“Game theory model for the development of optimal strategy towards innovative products manufacturing at the enterprise”

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GAME THEORY MODEL FOR THE DEVELOPMENT OF OPTIMAL STRATEGY TOWARDS INNOVATIVE PRODUCTS MANUFACTURING AT THE ENTERPRISE

Abstract

The carried out research confirms the expediency of economic mathematical modeling (game theory) implementation in practice of economical activity. The paper presents a designed game theory model of optimal innovative strategy for product manufacturing at the enterprise considering the expenses due to the production, storage and transportation of basic goods; extra expenses for the development of innovative products and supplementary costs granted by the company for the innovative products development in order to decrease possible material losses by the defined reasons.

The developed game theory model aims to develop the optimal strategy for innovative products manufacturing was implemented and approved at the enterprise, which produces different means of operative communication. The assigned solution of a task included the calculation of the company's optimal innovative product release with the aim of receiving a maximum income from the developed products realization. The model enables to define the percentage ratio of the efficient manufacturing of innovative products at the enterprise, considering the state of the market and competitive behavior in overall product assortment, the possibility of this ratio optimal correction in order to maximize the income from innovative products realization.

Performed calculations allow the company's managers to determine the beneficial and non-beneficial market state for certain types of innovative products and to improve the decision making process concerning the increase or the reduction of innovative products manufacturing.

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INTRODUCTION

World community has been directed to the development of innovative products, new technologies, knowledge and information storage, high-fidelity products export. For this purpose, the EU and Scandinavian countries, the USA, China, Singapore, and Japan have been investing significant financial and human recourses into the innovation activity (Jaumotte, Pain, 2005).

The deterioration of economic environment caused by the influence of world crisis demands searching new solutions to optimize the economic activity. The strategic actions like improvement of the management process at the enterprise, production of innovative goods and services, taking actions to develop a strategy for optimal product manufacturing contribute the effective functioning of entrepreneurs and overcoming the financial economic crisis.

M. Porter (2005) in the study of competitive activity examines the participants and emphasizes on the necessity of developing the strategies in which the uniqueness of a product or low expenses level form the ground of strategic superiority. In order to achieve this goal, it is necessary to provide the continuity of ideas of developing and creating markets of future (*Prahalad, Hamel,* 2003). At the same time, the actions of economic agents basically depend on the information they have accumulated and processed (*Somaya, Teece, Wakeman,* 2011).

The scholars Teece, *Pisano*, Shuen (2003) who researched the strategy and competitive advantages within the game theory were concentrated on the prognosis of competitive actions and on the search of market signals, which influenced their behavior. This study approach to competitive behavior has led to the increase of reputation, investments into the production capacity. *Prahalad, Hamel* (2003) in their research made the conclusion that real sources of stable competitive advantages include the ability of management to consolidate dispersed technologies at corporation and productive skills in competence, providing separate business units with the potential of quick adaptation to the changeable market opportunities.

The development of resource concept (Barney, 1986; Grant, 1996; Rumelt, 1984) altered the focus of the successful competitive strategy from the orientation on rivals struggle to the development of organization competences, which are difficult to be copied. In other words, such orientation of strategic efforts gives the opportunity for the companies to form the competing ability on the levels of product manufacturing and company development emphasizing the improvement of personal competences and skills.

Markides (2010), Katkalo (2006) consider strategic advantages of company through the lens of their business models, services and products competition. The study of *Lambin* (1996) states that in order to "survive" in modern highly competitive markets economic objects require both the effectiveness of functioning and creating the greater value in satisfying the needs in comparison with rivals.

The strategies development in order to solve the optimization tasks for the economic activity of entrepreneurial structures, management of production structures and their separate units in modern changeable market environment form a complicated process, linked to different risks and dependent on many factors. Taking into account the abovementioned arguments, management without the use of modern mathematical instruments, information technologies and computer resources is impossible.

1. LITERATURE REVIEW

Back in the previous century, innovations were recognized as the main factor of economic development (Drucker, 1986; Knight, 1994; Santo, 1990) in the sphere of economic agents and economic environment cooperation.

In the process of inner systemic transformations, the companies' management mainly accumulates its own efforts on short-term actions of financial recovery. In the periods of crisis, their main fear is the absence of sufficient investments for long-term projects realization (Popov, 2008; Cachon, Netessine, 2003; Maskin, 2011). Despite that, insignificant number of companies are looking for the ways to overcome economic depressions and take the risk in implementing innovative projects by setting the goal – the growth of market value owing to innovations, which results in attraction of more investments for their own strategic development.

