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Mathematical Model of Modern Economy

Summary

There is conducted an analysis of statistical results of economic activity of the largest companies of the world in 2013 based on the data of the Forbes magazine. The innovative market model (IMM) of open market is applied for this analysis. This IMM was developed before. The innovative market model (IMM) of open market is confirmed by statistical material of the world economy. This model allows forecasting and affecting objective factors, influencing profitability and prospects of growth of efficiency of the company, and is applied for increase of its capitalisation.

Key words: modern economy, technological progress index, information adaptation coefficient, information application coefficient, information accumulation law, innovative economy.

JEL codes: C63, C67, D57

The problem

The mathematical model of barter of free commodity producers is developed for the conditions of the unexpanded reproduction and of the expanded reproduction by introduction of innovations (Дубовиков Н.М. 2009; Dubovikov N.M. 2011; Дубовиков М.М. 2013а). We will analyse efficiency of application of this model for the analysis of results of economic activity of 2000 largest corporations in the world from the list of the Forbes magazine (*Forbes Global 2000 2013а*).

Corporations are the global subjects of the world market and factors of development of world productive forces and technological progress (Самуэльсон П. Э. and Нордхауз В. Д. 2000). It is very important to explore their parameters effectively. It allows multiplying their capitalisation and effective dirigibility on the base of laws of the open market.

The analysis of the last researches and publications

For estimation of efficiency of functioning of companies for a certain period, for example, one year, the best known method is Forbes Global 2000 rank.

To create first four separate lists of the 2000 biggest companies there were used in each of the metrics: sales 2000, profits 2000, assets 2000 and market value 2000. Each of the 2000 lists has a minimum cut-off value in order for a company to qualify: sales of \$3.89 billion,

profits of \$232.2 million, assets of \$7.85 billion, and market value of \$4.25 billion. A company needs to qualify for at least one of the lists in order to be eligible for the final Global 2000 ranking. This year 3,400 companies were needed to fill out the four lists of 2000, each company qualifying for at least one of the lists. Each company receives a separate score for each metric based on where it ranks on the metric's 2000 list. If a company ranks below any metric's 2000 list cut-off (see above minimum cut-off values), it receives the zero score for that metric. The tasks to be performed: to add up the scores for all four metrics (equally weighted) and compile a composite score for each company based on their rankings for sales, profits, assets and market value; to sort the companies in descending order by the highest composite score and then apply Forbes Global 2000 rank. The highest composite score gets the highest rank (Forbes Global 2000; 2013a).

This rating fixes the actual state of businesses in a company at the moment of drafting of rating. It does not allow seeing the dynamics of process and factors, affecting economic indicators of the company, and prognostication of its prospects, in the future.

To know also the Fortune Global 500, Global 500 there is an annual ranking of the top 500 corporations worldwide as measured by revenue (*Fortune 500* 2013). The list is compiled and published annually by the Fortune magazine. The Global 500 adds to information yet less.

To estimate the activity of economic agents for distributing of companies on the volume of assets there is used the Pareto chart (Мельничук М.В. 2011). The Pareto chart, named after Vilfredo Pareto, is a type of chart that contains both bars and a line graph, where individual values are represented in the descending order by bars, and the cumulative total is represented by the line. It enables to estimate the place of a given company in the world economy and its nearest economic prospect.

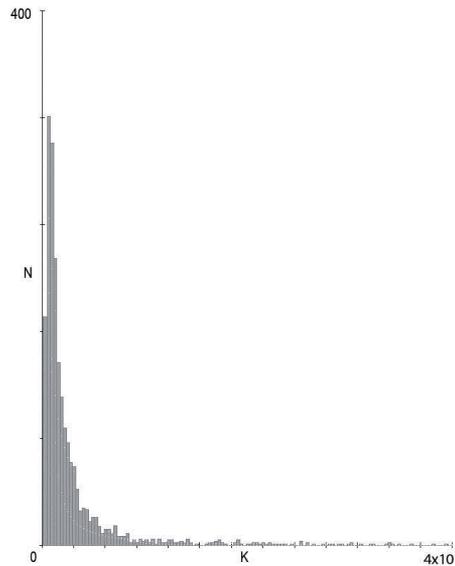
In Figure 1, distribution was represented by 2000 largest companies from the list of Forbes for 2013 (*Forbes Global 2000* 2013a).

