated from Vilnius University Kaunas Faculty of Humanities in 2010 and obtained MSc in Economics. Her research interests include analysis of economic cycles and bubbles, climate change mitigation policy in energy sector, evaluation of macroeconomic policies impact on economic cycles.