The choice of the strategy guarantees the success of the enterprise. System approach to define the directions for modernization and development at the enterprise, product manufacturing and selling provide for deep research of many management aspects by mathematic apparatus and computer systems of supporting management decision making.

Scientific interest to the problems of product manufacturing in the company with the usage of mathematic apparatus provoked the interest to analyze accumulated theoretical and analytical material.

The studies of Porter (2011) are very important and significant for economic science, as they apply the

main concepts of game in the context of business affairs. The scientists McMillan (1996), Myerson (1997), Gibbons (1992), Binmore (2007), Fudenberg and Tirole (1991), Cachonand, Netessine (2003) ascertain that managers can use the game theory in order to make more effective administrative decisions. Cooperation (*Brandenburger*, *Nalebuff*, 2012) and the implemented strategy play an important role in strategic situations. Effective decisions must represent acceptable combination of competition and cooperation.

The game theory has already reached significant success (Hurwicz, Reiter, 2006; Greif, 1996; Maskin, 2011; Myerson, 1997; McAfee, 2005) in the direction of traffic stream optimization, determination of rivals and partners, agreements and contracts developing, auctions holding and auctions design, cooperative agreements, creation of advantages detection mechanisms, information economics, institutes analysis.

The economists Gallini and Winter (1985), Muto (1987), Fudenberg and Triola (1987), Park (1987), Herbig (1991) have concentrated their attention on the possibility of game theory application to predict competitive behavior, to solve marketing tasks, in particular, role of patents in marketing management. ELFakir and Tkiouat (2016) tried to help financial institutions in their agent selection process and hedge its risky contracts to solve the adverse selection problem in the Mudaraba contracts with respect to the projects privately known prospects.

Winer (2002) claims that game theory can be applied to decisions administration regarding new products implementation. The conditions for its possible implementation include the presence of first move advantages, prediction of rivals' actions pertaining to new product type presentation and approving decisions concerning strategy choice. The papers of Mitchell and Hustad (1981), Kaiser (2001) are significant in this direction. However, nowadays, the research concerning the possibility of decisions implementation regarding the optimization of innovative products release using game theory still lacks.

The classic optimization models of industrial company management provide for the income maximization by means of release volume alteration. The companies' owners, investing in companies' development, are primarily interested in receiving a maximum income from investments. However, there are still some questions that remain unsolved in research such as optimization of the innovative product release considering extra expenses resulting from the development, investigations and manufacturing of this product.

2. METHODOLOGY

The section discusses and determines the problem of enterprise activity strategy development used for the nomenclature determination, range and manufacture output of improved production and its delivery to the consumers. The tasks of this type are highly influential for the companies, especially in conditions of market ambiguity. The significant issue for the company which deals with new products manufacturing is developing a correct strategy for the production and realization of certain product range, selling of which might provide enough financial profit for the company.

The products released by the enterprise on the market are usually characterized by certain profitability. However, it is well-known that any product (with the exception of some types, e.g., food items) has limited retention time. At the end of this period, its market value gradually becomes lower than its net costs. Thus, the release of such product is not beneficial for the company anymore. In order to be competitive in the market, the enterprise should in advance take care of the released product renovation and modernization with the exception of basic (old) and some improved products. In order to achieve this goal, extra costs are assigned for the scientific research, organization and modernization of the manufacturing process, solving the range of organization tasks, etc.

Normally, some game G is defined by a group of three *(X, Y, U)* in the following way (Blackwell, 1958):

$$G =< X, Y, U >, \quad (1)$$

where X = the space which determines the product of possible changes regarding development costs, implementation and manufacturing of improved production; Y = the space which defines the product of possible company's actions regarding the

income earned as a result of improved products realization; U = the limited numeral function (the utility function of the enterprise), which is described on the space of multiplication products $X \times Y$ of pairs (x, y), $x \in X, y \in Y$.

