Analysis of the Share Price Bubbles in the Baltic Countries

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Abstract. The last two years where marked with the formation of a number of financial bubbles and their bursts in various markets of capital, real estate and raw materials. The years 2007-2008 became a large scale trial both for professional and home economy that unavoidably was related with finance. Both bubble formation and burst determined the damage of the clients' global confidence in financial institutions and confounded their expectations. It caused corrections in the economic growth prediction since a number of countries found themselves on the verge of financial crisis. Three Baltic states that were earlier called the tigers of the European growth had encountered the described situations with the special difficulty – the indices of consumer and business confidence decreased by ten years; the growth of gross internal product decreased to minimum, or even acquired the features of recession, and the capital markets lost about one third of capitalization. The paper aims at the analysis of the alteration of the share market in the three Baltic countries – Lithuania, Latvia and Estonia – during the last nine years with regard to price bubble formation and bubble bursts. The research was carried out with the use of the comparative analysis of the scientific literature, the method of mathematical analysis and generalization. The analysis revealing how the three capital markets reached the level of capital saturation and when it manifested itself was performed with the computation program "Loglet Lab2".

Keywords: share price bubble, logistic growth model, Baltic stock exchange, index.

1 Introduction

Sometimes finance markets, similarly to other constituent parts of the economic structure, demonstrate an 'unnaturally' rapid growth of prices. It is considered that such upturns which last for several months or even years do inevitably end in a sudden drop to their 'true level'. The mentioned phenomenon is called the price bubble or crisis, and occurred in the Baltic countries as well. The dictionaries of financial terms describe the price bubble theory as "a theory under which security prices sometimes move wildly above their true values, or the price falls sharply until the 'bubble bursts'. It is also possible for a bubble to deflate gradually" [1].

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Each financial bubble burst results in heavy economic outcomes. Therefore this financial phenomenon deserves a special concern of researchers. In other words, the analysis of the errors of the past might help to avoid them in the future.

The paper aims at the analysis of the indices of the Baltic stock exchanges by focusing on the functions of the limited growth (or logistic functions) that describe the process of the capital accumulation (or growth).

The specificity of the logistic function lies in its limited growth aspect. To say more, it undergoes alteration exclusively within a described interval: from zero to a particular (maximum) rate. The logistic growth is a characteristic feature not only with respect to capital but, actually, to any population whose rate of growth is proportional to its size.

On the whole, the logistic models have been widely applied for the investigation of the biological systems. In the field of economic inquiry, they have been seldom applied – only single attempts at the analysis of the economic systems have been discovered by the authors of the paper [3], [4]. The main drawback of such models is that they do not offer the growth function expressed in compound interest. In Lithuania, the exploration of the mentioned problem started in 2002 [5].

By performing the analysis of the index alteration of the Baltic and employing information technologies it will be determined whether the explored logistic functions might be applied for the analysis of the practical data. The paper aims at determining whether the capital markets of the Baltic countries were faced with the price bubble burst situation and whether they reached the limited capital saturation that most probably provoked the sudden financial slumps.

The objective of the paper is to find out whether the capital markets of the Baltic countries have reached the level of the limited capital saturation by employing the logistic functions.

The object of exploration is the history of the indices of the Baltic countries in 2000-2009.

Methods of research: analytical, also embracing the methods of comparative and mathematical analysis and econometric calculations.

2 Logistic Modeling of Investments

Excluding rare exceptions, the contemporary economic research and specifically, in the field of investment postulates that economic growth is unlimited. While actually, sooner or later each growth gets exhausted. It is observed in the course of nature. The models analyzing the growth of populations in biology were worked out more than a hundred years ago. The cyclic development of economy in various regions and states confirms that the economic growth is limited as well. A recently created and developed theory of the logistic management of capital at Vilnius University, Lithuania, fits well for the description of the limits of the economic growth and the causes of the economic bubble formation, and might provide the researchers and patricians with the proper tools – the logistic growth models – to formalize these processes [10], [11].