The Pareto chart can approximate the only descending area of histogram, where assets of companies are the more expected value of all aggregate of assets (Райзберг Б.А. et al. 2006). This chart cannot approximate the ascending area of histogram. Pareto curves are only the approximating curve which does not predict, therefore, when companies with high assets are disposed on a histogram at intervals, discretely.

It predicts differentiation of assets of companies, the so-called nonlinear trade-investment model of the open market (TIM) developed in the works (Мельничук М.В. 2011; Scafetta N. et al. 2004). The presence of preference at barter in the conditions of the open market conduces to stratification of capitals of commodity producers (Дубовиков Н.М. 2009; Dubovikov N.M. 2011). Consequently, there is a high probability that few people accumulate almost the entire wealth available and the others become devastatingly poor (Symmetric-chance trade-alone model) (Мельничук М.В. 2011). The distributions are fitted by the Gamma distribution (Корн Г. and Корн Т. 1984).

This model creates a redistribution mechanism that advantages the poor and is implemented by supposing that the probability distribution of transaction of wealth is biased in favour of the poorer trader. The bias is introduced through the mean transaction wealth and

Figure 1
On a size distributing of assets of the K 2000 largest companies
from the list of *Forbes Global 2000* rank



N is the number of companies.

social index $f > 0$ provides an advantage to the poorer of the two traders. The wealth condensation increases by decreasing the social index f (Мельничук М.В. 2011). The index f gets out arbitrarily, therefore unconnected with concrete objective factors influencing the real economic process. Consequently, the TIM model does not allow objective and reliable estimation of these factors and prediction of the real dynamics of functioning of economic agents in the world economy.

In the works (Дубовиков Н.М. 2009; Dubovikov N.M. 2011; Дубовиков М.М. 2013а; Дубовиков М.М. 2012), the innovative market model (IMM) of barter of free commodity producers is developed for the conditions of both the unexpanded reproduction and in the conditions of the expanded reproduction. We will apply this model for the analysis of results of economic activity of the largest companies of the world in 2013 based on the data from the Forbes magazine.

The aim of this article

The aim is the analysis of results of economic activity of the largest companies of the world in 2013 based on the data of the Forbes magazine with innovative market model (IMM) of the open market for verification of its model on actual statistical material.

Main body

The mathematical model of barter of free commodity producers is developed on the basis of vehicle of casual functions and game theory, adequately describing the real open market and allowing forecasting the dynamics of its changes, coming from its primary descriptions (Дубовиков Н.М. 2009; Dubovikov N.M. 2011).

In the work (Дубовиков М.М. 2013а), this model is developed in the mathematical model of barter of free commodity producers in the conditions of the expanded reproduction on the base of mathematical model of the open market (Дубовиков Н.М. 2009, Dubovikov N.M. 2011), the neoclassical model of economic growth of Robert Solow (Солоу Р. 1996), the influence technological progress by J. Tinbergen (Тинберген Я. and Бос Х. 1967) and the model of functional dependence of the technological progress index when technological progress is the exogenous factor of economic growth and reflects the information accumulation law in the economic system (Дубовиков М.М. 2012). In this case, current capital is described for a commodity producer at a specific moment by means of the following equation (Дубовиков Н.М. 2009, Dubovikov N.M. 2011; Дубовиков М.М. 2012; Дубовиков Н.М. 2013b):

$$K_i^j = K_i^{j-1} + \Delta K_{il}^j(K_i^{j-1}, K_l^{j-1}) + \Delta K_i^j(\beta)$$

K_i^j – current capital i commodity producer at the moment of time t_j , in j act of barter; K_i^{j-1} – initial capital i commodity producer at the previous moment of time t_{j-1} ; $\Delta K_{il}^j(K_i^{j-1}, K_l^{j-1})$ – casual function of increase of a capital i commodity producer at the moment of time t_j , depending on the capital i commodity producer at the moment of time t_{j-1} and capital l commodity producer at the moment of time t_{j-1} , conditioned by barter operation with l commodity producer (Дубовиков Н.М. 2009; Dubovikov N.M. 2011); $\Delta K_i^j(\beta)$ – casual function of increase of the capital i commodity producer at the moment of time t_j due to introduction of innovations because of adaptation and introduction of information, information application coefficient β ; here it is of the evenly distributed casual size, among all commodity producers, without depending on the volume of their capital (Дубовиков М.М. 2012).