If to suppose that the company can manufacture *m* types of special products, the matrix form of *U* wins will be the following:

$$U = \begin{pmatrix} d_0 + d_1 - t_1 & -s_0 - s_1 + t_1 & \ldots - s_0 - s_1 + t_1 \\ -s_0 - s_2 + t_2 & d_0 + d_2 - t_2 & \ldots - s_0 - s_2 + t_2 \\ \ldots\ldots & \ldots\ldots & \ldots\ldots \\ -s_0 - s_i + t_i & \ldots\ d_0 + d_i - t_i & \ldots - s_0 - s_i + t_i \\ \ldots\ldots & \ldots\ldots & \ldots\ldots \\ -s_0 - s_n + t_n & -s_0 - s_n + t_n & \ldots\ d_0 + d_n - t_n \end{pmatrix}$$

$$\text{or } U = \| u_{ij} \| = \begin{cases} d_0 + d_i - t_i, & \text{when } i = j, \\ s_0 + s_i - t_i, & \text{when } i \neq j. \end{cases} \quad (2)$$

s_0 = income of the company as a result of basic product unit realization; d_0 = costs spent by the enterprise on production, storage, transportation of this product unit; s_i = additional income gained by the company, resulting from the realization of unit *i*-o from the improved range of products (it is considered that $d_1 \le d_2 \le \ldots \le d_n$, $i = \overline{1, n}$, where *n*= total number of improved product types or ranges); d_i = additional costs spent by the enterprise as a result of development and manufacturing of the improved range of product unit *i*-o; t_i = additional costs granted by the company to improve the range of products *i*-o in order to decrease possible expected damages caused by mentioned reasons; j = type of improved products manufactured at the enterprise.

The matrix of wins (1) is a game theory model of real conflicts. The optimal game strategies are found on the basis of this matrix. The conflicting sides of the game are both the company, which manufactures improved products, and the market, which directly influences the amount of expenses and income.

The matrix of wins (1) was reduced to the form with zero diagonal in the process of matrix game. In order to obtain this result, the first matrix row (1) was multiplied by the number k_1, the second one was multiplied by the number k_2, etc., in order to follow the condition:

$$d = k_i(d_0 + d_i - t_i) \quad i = \overline{1, n}. \quad (3)$$

Resulting from the performed transformations of the matrix *U*, we get new matrix *U**, elements of which will be the following:

$$U^* = \| u_{ij}^* \| = \begin{cases} 0, & \text{if } i = j, \\ -g_i, & \text{if } i \neq j, \end{cases} \quad (4)$$

where $g_i = s_0 + s_i - t_i \quad (i = \overline{1, n})$. (5)

On the basis of known theorem (Dyubyn, Suzdal, 1981) the group of three (X^*, Y^*, v) is the solution of the game $G = < X, Y, U >$ only if $(X^*, Y^*, kv + a)$ is the solution of the game $G^* = < X, Y, kU + a >$, where a = any real number, $k > 0$. Statement of this theorem results from the fact that inequalities

$$\begin{aligned} & U(X, Y^*) \le U(X^*, Y^*) \le U(X^*, Y), \\ & X \in X,\ Y \in Y, \\ & kU(X, Y^*) + a \le kU(X^*, Y^*) + \\ & + a \le kU(X^*, Y) + a,\ X \in X,\ Y \in Y, \end{aligned} \quad (6)$$

are equivalent. Therefore, the matrices *U** and *U* are equivalent, and the actions performed to transform the matrix (1) do not change the set of optimal strategies of the enterprise and the market, which are the participants of the game. However, the usage of the matrix *U** simplifies the search of strategies for the game participants.

To simplify the procedure of transformation from the matrix (1) to the matrix with zero diagonal (4), the rows of the matrix (1) are placed in the mode in order to follow the condition

$$g_1 > g_2 > \ldots > g_i > \ldots > g_n > 0, \quad (7)$$

after transformation to the matrix (4). However, in general task formulation, the order of rows placement does not influence the solution of the task and game value.

The optimal strategy of the company regarding the profit making is marked as $Y=(y_1, y_2,..., y_n)$. In case of balance, mathematical win expectation $U^*(n, Y^*)$ by the company should be equal with the game value $v=-g_n$, i.e., such relation will be true (valid)

$$U^*(n, Y^*)=-g_n\sum_{i=1}^{n} y_i=-g_n(1-y_n)=g_n. \quad (8)$$

Taking into account that $g_n>0$, on the basis of the correlation (8), it should be noted as $y_n=0$.