Usually, the analysis of the growth of capital means that there is a particular **Investment Capacity** (or range) of the limited size which the given capital might

occupy. As a rule, the invested capital fills only a part of investment capacity. This part of capacity will be defined as **Investment Coverage**. A residual free part of capacity is intended for the capital growth and will be called **Resources of Growth**. Occasionally, investment capacity can be equal to capacity of the whole economic structure [3]. Consider:

Investment Capacity = Investment Coverage + Resources of Growth

The relation between variables in the logistic model is schematically shown in Figure 1.

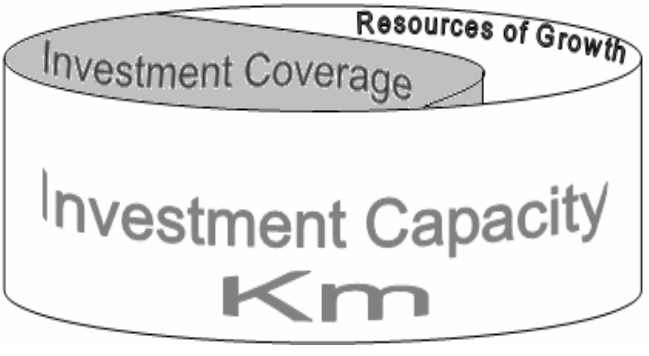

Fig. 1. The relation between variables of the logistic model

Investment capacity is limited, and with an increase of investment coverage the growth resources are diminishing. Therefore investment capacity limits the growth of investments. When investments are approaching the capacity limits, the economic bubbles begin to burst [9]. The bubble is formed when Investment Coverage increases in the fixed Investment Capacity and thus Resources of Growth decrease. In this situation, efficiency of investments, or logistic internal rate of return increases very sharply. Such behavior of the system causes the formation of the so called *bubble effect*.

It has been proved that the bubble can provoke crises (i.e. increase inflation, etc.) in the whole economy, into which certain capital is integrated. Hence it is necessary to emphasize that it is not inflation that causes the formation of the bubble, but vice versa – the forming bubble initiates and increases the processes of inflation.

The worked out logistic theory of capital management shows how to avoid the phenomena of overheated economy, or how to mitigate its fatal consequences. For this purpose, it is necessary to enlarge the capacity of capital. Seeking to escape the price bubbles, the investment capacity should be extended through globalization and by entering the new markets (an extensive mode), or through an implementation of technological innovations (an intensive mode). It is obvious that the second mode is more perspective.

Most frequently, in the cases when various financial problems occur in relation to payments or cash rate at the given moment of time, or when it is urgent to model the capital price, investments or any other cash flows, the present or future value of

capital is calculated. As a rule, such calculations are based on the so called formula of compound interest [2]. Consider:

$$K = K_0 \cdot r^t \tag{1}$$

here: K_0 is the present capital rate; K expresses the future capital rate, or the capital rate at the t moment of time; r describes the coefficient of accumulation rate; ($r = 1 + i$ here: i is interest rate); t is the duration of accumulation expressed in time units that are fixed in interest rate. Sometimes Equation (1) is called an exponential function of capital accumulation.

Traditionally, Equation (1) is used to calculate the growth of capital (population, products, etc.). However, such calculation may be performed only until the capital growth is not restricted by external factors [6]. Capital cannot increase at an equal rate endlessly, the more so if the system is completely or partially closed. When growing within such a system, it exhausts the limited resources in its environment. In other words, it enters into self-competition, which diminishes its growth – the system gets 'satiated'.

It is assumed that in the given environment, capital may increase up to a certain limit (in the given environment, only a particular amount of capital not larger than the determined one may be invested). The maximum rate of growth is K_m. Then the interval of the capital alteration or capital growth (relatively, it may be considered as an areal or space of growth) is as follows:

$$K_0 \leq K \leq K_m .$$

The growth of capital will be described by the logistic function of growth [5]. Consider:

$$K = \frac{K_m \cdot K_0 \cdot r^t}{K_m + K_0 \left(r^t - 1\right)} \tag{2}$$

here: K_0 is the present capital value; r defines the accumulation rate coefficient and t is time expressed in the same units as the time estimated in the interest rate of growth (in most cases, it points to the whole periods of the interest rate re-calculation).