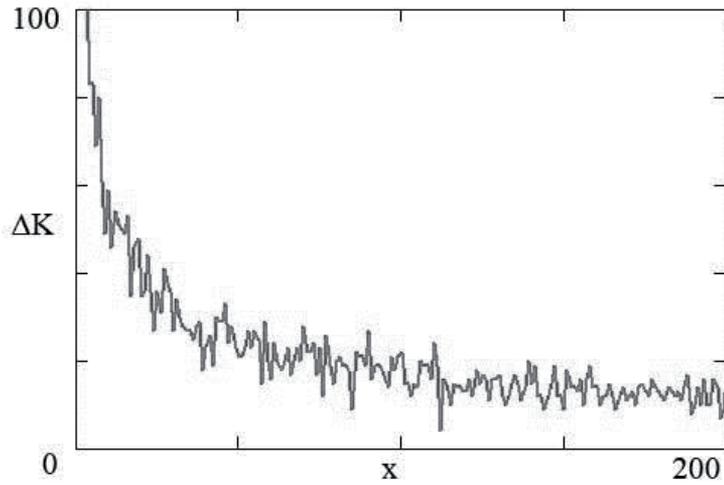
The IMM model and the TIM model predict the decline companies arrived from the effect of complete monopolisation of a separate market by one or a few companies. There can be seen designing of the system from 500 commodity producers, with the percent of the expanded reproduction of 0% and with an initial capital of 200 units, for 200 acts of barter. We will get the graph of casual function ΔK – arrived commodity producer with a maximal capital presently from motion of barter, Figure 2.

It is visible on the graph that an income quickly decreases to the zero, because all capital is concentrated at not many commodity producers.

This theoretical fact is confirmed by distributing profitability of assets of the real companies from the list of Forbes (*Forbes Global 2000 2013*), Figure 3.

Figure 2

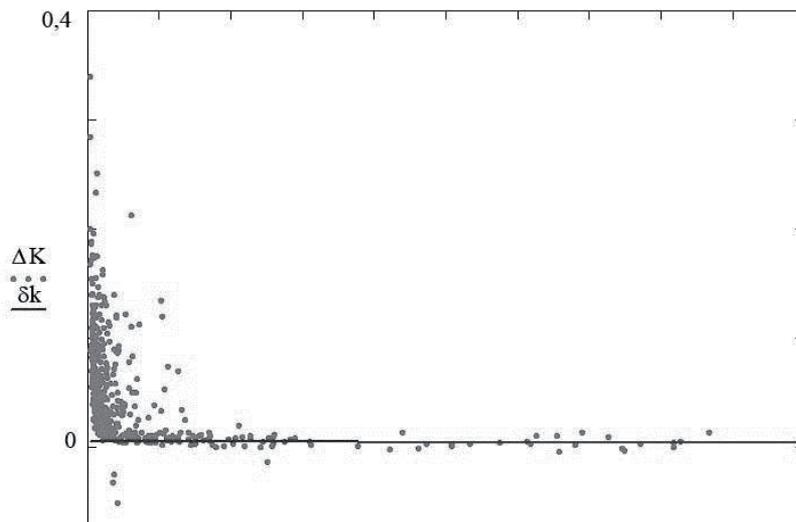
Graph of casual function ΔK – arrived commodity producer with a maximal capital presently from motion of barter



X – acts of barter.

Figure 3

Distributing profitability of assets



ΔK real 500 biggest companies from the list of Forbes.

δk – approximating the clouds of points of casual function ΔK profitability of companies from the region of large assets

K – volume of assets of companies.