On the basis of optimal company strategy Y* such inequalities should be performed

$$U(i, Y^*)=-g_n(1-y_i)\le -g_n, \quad 1\le i\le n-1. \quad (9)$$

The correlations (9) are equipotent to the inequalities

$$y\le 1-\frac{g_n}{g_i}, \quad 1\le i\le n-1. \quad (10)$$

If in the conflict situation the company follows the strategy Y* with the component $y_n=0$ and the inequalities (9) are true, as well as the inequalities (10), the value of game, as it was mentioned before, will be $v=-g_n$ and this strategy is optimal for the company. In this case, the inequalities (9) are transformed into equalities, the value of game will be negative, i.e., for the company, the situation becomes losing. It permits to deduce a condition, which can help to avoid the development of such event.

Now both company and market correspond the actions, when their clear strategies are used with positive probabilities. In this case, clear strategy of one of the game participants is placed in the spectrum of its optimal strategy. Its winning in the situation developed by this clear strategy and by the randomized optimal strategy of other game participant will be equal to the game value. Therefore, optimal strategy Y for the market element will satisfy the equations system:

$$U^*(i, Y)=-g_i(1-y_i)=v, \quad (11)$$

where v = game value.

Resulting from the transformations, the formulae to calculate the strategy components of the enterprise y_j were derived as the follows (12):

$$y_j=\frac{1-n+(s_0+s_j-t_j)\sum_{i=1}^{n}\frac{1}{(s_0+s_i-t_i)}}{(s_0+s_j-t_j)\sum_{i=1}^{n}\frac{1}{(s_0+s_i-t_i)}}, \quad 1\le j\le n. \quad (12)$$

The mixed strategy of market, which directly influences the revenue position, is marked as x_j and defined using the formula (13):

$$x_j=\frac{1}{(s_0+s_j-t_j)\sum_{i=1}^{n}\frac{1}{(s_0+s_i-t_i)}}, \quad 1\le j\le n. \quad (13)$$

The mentioned strategies will also be optimal in the game determined by the matrix (1). At the same time, game value can be found using the formula (14).

$$v=\frac{n-1}{\sum_{i=1}^{n}\frac{1}{s_0+s_i-t_i}}. \quad (14)$$

3. RESULTS OF INVESTIGATION

The developed model is applied to determine the optimal way of improved production output. As an example, we will use the information about products manufactured at the "MATEZIS" Ltd. The company manufactures such types of goods as antenna receiving and transmitting satellite signals, HF antenna, UHF antenna, demodulator for signal processing, which served as the basis for the improved options of products. The release data on mentioned products in regard to inflation level are presented in Table 1.

Table 1. The data on the range of products manufactured at the enterprise

Indicator	Product type							
	Antenna receiving and transmitting satellite signals		HF antenna		UHF antenna		Demodulator for signal processing	
	2013	2015	2013	2015	2013	2015	2013	2015
Income received by the company for the realization of the traditional product unit (s_0), UAH	892	903	480	550	490	574	264	302
Costs spent by the company on production, storage, transportation of traditional product unit (d_0), UAH	458	478	140	220	200	290	96	145
Additional income gained by the company resulting from the realization of improved range of products i-o unit (s_i), UAH	946	934	487	588	505	595	275	368
Additional costs spent by the company as a result of development and manufacturing of improved products i-o unit (d_i), UAH	481	494	159	267	224	325	117	175
Extra costs assigned by the company for improved range of products i-o unit (t_i), UAH	190	146	62	82	65	54	35	45

Thus, data, i.e., estimation of improved production manufacturing profitability and calculation of its output strategies, which can be used to solve a game theory model, are present.

The analysis of Table 1 shows that products manufactured at the enterprise are characterized by different incomes and expenses related to manufactured product unit. There are several possible ways to compensate for this difference, e.g., by increasing the price of product, by improving the product profitability or by using both of the mentioned actions simultaneously. At first sight, the increase of the price seems to be the simplest way and it is generally used by Ukrainian companies. However, in the market conditions of tough competitive struggle between product manufacturers, this measure can lead to even bigger loses and cause irreversible damage.

The increase of profitability concerning product manufacturing is always a desired direction for the entrepreneur. However, this measure is mainly connected with innovative processes, in particular with new constructions and technologies, modernized equipment and appliances, product sales, higher qualification of specialists, organization of their continuous training and improving qualifications. Achieving of these goals requires additional investments and some time. In any case, it is always necessary to estimate the profitability of released products in order to plan market behavior and to have a possibility to choose a right administrative decision, in particular, choosing the products to manufacture, broadening the range of released products.