It should be noted that, if the maximum value of the product K_m increases and approaches infinity $(K_m \to \infty)$, i.e. if for Equation (2) the limit $\lim_{x \to \infty} K$ will be calculated, then, as it might have been expected, Formula 2 will turn into an ordinary rule of compound interest (1). Then the formula of compound interest (1) will make a separate case of the logistic accumulation function (2), where the maximum capital rate K_m is extremely high.

On the basis of the studies concerning the logistic growth models the explanations of the formation of the stock market bubbles will be extended. Usually, in the analysis of capital price, investments, or other money flows the present value or future value of capital is calculated. The logistic present value may be expressed by the following equation [3], [7], [8], [9]. Consider:

$$K_0 = \frac{K_m \cdot K}{K + (K_m - K) \cdot r^t} \tag{3}$$

Here: K_0 is the present rate of capital; K describes the rate of capital at the time moment t; r denotes the rate of growth accumulation with the interest rate I; t is the time of accumulation in time units fixed in the interest rate. Actually, the described expression is the formula of logistic discount.

The logistic function of accumulation (2) is differentiated with respect to the coefficient of the accumulation rate r. The dependence of the logistic capital accumulation rate is found out from the coefficient of the accumulation rate r:

$$\frac{dK}{dr} = \frac{K_0 \cdot K_m \cdot r^{t-1} \cdot t \cdot (K_m - K_0)}{\left(K_m + K_0 \cdot \left(r^t - 1\right)\right)^2} \tag{4}$$

Figure 2 shows the dependence of the capital accumulation rate on the interest rate, when the rates of marginal capital vary, the value of the initial capital is equal to 1 (K_0 = 1) and duration of accumulation is equal to ten (t =10).

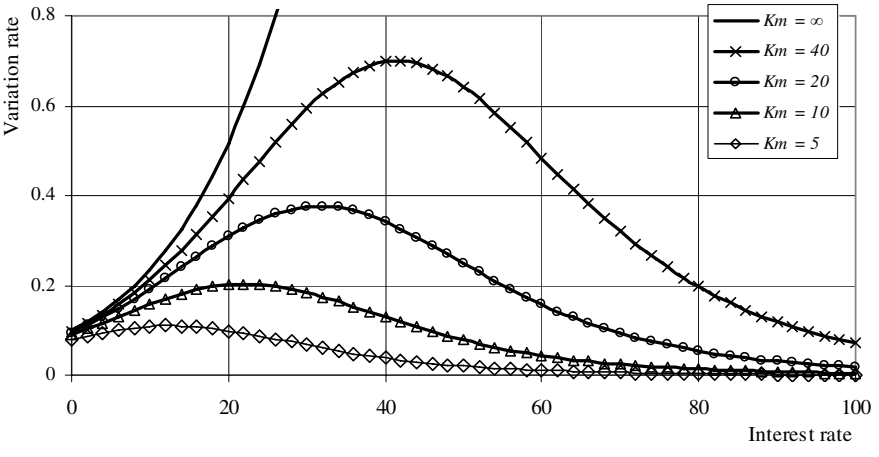

Fig. 2. Dependence of the capital accumulation rate on the interest rate when the rates of marginal capital differ; t = 10 and K_0 = 1

The logistic model demonstrates the economic growth under constraints. The pressure of constraints starts after having reached the peak of the diagram representing the growth rate (called the marginal growth rate) and then is going down which shows the slowing down rate of the economic growth, finally approaching an economic crisis. In fact, only the rapid progress in research and technologies may help to solve this problem allowing the entrance into a new stage of the economic development based on the implementation of the new transparent, efficient and resource-saving technologies.

3 The Situation in the Baltic Countries

The capital markets of Lithuania, Latvia and Estonia have a fifteen-year history. However, during this short period of time they experienced several vital conversions – the Baltic countries entered the NATO and the European Union; in 2005 they joined the OMX, i. e. the North Europe Security Trade System.