It is visible on the graph that profitability of assets of companies sharply goes down with growth of volume of their assets, in area of large assets practically does not depend on their volume. Thus value of coefficient of correlation between profitability of assets and volume of assets of company for this group of economic agents, less than 0.1. Thus, the IMM model and the TIM model are confirmed by the present statistical material. It specifies that under reaching the market saturation its physical expansion is a unique effective way, including due to the increase of necessities user.

It is necessary to mean that probability of redistribution of capital from one commodity producer to another in obedience to IMM (Дубовиков Н.М. 2009; Dubovikov N.M. 2011) proportional

$$1 - \frac{K_i}{K_{\max}}$$

K_i – capital of current commodity producer and K_{\max} – capital of commodity producer with the maximal capital that at a barter with near capitals redistribution of capital between commodity producers aspires to the zero, and, *vice versa* – at the wide difference of capitals redistribution of capital aspires to 1, what corresponds to the law of Pareto. Therefore, the Pareto curve is approximating for distributing of described by the model IMM in the area of large assets on the intermediate stage of differentiation of commodity producers, and the region of large assets is represented by single firms (discretely).

We can look after the decline of the number of unprofitable companies in the area of companies with large assets, Figure 4.

It corresponds to the mathematical model of the open market (Дубовиков Н.М. 2009; Dubovikov N.M. 2011), Figure 5.

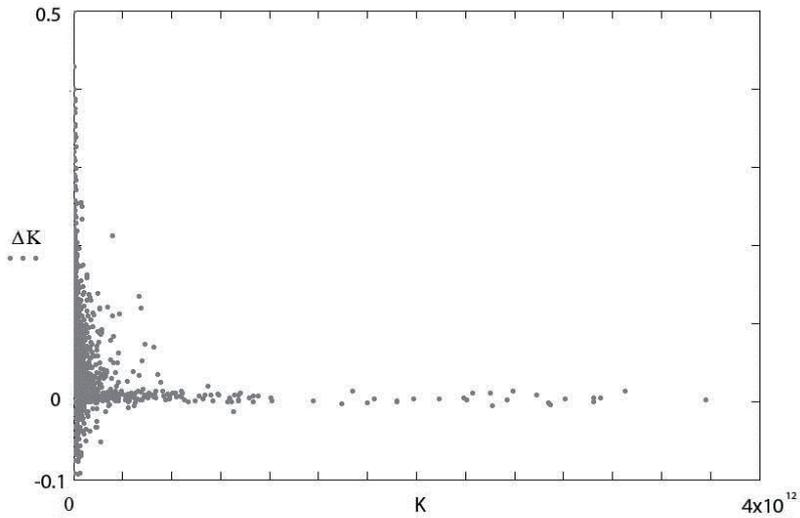
The mathematical IMM model predicts the diminishing number of ruining themselves commodity producers during monopolisation of the open market. The increase of assets of the company is instrumental in its survival at the open market.

We will model the barter of 50 commodity producers with an initial capital of 50 units for 80 acts of barter at the rates of expanded reproduction of capital of 0.075% for the cycle of barter, in accordance with the work (Дубовиков М.М. 2013а); the result is presented in Figure 6.

The obtained histogram of distributing commodity producers (economic agents) has all signs of the real distributing of companies represented in Figure 1. There are the ascending and descending branches of distributing, there is discretion of assets in the area of their large sizes for commodity producers and the diminishing number of ruining themselves commodity producers in this region.

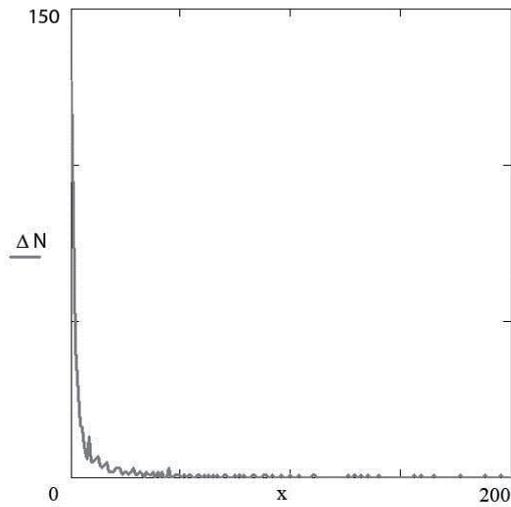
It is known in addition that at the low rates of growth of the expanded reproduction, results somehow differ from the results of the model of unexpanded reproduction and in a limit conduce of commodity producers (Дубовиков Н.М. 2009; Dubovikov N.M. 2011; Дубовиков М.М. 2013а) to the bimodal distribution. It creates discretion of assets in the

Figure 4
Distributing of profitability of assets



ΔK – real companies from the list of Forbes.
 K – volume of assets of companies.

