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FINANCIAL AND TECHNOLOGICAL LEVERAGE IN THE SYSTEM OF ECONOMIC EVALUATION OF INNOVATIVE TECHNOLOGIES

Abstract. The article examines the conceptual, theoretical and methodological guidelines for economic evaluation of innovative technologies through financial and technological leverage. The concept of financial–technological linkage was developed with the aim of establishing a relationship between technological efficiency and effectiveness of operational and financial activities of the enterprise. The authors have developed measurement technology and the use of technological linkage as a tool for assessing commercial potential of new technologies, which allows establishing a link between technological efficiency and effectiveness of operational and financial activities of the engineering enterprise.

It is proved that the concept of technological linkage explains how the creation of new technologies can raise the value of the business, exceeding significantly the value of the underlying technological innovations taken in isolation. In addition, there is a real possibility of effective monitoring of the economic impact (need, usage, efficiency) from the use of технологiчної development, the exclusive rights which are at the disposal of the enterprise.

Determined that the level of commercial potential of intellectual technology is not limited only to the influence of technological leverage. The potential power can be represented as a dependence of the level of commercial potential of several very important factors that act in parallel. They proposed to include the following, the most important components of the level of commercial potential of innovative technology: the lever of the early stages of the life cycle of an innovative product; the lever of the developer technological innovations; financial leverage.

The effect of financial and technological leverage depends on innovation activity and innovation capacity of the enterprise—the developer of a technological product. Its value is usually higher for industries with higher technological level of production, which is very typical for innovative enterprises.

Keywords: Finance, technology, technological leverage, innovation, cost, effect, enterprise

JEL Classification: G32, O32, O33

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ФІНАНСОВО–ТЕХНОЛОГІЧНИЙ ВАЖІЛЬ В СИСТЕМІ ЕКОНОМІЧНОЇ ОЦІНКИ ІННОВАЦІЙНИХ ТЕХНОЛОГІЙ

Анотація. В статті розглянуто концептуальні теоретико–методичні положення економічної оцінки інноваційних технологій на засадах фінансово–технологічного важеля. Обґрунтовано, що концепція технологічного важеля пояснює, яким чином створення нової технології може підняти вартість бізнесу, перевищуючи в рази цінність базової технологічної інновації, взятої ізольовано. Крім того, з'являється реальна можливість ефективного моніторингу економічної віддачі (потреби, використання, ефективності) від використання технологічної розробки, виключні права на яку знаходяться в розпорядженні даного підприємства.

Ключові слова: фінанси, технологія, технологічний важіль, інновації, витрати, ефект, підприємство

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ФИНАНСОВО–ТЕХНОЛОГИЧЕСКИЙ РЫЧАГ В СИСТЕМЕ ЭКОНОМИЧЕСКОЙ ОЦЕНКИ ИННОВАЦИОННЫХ ТЕХНОЛОГИЙ

Аннотация. В статье рассмотрены концептуальные теоретико–методические положения экономической оценки инновационных технологий на основе финансово–технологического рычага. Обосновано, что концепция технологического рычага объясняет, каким образом создание новой технологии может поднять стоимость бизнеса, превышая в разы ценность базовой технологической инновации, взятой изолированно. Кроме того, появляется реальная возможность эффективного мониторинга экономической отдачи (потребности, использование, эффективность) от использования технологической разработки, исключительные права на которую находятся в распоряжении данного предприятия.

Ключевые слова: финансы, технология, технологический рычаг, инновации, затраты, эффект, предприятие

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Introduction. The concept of «linkage» is widely used in various natural Sciences and refers to a device or mechanism that allows increasing the impact on a particular object. For example, in the financial management as such a mechanism acts as a constant component in the total costs of the enterprise. In the context of this study the concept of technological lever will display the rate of change of the increment of capital of the company in relation to the level of change it costs of intellectual and technological development. If a positive value of technology leverage is possible to conclude about the level of innovative receptivity of enterprise–developer of technological innovations, skills and abilities not only to create a progressive innovative technologies (*IT*), but to effectively use (commercialization) in his own intellectual development.