Despite an expanded market accessibility to investors these three stock exchanges have remained rather limited and enclosed. First and foremost, small market capitalizations (on an European scale) determined that there market liquidity was insufficient to receive large capital; secondly, the frozen list of the quoted companies did not allow to expand the markets.

An assumption has been made that the capital markets of the Baltic countries were limited enough to reach the level of limited capital saturation, which later on caused the price bubble bursts and initiated the market crises.

In 2008, the indices of the three Baltic countries approximately lost about 2/3 of their rate and thus considerably exceeded the world scale of crisis when the average drop of 70 most popular indices reached 40%. Due to the data of the stock exchanges, the main index OMXV (of Vilnius Stock Exchange) decreased to 65.14%; the main index OMXR (of Riga Stock Exchange) dropped down to 54.43% and the main index OMXT (of Tallinn Stock Exchange) dropped down to 62.98%.

The differences having been considered, each Baltic market was examined individually. The computation program LogLet was used to determine whether the rate of potential capital (i. e. the point of capital saturation) was reached and where it was likely to be fixed.

3.1 Vilnius Stock Exchange

The data of the Vilnius Stock Exchange index OMXV that covered the period of 2000–2009 has been thoroughly examined in Figure 3. The index break served as a signal of the formation of the bubble whose burst later on caused the crisis. The economic logistic analysis shows that when the market exhausts its growth possibilities, i. e. approaches the rate of potential capital (the limit of growth), an accelerated increase of invested capital return takes place. It evokes illusory optimism among the investors, thus encouraging people to get interested in this alternative way of capital management.

Such moves were observed both in 2005 and in 2007. In the first half of 2006 an obvious equity price correction was carried out on the basis of the apprehension for the future financial situation when the rapidly growing prices for raw materials and especially for crude oil initiated the growth of inflation.

Meanwhile, in the second half of 2007 the information about the price bubble burst in the real estate market was received. In fact, an obvious chain reaction in the price bubble bursts took place within the economic structure.

The graph shows that a few stages of the increase of the investors' optimism occurred in Vilnius Stock Exchange which ended in the price bubble burst. It should be stressed that the growth of index above the line of limited capital saturation indicates the price bubble formation.

Among the reasons causing bubble formation one of the most important was the limitation of the market amount. When the trade list is not expanding with the additional quoted companies, the potential (i. e. limited) capital rate is reached. The very fact that no new companies appear on the market determines the limited choice open for the investors as well as the limited amount of the potential investments. It means that the new investors are forced to 'buy' the former investors as well and thus against their will they do increase the distance between the share market prices of the

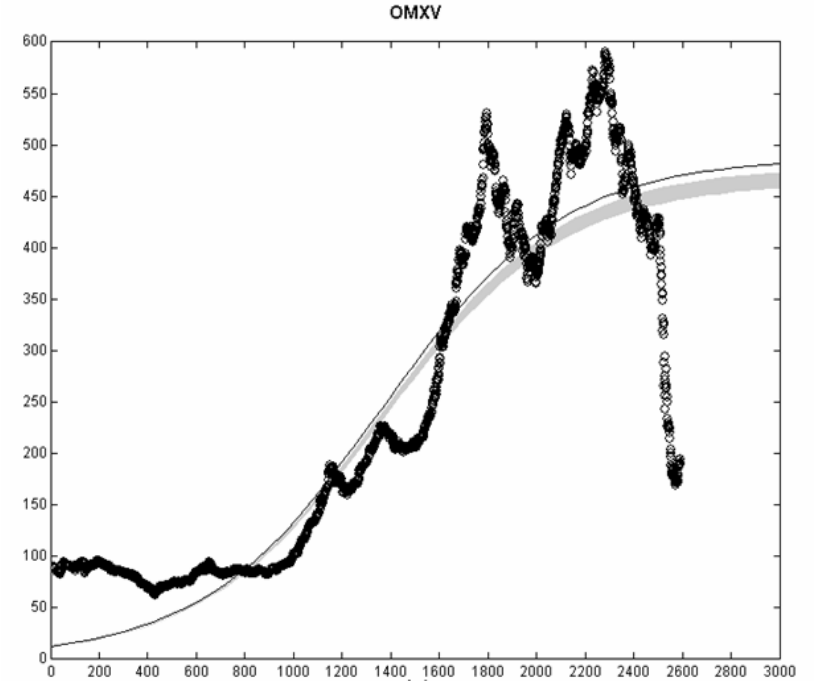

Fig. 3. Dynamics of the Vilnius Stock Exchange index and the curve of capital saturation