Now, using the developed game theory model, we will estimate the commercial activity of economic agent by the types of manufactured products and calculate the company's manufacturing strategies for the specific improved types of products.

The calculations were performed using Microsoft Office Excel.

Taking into consideration the data in Table 1 and taking into account that $t_i = 0$ $(i = \overline{1,n})$, the elements of win matrix (1) for 2013 will be as follows (15):

$$d_0 + d_1 - t_1 = 749,\ d_0 + d_2 - t_2 = 237,$$
$$d_0 + d_3 - t_3 = 359,\ d_0 + d_4 - t_4 = 178, \quad (15)$$

$$s_0 + s_1 - t_1 = 1648,\ \ s_0 + s_2 - t_2 = 905,$$
$$s_0 + s_3 - t_3 = 930,\ \ s_0 + s_4 - t_4 = 504.$$

For 2015, the elements of win matrix (1) will be as follows (16):

$$d_0 + d_1 - t_1 = 826,\ d_0 + d_2 - t_2 = 405,$$
$$d_0 + d_3 - t_3 = 561,\ d_0 + d_4 - t_4 = 275, \quad (16)$$

Table 2. Calculated optimal strategies of improved product manufacturing

No.	Product name	Strategy of company y_j		Strategy of market x_j	
		2013	2015	2013	2015
1	Antenna receiving and transmitting satellite signals	0.12	0.21	0.29	0.26
2	HF antenna	0.41	0.33	0.2	0.22
3	UHF antenna	0.21	0.19	0.26	0.27
4	Demodulator for signal processing	0.26	0.26	0.25	0.25

$$s_0 + s_1 - t_1 = 1691, \quad s_0 + s_2 - t_2 = 1056,$$

$$s_0 + s_3 - t_3 = 1115, \quad s_0 + s_4 - t_4 = 625.$$

The matrix *U* for 2013 will be as follows (17):

$$U = \begin{pmatrix} 749 & 1648 & 1648 & 1648 \\ 905 & 237 & 905 & 905 \\ 930 & 930 & 359 & 930 \\ 504 & 504 & 504 & 178 \end{pmatrix}. \quad (17)$$

The matrix U for 2015 will be as follows (18):

$$U = \begin{pmatrix} 826 & 1691 & 1691 & 1691 \\ 1056 & 405 & 1056 & 1056 \\ 1115 & 1115 & 561 & 1115 \\ 625 & 625 & 625 & 275 \end{pmatrix}. \quad (18)$$

On the basis of the data in Table 1, resulting from completed operations regarding the transformation of *U* matrix and performed calculations of strategy elements of the enterprise, market influence according to formulae (12) and (13), the results of company's strategy components y_j and market influence x_j are derived and presented in Table 2.

In order to define the win of the enterprise for the output and sales of products according to calculated strategies, we will use the correlation (14). Substitution of the parameters values mentioned before in correlation (14) allows to find the game value for the company (income for the sales of improved product unit), which in 2013 equaled 2120.79 UAH and in 2015 decreased to 1989.3 UAH.

According to the values of vector x_j, the state of market was the most beneficial in 2013 for antenna receiving and transmitting satellite signals production (29 %) and, on the contrary, disadvantageous in case of HF antennas sales (20%). In 2015, the most advantageous state of market concerned the development of antenna receiving and transmitting satellite signals (22%) and UHF antennas (27%).

In 2013 and 2015, the company had the best opportunities to achieve optimal results from the development and sales of HF antennas (41% and 33%, respectively) and demodulator for signal processing (26% for two mentioned years).

CONCLUSION

Modern market conditions require a continuous control over the competitiveness of products, as well as the development of new variety of products. The ability to apply a systematical and rational approach in company management and to plan the expenses for research and product manufacturing in periods of market changes effectively has the potential to increase the chances of the enterprise to survive in the market.

In order develop the optimal strategy for the functioning of the enterprise, taking into account profitability of certain products types, it is necessary to consider the influence of many factors, in particular the expenses needed for the development of new products, manufacturing, storage, transporting of products.

The manufacturing process requires the rational use of natural recourses, raw products, materials, fuel, energy, labor resources and main methods necessary for receiving ready further sold products.