Analysis of the research and the problem statement. A significant contribution to the development of theoretical and methodical provisions financial provision and commercialization of technological innovations made in the scientific works of Zhehus O.V. [1], Gladenko I.V. [2], Kosenko A.P. [3–5], Kotsiski D. [6, 7], Pererva P.G. [8, 9], Platonov V.V. [10], Poberezhna N.M. [11], Pogorelov I.M. [12], Rogova O.M. [13], Savenkova O.N. [14], Starostina A.A. [15] and others [16–19].

The concept of financial and technological leverage has been developed by a number of scholars [3, 6, 8, 10, 13] with the aim of establishing a relationship between technological efficiency and effectiveness of operational and financial activities of the enterprise. In [10, 13] technological lever is defined as a measure of the ability of innovative enterprises to disseminate knowledge, technology, application know–how (that is, to implement the transfer of technology) obtained in the process of creating a basic *IT* (IT_{bas}), many products for end users.

However, an extremely important task is the development of the concept of technological linkage as a tool for assessing commercial potential of technologies that allows to establish a link between technological efficiency and effectiveness of operational and financial activities of the engineering enterprise.

Results of Research. Analytical model of technological leverage can be expressed using the cost approach of accounting, the carrying value of tangible assets used in the following way:

$$TL = \sum_{i=1}^N \frac{C_i + C_{bas}}{C_{bas}}, \quad (1)$$

where TL – the technological arm; N – is the number of new areas and the use of basic intellectual and innovative technology (IT_{bas}) in products and technologies; C_{bas} – costs (the cost of tangible assets) related to the development IT_{bas} ; C_i – valuation of material expenses for the development of the i -th product or technology created with the use of IT_{bas} .

However, we are aware of the fact that the actual costs associated with the creation of new spheres and directions of use of the basic intellectual–innovative technologies in products and technologies in the General case can be considerably higher than those indicated in the formula (1). The fact that research and innovation activities always involve risk of obtaining a negative result, that is, the economic result a positive character (reproduced in the model (1) is achieved with larger total costs C_{Σ} . This package can be played like this:

$$C_{\Sigma} = C_{\Sigma} P_{noz} + C_{\Sigma} P_{hez}, \quad (2)$$

where P_{pos_i} , P_{neg_i} – is the probability, respectively, a positive or negative result from the use of and development costs C_{Σ_i} , the direction of i -th scope of use IT_{bas} .

Due to the fact that the probabilities P_{pos_i} and P_{neg_i} constitute the complete group of incompatible events (as each i -th direction, and across product and technology platform as a whole), then the fair will be the following equality: ($P_{pos_i} + P_{neg_i} = 1$) or ($P_{pos} + P_{neg} = 1$). Taking this into account, formula (2) takes the following form:

$$C_{\Sigma} = C_{pos} + C_{neg},$$

hence:
$$C_i = C_{pos} = (C_{\Sigma} - C_{neg}).$$

On this basis, determine the amount of total costs C_{Σ} that are associated with both positive and negative nature of their use in creating i -th directions or areas of application IT_{bas} . If the actual value of costs of the enterprise will be more optimally required cost $C_{fact} > C_{opt}$, the total negative costs of the enterprise for the creation of product and technological platforms will be:

$$C_{neg} = (C_{fact} - C_{opt}) = R_c (N_{\Sigma} - N_{pos}),$$

where N_{Σ} – is the total number of attempts of development i -th directions or areas of application IT_{bas} (both positive and negative), which carried out the enterprise, that is $N_{\Sigma} = N_{pos} + N_{neg}$. Of course, these opportunities at the enterprise not always, and that is each of them should be economically justified. If the company will not appropriate the funds, its total potential loss (loss of profits) from the use of i -th direction IT_{bas} will be $R_{los} (N_{\Sigma} - N_{pos})$, where: R_c , R_{los} – respectively, the average costs of the enterprise the creation of one of the directions of use IT_{bas} and the average economic losses (lost profits) in the event of his absence.