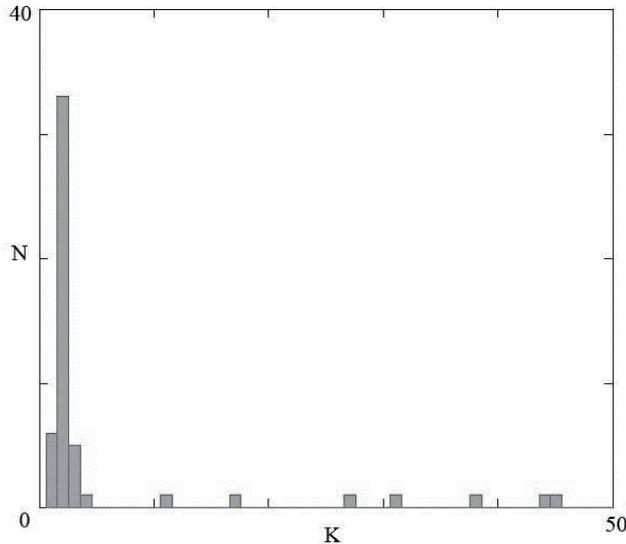
Figure 5
Graph of casual function



ΔN – unprofitable companies.
 X – acts of barter.

Figure 6

Histogram of result of barter between 50 commodity producers with an initial capital of 50 units for 80 acts of barter at the rates of the expanded reproduction of capital 0.075% for the cycle of commodity turnover



K – volume of capital of commodity producers.

N is the number of commodity producers with the concrete volume of capital.

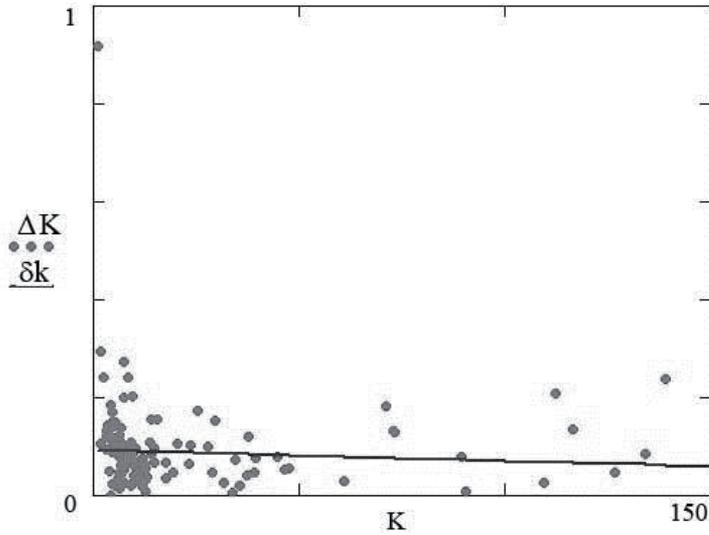
area of their large sizes. The redistribution of commodity producers moves yet faster to the bimodal distribution at presence of uneconomic preferences at separate commodity producers (Дубовиков Н.М. 2013с).

The IMM model uses, unlike the TIM model, concrete real economic factors determining the dynamics of development and distribution into the system of economic agents: due to the innovative growth of capitals of commodity producers, accumulation of information conditioned by processes in the economic system and its mediated agent man. In same queue, accumulation of information does not almost depend on the volume of capital and volume of expenses (Дубовиков М.М. 2012). That it is possible to see on the example of intercommunication of volume of assets and expenses of IT – companies from that list of *Forbes Global 2000* rank (*Forbes Global 2000* 2013a; *Forbes Global 2000* 2013b).