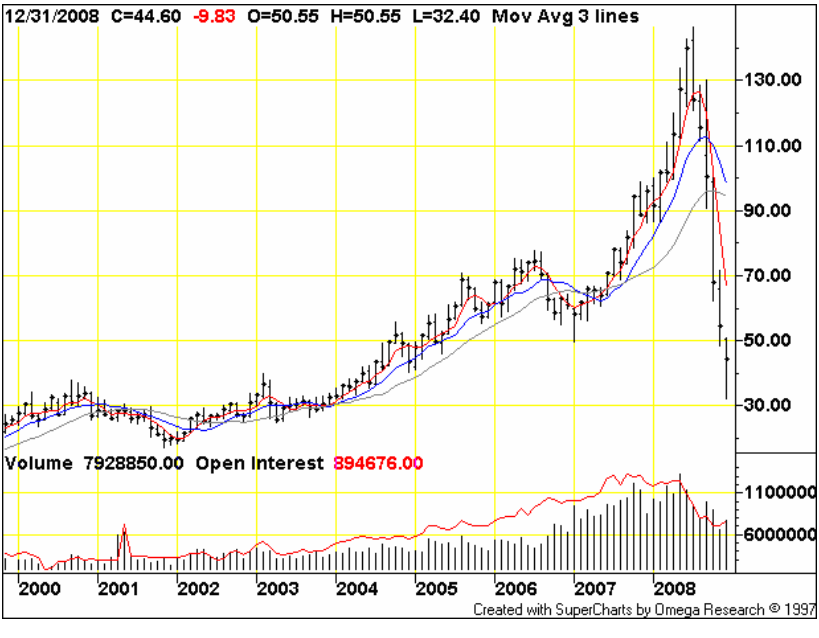

Fig. 4. Dynamics of crude oil prices

quoted companies and their real rate. The second reason is the debt capital increase within the market. It shows that, on the one hand, with the growing popularity of investment the market did not increase its share amount; on the other hand, the market was gradually filled with a rising amount of capital, a considerable part of which was made of debt capital. As the data of the Lithuanian Securities Commission embracing the three quarters of the year 2008 shows, every fourth deal in Vilnius Stock Exchange was financed with debt capital.

It should be also noted that the market growth observed in 2005 was stimulated by several essential changes in the Baltic (and hence the Lithuanian) capital markets. In that very year, the Baltic countries became the members of the European Union and the members of the OMX (i. e. the stock exchange net uniting all the stock exchanges around the Baltic Sea).

With their membership in the European Union and OMX, the Baltic markets attracted more attention that might be explained in the following way: the markets became open for the investment funds which could promote investment exclusively in the region around the Baltic Sea. It had certainly determined the growth of capital, since the funds had to invest at least a small amount of their capital in order not to leave a vacant field in the sample of their possible investments. Actually, it shows a direct link with the above discussed theory – the amount of invested capital grew rather rapidly when it was invested into the non-expanding market. The sample remained the same, but the amount of investments increased. Consequently, the markets reached saturation and even crossed the limits of the potential possibilities for capital growth.

The OMX membership formed a new sample of investors whose investment was done only within the OMX Net. Hence the Baltic countries still increased the round of their potential investors without increasing the depth of investments. Therefore the investment liquidity started growing on the base of its initial sample.