In advance it is impossible to call the number i -th directions IT_{bas} , which will be disbursed by the enterprise, proceeding from its capabilities, but with the known distribution function of development areas IT_{bas} possible to determine the expected costs for a given number of directions of use IT_{bas} in the form of economic–mathematical models, taking the integral costs for each direction multiplied by the appropriate probability $f(N_{pos})$:

$$R = R_c \int_0^N (N_{\Sigma} - N_{pos}) f(N_{pos}) dN_{pos} + R_{los} \int_N^{\infty} (N_{\Sigma} - N_{pos}) f(N_{pos}) dN_{pos}. \quad (3)$$

The task is to find such a number developed by the company and–x directions IT_{bas} in which the function of total costs and losses R will be the smallest. This is a common problem of differential calculus: $R = \min$, if $dR / dN_{noz} = 0$. Taking the derivative of expressions (3) and after simple transformations, we obtain the following equation:

$$\frac{\int_0^N f(N_{pos}) dN_{pos}}{\int_N^\infty f(N_{pos}) dN_{pos}} = \frac{R_{los}}{R_c} \quad (4)$$

The integral in the numerator of the left side of the expression (4) reflects the probability that the enterprise successfully (without negative consequences) will invest their money on creating i -th directions of use IT_{bas} , that is, it is the probability value P_{pos_i} . The integral in the denominator of the left side of the expression (4) reflects the probability that the enterprise failed (with negative consequences) will invest their money on creating i -th directions of use IT_{bas} , that is, the probability of the opposite event $1 - P_{pos_i}$. Substitute these values into the expression (4) and solve it on

$$P_{pos_i} : \quad \frac{P_{pos}}{1 - P_{pos}} = \frac{R_{los}}{R_c}, \text{ from this expression:}$$

$$P_{pos} = \frac{R_{los}}{R_c + R_{los}} \quad (5)$$

The obtained expression allows to more accurately determine the probability of a positive return on investment in the creation of product and technology platform steam enterprise on the basis of IT_{bas} , has more rigorous economic justification and excludes the elements of arbitrariness and subjectivity when making economic decisions in industry consumption IT_{bas} .

The presence of technological leverage in the enterprise, based on the logic of formula (1) can be defined only if the value of the TL in the formula (1) will be more than two ($TL > 2$). Otherwise, create IT_{bas} not allow to create anything significant because the obtained results do not exceed the cost of creating the most IT_{bas} . We conclude that the concept of technological linkage explains how the creation of new IT can raise the value of the business, exceeding significantly the value IT_{bas} taken in isolation. In addition, there is a real possibility of effective monitoring of the economic impact (demand, usage, applicability) of a particular IT , the rights to which are at the disposal of the enterprise, its impact on financial management system.

In this regard it should be noted that even before developed by the enterprise new areas and directions of use of the basic IT_{bas} will be materialized in new instruments of labor or commodities (namely, then there will be real changes in the cost structure material assets and capital of the company), the technological arm IT_{bas} will have an indirect effect on these assets. This is because when you create IT_{bas} and appearance with its use of the new developments and grow the intangible assets of the company, which primarily should include new knowledge, research and production experience, know-how, etc., which accordingly promotes the growth of the market value of the company. The presence of this factor helps to reduce the amount of investment in new development because it uses the already obtained results of investing in IT_{bas} . This allows to conclude that the impact of technological leverage will be directly proportional to the activity of the enterprise in two ways:

- first, the use of basic development IT_{bas} to generate new intellectual products;
- secondly, in the system of internal and external technology transfer.

The economic essence of technological leverage in the developer of IT and its user clearly shown in Fig.1.

Level of commercial potential of intellectual technology (LKP) is not limited to indicator (1), that is only technological lever. As the results of earlier studies [3, 16, 18, 19], the formation of the commercial potential of intellectual technology is influenced by not only technological arm TL .

The potential power can be represented as a dependence of LKP from a few very important factors that act in parallel. They proposed to include the following, as we think, the most important components of the LKP :

a) technological arm, the force of which is determined by the dependence (1) and condition $TL > 2$;

b) the lever for the early stages of the life cycle of an innovative product – LE , which occurs at the stage of market development for new products and supported by its originality, a high level of consumer properties and, consequently, a higher price, that is enforced price lever (price leverage IT).

In addition, the higher prices the company is a developer can install on their products and at the stage of monopoly presence in the market this IT_{bas} (the period of patent protection, exclusive licenses, etc.) and result in a higher profit margin (in addition to this enterprise at this stage to use IT_{bas} for the manufacture of more advanced products in this period no one has the right).