Because IT companies get, practically, their income all due to introduction of innovations in production and realisation of products, profitability of assets and norm arrived therefore, in obedience to the model IMM, must not depend on the volume of assets and expenses of these companies.

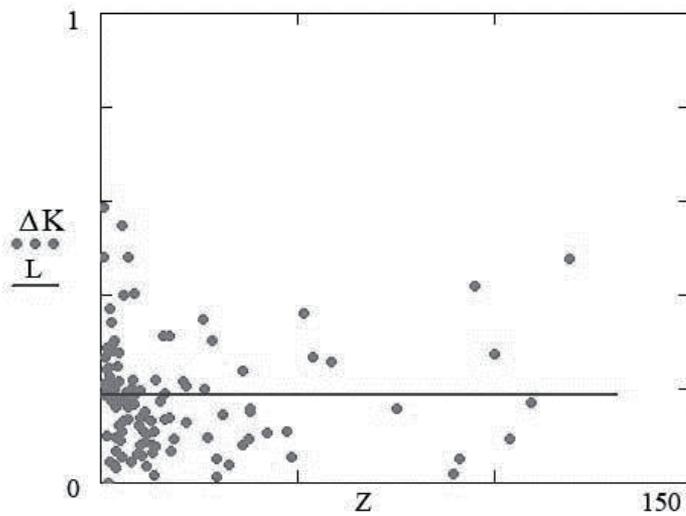
It is below possible to see the graphs of casual functions of dependence profitability of assets - volume of assets, Fig. 7, and norm arrived - expenses for the IT companies, Fig. 8.

Figure 7
Graph of casual function of dependence is profitability of assets



ΔK – volume of assets, K in billion dollars.
 δk – approximating the clouds of points of casual function ΔK profitability of assets of IT – companies from the list of Forbes.

Figure 8
Graph of casual function of dependence of norm arrived



ΔK – volume of expenses Z .
 L – approximating the clouds of points of casual function ΔK norms arrived depending on the expenses of Z in billion dollars for IT – companies from the list of Forbes.

It is easily to see that the proper approximation of the lines of clouds of points, axes are practically parallel to X, that is confirmation of independence of accumulation of information from the volume of capital and volume of expenses in the process of production. Increase of capital and economy growing conditioned by technological progress does not depend on the volume of capital and volume of expenses of the company, and it depends only on quality of the inculcated innovations. It is shown by these graphs and proper coefficients of correlation (Макаров Е. Г. 2005) between profitability of assets – volume of assets equals to 0.065 and norm arrived – expenses of 0.094. The process of introduction of innovations is described by a casual function with the evenly distributed casual volume of increase of capital of commodity producers due to technological progress as it is provided in the work (Дубовиков М. М. 2012).

Conclusions and prospects of researches

1. The mathematical model is developed on modern economy (innovative market model).
2. The innovative market model of the open market is confirmed by statistical material of the world economy.
3. The innovative market model of the open market allows forecasting efficiency of assets of the company, and affecting objective factors influencing its profitability and prospects of growth of its capitalisation.
4. The innovative market model of the open market allows promoting efficiency of the bank financing of subjects of the economic process due to the adequate design of objective laws of functioning of the open market.
5. The innovative market model of the open market comports with the TIM model for a case symmetric-chance trade-alone model.
6. The Pareto curve serves to approximating the curve for distribution described by the IMM model in the area of large assets on the intermediate stage of differentiation of commodity producers.
7. The innovative market model of the open market is described by the vehicle of stochastic functions with variable probability and variable dispersion and does not have the stable distribution; therefore, for distributing assets of economic agents approximating the Pareto curves have a variable index over time.
8. In prospect, perfection is needed for the innovative market model for an extrapolation design of the real economic agents over time.

References

- Dubovikov, N.M. (2011). *Mathematical Model of the Open Market*. Економічний вісник Донбасу, № 4, Луганськ.