Customer demand for antennas receiving and transmitting satellite signals in 2013, as well as in 2015, was not taken into consideration and, as a result, the enterprise received less income from the mentioned product sales. Company managers in 2013 should have approved a decision on the increase of antennas receiving and transmitting satellite signals output, as, according to the performed calculations, there was a deficiency of these products in the market. In 2015, this situation was somewhat corrected and the costs spent on the development and production of antennas receiving and transmitting satellite signals have increased.

Excessive demand occurs when the demand volume is bigger than the supply value. This situation is very favorable for developers and manufacturers of new products and contributes to their delivery to the market, demand formation for the certain types of the products and gives an opportunity to be in advance from the rivals. However, it is important to define this situation in time, to start the product manufacturing in advance and to advance from the rivals. Obviously, it is more convenient for a new product manufacturer to choose the leading strategy and to review the pricing policy.

The identical situation at the enterprise occurred regarding the production of UHF antennas. Its state on market was not estimated in time. Moreover, in the next year, the managers of the enterprise approved a decision to decrease manufacturing of this type of product. Total demand on innovation means its correspondence to the consumer wishes, demand and supply, as well as the transition of innovation into stage of maturity, i.e., the most desired situation for product manufacturer.

The manufacturing process of such products at the enterprise like demodulator for the signal processing in 2013 and 2015 was approximated to the demand in the market.

Consumer demand on HF antennas in 2013, as well as in 2015, was not taken into account and, as a result, the company manufactured smaller amount of products than required on the market. As a rule, the manufacturing companies do not have enough information about the actual demand. This task is easy to solve by the calculations and intentionally organized examination, which give the opportunity to predict the need for specific types of products and the volume of this need more precisely. The manufacturing companies is often informed about the actual demand for the products, but does not satisfy it. Such situation can be caused by the decreased business activity of the specialists, the lack of financial possibilities, free manufacturing capacity and labor resources. If the analysis reveals a low business activity of the specialists, it is suggested to review the working policy or motivation system. In other cases, it is necessary to calculate the possible options of manufacturing capacity load, consumption and replacement of materials, to analyze relative profitability of own production, purchasing of the components, involvement and stimulation of personnel, the credit price. In addition, it is necessary to connect this analysis with the selling volumes of improved products, reimbursement of costs on manufacturing, sales and receiving a desired income.

The designed model allows to define the percentage of a single type of products at the enterprise released in relation to the whole range of products, considering the state of market, actions of competitive manufacturers and the possibility of optimal correction of this correlation for the purpose of income maximization from the sales of improved products.

The suggested model forms the basis for the analysis of the demand for new products. The developed model permits to define the correlation required for the release of the products at the enterprise, i.e., types of improved products that should be manufactured in greater volumes and the ones in smaller volume, in order to have more significant profitability resulting from the sales of manufactured products. If the company whose activity has been analyzed in this paper manufactures and sells the products according to the strategy presented above, it can maximize its income from the sales of all improved product units. The calculations performed according to the suggested model will give an opportunity to plan actions, which will facilitate timely entering the market with improved products, being in advance from the possible rivals and leading the market segment.