Lever early stages of the life cycle of intellectual and innovative product LE (price leverage IT) shows how many times the rate of change of sales prices exceeds the rate of change of the net profit calculated according to the formula:

$$LE = \frac{P_{sal}}{PS} = \frac{PS + C_{var} + C_{const}}{PS} = 1 + \frac{C_{var}}{PS} + \frac{C_{const}}{PS}, \quad (6)$$

where P_{sal} – sales price of intellectually–innovative products, created using IT_{bas} ; PS – profit from sales; C_{var} – variable costs in the unit cost of intellectual and innovative products; C_{const} – fixed costs in product costs;

c) operating leverage (operating leverage natural) – OL – is closely associated with the lever for the early stages of the product life cycle and shows how many times the rate of change of net profit exceeds the rate of change of revenue. Progressive IT_{bas} , as a rule, is confirmed by growing volumes of production and marketing of technological products N_{pr} . For effective IT value N_{pr} , as a rule, more units, that is, when the increase of revenues (prices) by 1% profit will increase by a greater amount. Calculation of operating leverage of OL with respect to intellectual innovation of products should be determined according to the formula:

$$OL = \frac{N_{pr} - C_{var}}{PS} = \frac{(PS + C_{var} + C_{const}) - C_{var}}{PS} = 1 + \frac{C_{const}}{PS}. \quad (7)$$

d) the lever of the developer IT_{bas} (LD) – plays receiving IT_{bas} in the development of new knowledge, original information, research and production experience, know–how and the like, which can be used in the production of new or improvement of existing intellectual–innovative products and technologies. This can significantly affect the volume of investments in development that would be otherwise much more. Arm of the developer IT_{bas} – LD – can be determined on the basis of the classical theory of economic efficiency: as all of the j -th of the results obtained (this is the total amount of all receipts in the budget of the developer from the sale IT_{bas} and all

development on their basis $\sum_{j=1}^J E_j^{bud}$) to the total costs (total costs of creation and promotion of all j -th development on the basis of basic intellectual technologies IT_{bas} , including the base costs for the creation and promotion of $IT_{bas} - \sum_{j=1}^J C_j^{IT}$).