The Lithuanian brokerage company *Jusu tarpininkas (Your Broker)* agreed to provide data on the alteration of the number of clients who participated in the market and were actively involved in the Inernet access. Consider Figure 5:

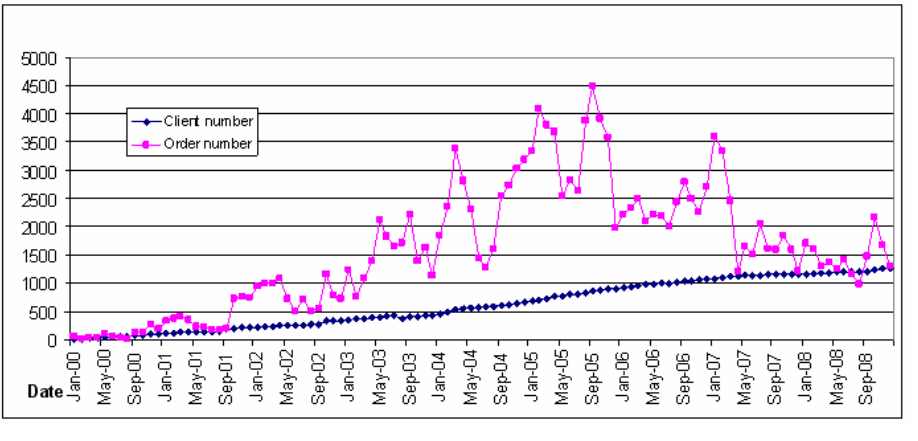

Fig. 5. Dynamics of client and order number in FBC *Jusu tarpininkas (Your Broker)*

Figure 5 also confirms that in 2005 the high dynamics of investment service was observed. It provoked a growing amount of additional capital in the market. It should be stressed that the growth of the number of clients was followed by a similar level of growth of the number of orders, which testifies to the growing activity of the investors and their growing market concern.

3.2 Riga Stock Exchange

Similar financial moves may be observed in Riga Stock Exchange that demonstrates similar tendencies. The graph below (Fig. 6) shows that there were two similar attempts at breaking away from the curve of capital saturation that took place at the same time as in the Lithuanian capital market. Both attempts ended in the index downgrade corrections. The OMXR index reduction in 2007-2008 indicates an obvious bubble burst. Consider:

It is interesting to note that the level of capital saturation of the Riga Stock Exchange index with the current population of the quoted companies was formed at point 681.

3.3 Tallinn Stock Exchange

The index of Tallinn Stock Exchange indicates similar tendencies (Fig. 7) as well which allow to consider that the indices of the three Baltic countries demonstrate a strong correlation and thus support the popular attitude claiming that these three markets are often regarded as one larger market.