REFERENCES

1. Barney, J. (1986). Strategic Factor Markets: Expectations, Luck and Business Strategy. *Management Science, 32*(10), 1231-1241.
2. Binmore, K. (2007). *Playing for Real: A Text on Game Theory.* New York: Oxford University Press.
3. Blekuell, D., & Girshik, M. (1958). *Теория игры стратегических решений. [Teoriya igri statisticheskih resheniy].* Moskva: Izdatelstvo inostrannoy literaturyi.
4. Brandenburger, A., & Neylbaff, B. (2012). *Конкурентное сотрудничество в бизнесе. [Konkurentnoe sotrudnichestvo v biznese].* Moskva: Keys.
5. Cachon, G., & Netessine, S. (2003). *Game theory in supply chain analysis*. (Working paper). The Wharton School of Business, University of Pennsylvania, Philadelphia, PA.
6. Drucker, P. (1986). *Innovation and entreprenership: Practice and principles*. London: HarperCollins Publishers.
7. Dyubin, G., & Suzdal, V. (1981). *Введение в прикладную теорию игр. [Vvedenie v prikladnuyu teoriyu igr].* Moskva: Nauka, Glavnaya redaktsiya fiziko-matematicheskoy literaturyi.
8. ELFakir, & Tkiouat. (2016). A multiagent game theoretical approach to adverse selection in corporate financing. *Investment Management and Financial Innovations, 13*(2-2), 292-299. Retrieved from https://business-perspectives.org/component/zoo/a-multiagent-game-theoretical-approach-to-adverse-selection-in-corporate-financing
9. Fudenberg, D., & Tirole J. (1991). *Game Theory*. Cambridge, MA: MIT Press.
10. Gallini, N., & Winter R. (1985). Licensing in the Theory of Innovation. *Rand Journal of Economics, 2,* 237-252.
11. Gibbons, R. (1992). *Game Theory for Applied Economists*. Princeton, NJ: Princeton University Press.
12. Grant, R. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, *Winter Special Issue, 17,* 109-122.
13. Greif, A. (1996). *Economic History and Game Theory*. (A Survey Stanford Working Paper).
14. *Hurwicz, L., & Reiter, S. (2006). Designing Economic Mechanisms.* New York: *Cambridge University Press.*
15. Jaumotte, F., & Pain, N. (2005). *An Overview of Public Policies of Support Innovation.* (OECD Economics Department Working Paper, 456). Retrieved from http://www.oecd.org/eco/39619246.pdf
16. Kaiser, U. (2001). *Product Innovation and Product Innovation Marketing: Theory and Microeconometric Evidence.* (ZEW Discussion Paper). Retrieved from http://tp.zew.de/pub/zew-docs/dp/dp0131.pdf
17. Katkalo, V. (2006). *Эволюция теории стратегического управления. [Evolyutsiya teorii strategicheskogo upravleniya].* Sant-Peterburg: Izdatelskiy dom Sant-Peterburgskogo gosudarstvennogo universiteta.
18. Knight, F. (1994). The concept of risk and uncertainty. *THESIS, 5,* 12-28.
19. Lamben, Zh. (1996). *Стратегический маркетинг. [Strategicheskiy marketing].* Sant-Peterburg: Nauka.
20. Markides, K. (2010). *Новая модель бизнеса. Стратегии безболезненных инноваций. [Novaya model biznesa. Strategii bezboleznennyh innovatsi].* Moskva: Vidavnitstvo Yurayt, Alpina Pablisher.
21. Maskin, E. (2011). Commentary: Nash equilibrium and mechanism design. *Games and Economic Behavior, 71*(1), 9-11.
22. McAfee Preston, R. (2005). *Competitive Solutions: The Strategist's Toolkit*. Princeton, NJ: Princeton University Press.
23. McMillan, J. (1996). *Games, Strategies, and Managers: How Managers Can Use Game Theory to Make Better Business Decisions*. New York: Oxford University Press.
24. Mitchell, T. J., & Hustad, T. P. (1981). The Analysis of Options Approach to New Product Screening. *Research in Marketing, 4,* 143-179.
25. Muto, S. (1987). Possibility of Relicensing and Patent Protection. *European Economic Review, 1,* 927-946.
26. Myerson, R. (1997). *Game Theory: Analysis of Conflict*. Cambridge, MA: Harvard University Press.
27. Popov, A. (2008). *Инновационная экономика: лекция. [Innovat-*

sionnaya ekonomika: lektsiya]. Tambov: Izdatelstvo Tambovskogo gosudarstvennogo tehnicheskogo universiteta.

28. Porter, M. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: The Free Press.
29. Porter, M. (1998). *Competitive Strategy. Techniques for Analyzing Industries and Competitor.* New York: The Free Press.
30. Prahalad, C. K., & Hamel, G. (1990). The Core Competence of the Corporation. *Harvard Business Review, 68*(3), 79-91.
31. Rumelt, R., & Lamb, R. (Eds.). (1984). Towards a strategic theory of the firm. In *Competitive Strategic Management* (pp. 556-570). Englewood Cliffs, NJ: Prentice Hall.
32. Santo, B. (1990). *Innovation as a tool for economic development*. Moscow: Progress.
33. *Somaya, D., Teece, D.,* & *Wakeman, S. (2011).Innovation in Multi-Invention Contexts: Mapping Solutions to Technological and Intellectual Property Complexity. California Management Review, 53(4), 47-74. University of California, Berkeley.* https://doi.org/10.1525/cmr.2011.53.4.47
34. Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management, *Strategic Management Journal, 18*(7), 509-534.
35. Von Neumann, J., & Morgenstern O. (1944). *Theory of Games and Economic Behavior.* Princeton, NJ: Princeton University Press.
36. Winer, R. (2002). *Marketing Management*. Milan (IT): Apogeo.