$$LD = \frac{\sum_{j=1}^J E_j^{bud}}{\sum_{j=1}^J C_j^{IT}} \quad (8)$$

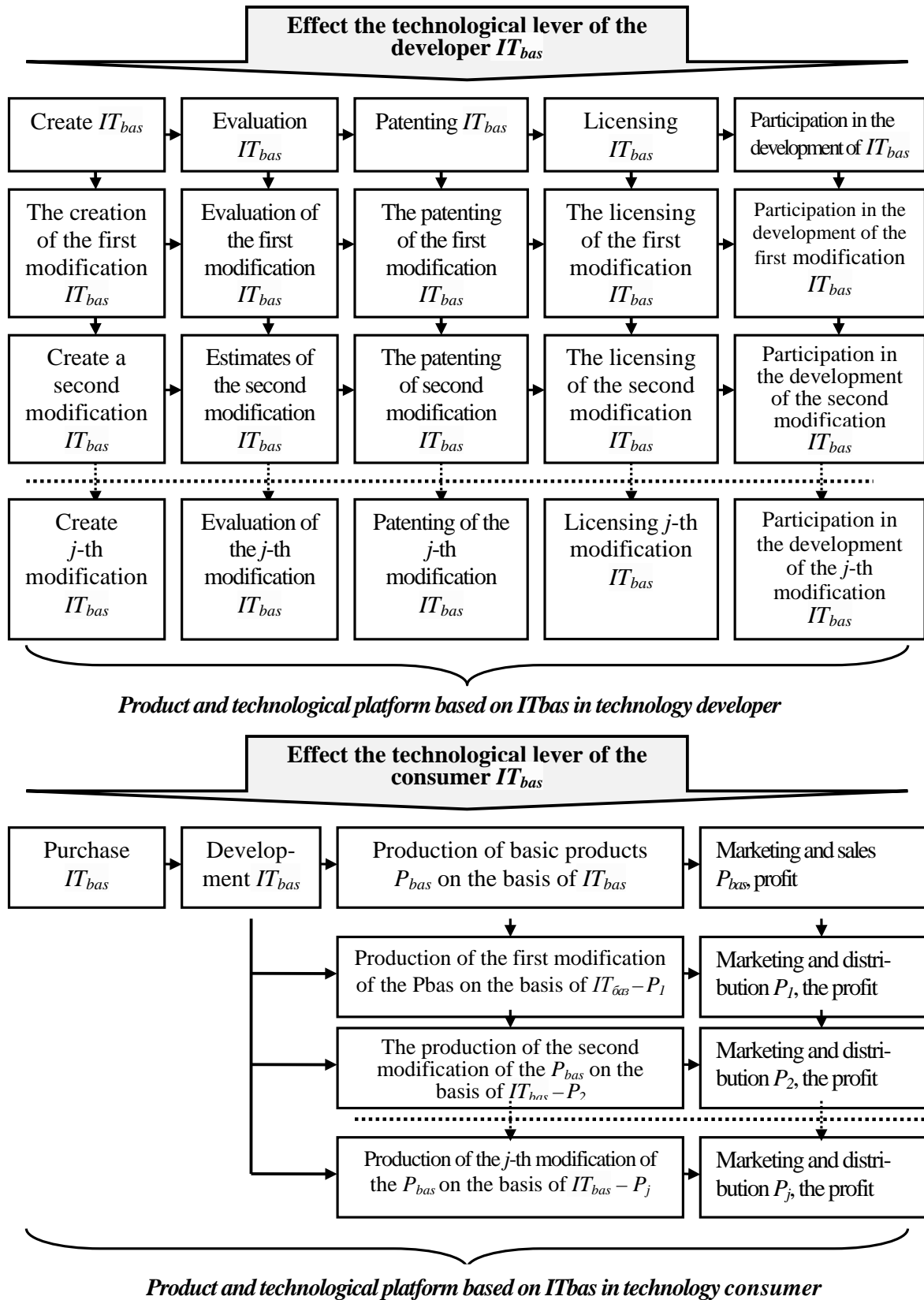


Figure 1. The economic essence of technological level of the developer and the consumer of IT
 Source: compiled by the authors based on own researches

e) the strength of the commercial potential IT_{bas} can also be considered as some function of financial lever – FL (financial leverage IT), reflecting the ratio of debt of the enterprise to equity –

K_{bor} enterprise to equity K_{own} , that is $FL = \frac{K_{bor}}{K_{own}}$. The smaller the value of financial leverage of the FL , the more stable position of the enterprise. On the other hand, borrowed capital allows to increase the rate of return on equity, i.e. to get additional return on equity. The indicator reflecting the level of additional income with the use of borrowed capital determines the effect of financial leverage (E_{FL}). In the traditional formulation this indicator is calculated by the following formula:

$$E_{FL} = K_{bor} \frac{(1 - H_{tax})(R_{ass} - CI)}{K_{own}} = FL(1 - H_{tax})D, \quad (9)$$

where H_{tax} – the income tax (in shares); R_{ass} – return on assets (ratio of gross profit to the average cost of all assets); CI – credit interest rate; D – the differential (the difference between return on assets and interest rate for the loan).

Conclusions. «The leverage effect» depends on the innovation activity and innovation capacity of the enterprise—the developer of IT . The value of E_{FL} , tend to be higher for industries with higher technological level of production, which is very typical for innovative enterprises. This situation contributes to the strengthening of the mechanism of efficiency of use of borrowed funds. If the implementation of a concrete investment project for the commercialization of IT_{bas} the investment of capital provides an economic return on assets R_{ass} and assets covered by own capital investments and debt K_{own} funds at an interest rate of K_{bor} , the return on equity R_{own} defined as follows:

$$R_{own} = R_{ass} + \frac{K_{bor}(1 - H_{tax})(R_{ass} - CI)}{K_{own}} = R_{ass} + E_{FL}. \quad (10)$$

From the formula (10) follows the obvious conclusion that if a positive value of the differential lever ($D = R_{ass} - H_{tax} > 0$) and a positive value for the «lever arm» ($FL = K_{bor} / K_{own} > 0$), the profitability of own funds more economic return on assets R_{ass} ($R_{own} > R_{ass}$).

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