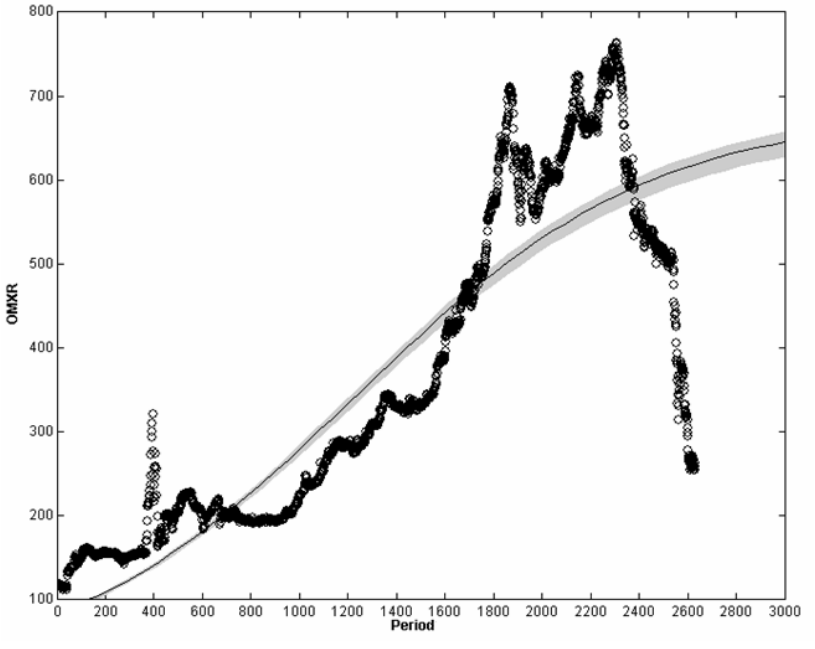

Fig. 6. Riga Stock Exchange index OMXR dynamics and its saturation curve

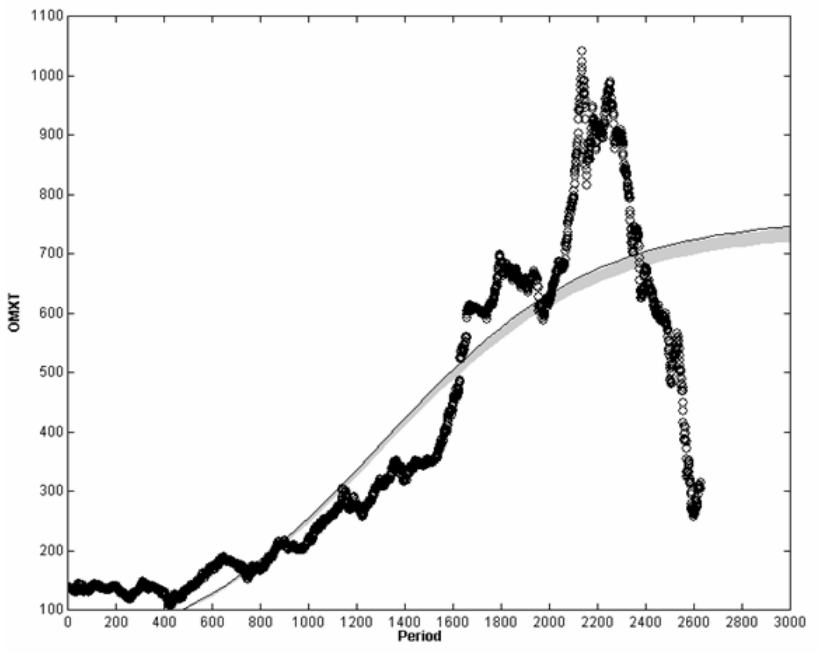

Fig. 7. Tallinn Stock Exchange index dynamics and its saturation curve

It should be stressed that Tallinn Stock Exchange is distinguished among the three Baltic countries in that the float of index in 2005–2006 was inconsiderable and thus did not indicate a marked bubble formation. Nevertheless, in 2007 a very strong break away from the fundamental rates was observed thereby much more obviously demonstrating the bubble formation.

4 Conclusions

1. The logistic economic analysis shows that in the stock exchanges of the Baltic countries the price bubble formation occurred and resulted in the bubble bursts. The capital markets collapsed under the pressure of their own weight. Rather self-contained capital markets demonstrated that such bubble formation was caused by the flow of additional money resources. All the three Baltic capital markets show a serious proof that market saturation (i. e. approaching limited capital) determines bubble inflation.
2. All the three Baltic countries demonstrated similar tendencies and this confirms expectations to consider them as a single larger market.
3. To avoid such undesirable situations in the future the market expansion is urgent. To escape bubble inflation it is necessary to introduce the new investment objects, or with the introduction of investment instruments, to push capital behind the limits of the market. Only thus market saturation will be escaped.

4. The financial crisis in the Baltic stock exchanges was caused by the burst of the share price bubble. The economic logistic analysis demonstrates that two conditions are necessary for the bubble formation: the fundamental and the psychological one. The first condition is related with the exhaustion of growth resources; the second one reflects the psychological inclination to earn much money. Therefore the process of bubble formation undergoes two stages: the first, or fundamental stage occurs when due to an exhaustion of growth resources the market starts increasing its capital return (i. e. gives a signal to the market participants about the growing returnability), and the second, or psychological stage occurs when the participants experience an ardent desire to invest profitably and earn much money. The first condition guarantees the birth of the bubble; the second one determines its size.
5. The Baltic stock exchange indices suffered a stronger collapse than in other countries, which confirms the inertia of the small markets and an adequate degree of risk.
6. To understand the lessons of the past financial events further inquiry into the theory of logistic capital should be conducted. The methods of logistic analysis should be employed to avoid financial crises, or at least to soften their consequences.

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