- Forbes Global 2000 (2013a). *The World's Biggest Public Companies*, Forbes, <http://www.forbes.com/global2000/list/> [access: 22.04.2014]
- Forbes Global 2000 (2013b). *Рейтинг Форбс 2000 крупнейших компаний мира. Лидеры ИТ-рынка*, Forbes, <http://baguzin.ru/wp/?p=4455> [access: 22.04.2014]
- Fortune 500 (2013). *Fortune 500*, Fortune, http://money.cnn.com/magazines/fortune/fortune500/?iid=F_Sub [access: 22.04.2014].
- Scafetta, N., West, B. J. and Picozzi, S. (2004). *Trade-Investment Model for Distribution of Wealth*, Physica D, 193.
- Дубовиков, Н.М. (2009). *Математическая модель дифференцирования капиталов товаропроизводителей на свободном рынке*. Моделирование и информатизация социально-экономического развития Украины, № 10, Киев.
- Дубовиков, М.М. (2012). *Визначення об'єктивного виду функції багатofакторної продуктивності праці*, Часопис економічних реформ, № 4, Луганськ.
- Дубовиков, М.М. (2013a). *Математична модель інноваційної економіки*. Часопис економічних реформ, № 2, Луганськ.
- Дубовиков, Н.М. (2013b). *Математическая модель международного валютного рынка*, (in:) Дубовиков Н. М., *Математическая модель социально-инновационной экономики*, LAP LAMBERT Academic Publishing.
- Дубовиков, Н.М. (2013c). *Дифференциация товаропроизводителей в условиях неэкономических предпочтений*, (in:) Дубовиков Н. М., *Математическая модель социально-инновационной экономики*, LAP LAMBERT Academic Publishing.
- Корн, Г. and Корн, Т. (1984). *Справочник по математике*, Наука, Москва.
- Макаров, Е.Г. (2005). *Инженерные расчеты в MathCAD*, Питер, СПб.
- Мельничук, М.В. (2011). *Методология формирования стратегии регионального социально-экономического развития (инвестиционный, инновационный, институциональный аспекты)*, Москва, <http://www.pandia.ru/text/77/204/79315.php> [access: 22.04.2014].
- Райзберг, Б.А., Лозовский, Л.Ш. and Стародубцева, Е.Б. (2006). *Современный экономический словарь*, ИНФРА-М, Москва.
- Самуэльсон, П.Э. and Нордхауз, В.Д. (2000). *Экономика*, Вильямс, Москва.
- Солоу, Р. (1996). *Перспективы теории роста*, Мировая экономика и международные отношения, № 8, Москва.
- Тинберген, Я. and Бос, Х. (1967). *Математические модели экономического роста*, Прогресс, Москва.

Matematyczny model nowoczesnej gospodarki

Streszczenie

Przeprowadzono analizę wyników statystycznych działalności gospodarczej największych firm na świecie w roku 2013 na podstawie danych czasopisma *Forbes*. Do analizy zastosowano model rynku innowacyjnego (MRI) na otwartym rynku. MRI został opracowany wcześniej. Model rynku innowacyjnego (MRI) na otwartym rynku znajduje potwierdzenie w materiałach statystycznych gospodarki światowej. Model ten pozwala na prognozowanie i oddziaływanie na obiektywne czyn-

niki, wpływając na rentowność i perspektywy wzrostu skuteczności firmy i jest stosowany do zwiększenia jej kapitalizacji.

Słowa kluczowe: nowoczesna gospodarka, wskaźnik postępu technologicznego, współczynnik adaptacji informacji, współczynnik zastosowania informacji, prawo akumulacji informacji, innowacyjna gospodarka.

Kody JEL: C63, C67, D57

Математическая модель современной экономики

Резюме

Провели анализ статистических результатов экономической деятельности крупнейших компаний в мире в 2013 г. на основе данных журнала «Форбс». Для этого анализа применили модель инновационного рынка (МИР) на открытом рынке. Модель МИР была разработана раньше. Модель инновационного рынка (МИР) на открытом рынке подтверждается статистическим материалом мировой экономики. Эта модель позволяет прогнозировать и она оказывает воздействие на объективные факторы, влияя на рентабельность и перспективы роста эффективности компании; она применяется для повышения капитализации активов фирмы.

Ключевые слова: современная экономика, показатель технологического прогресса, коэффициент приспособляемости информации, коэффициент применимости информации, закон накопления информации, инновационная экономика.

Коды JEL: C63, C67, D57.

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