XII. PROTECTION OF INTELLECTUAL PROPERTY IN INNOVATIVE ACTIVITIES AND ITS IMPACT ON ECONOMIC DEVELOPMENT

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Introduction. Innovative activities are related to the introduction into production of new products, methods, ideas, technologies, management methods, designs, industrial designs and are the intellectual property of specific individuals. Intellectual property will always be at the core of the personification of innovation, and its valuation and protection are important ingredients for the success of innovation. Given the process of ensuring the effectiveness of innovation management, ensuring the protection of intellectual property rights becomes relevant both legally and economically. Also, the state of intellectual property protection needs to be assessed over time in order to see the main trends that directly affect the efficiency of innovation activities; this certainly has an impact on economic development as well. The main purpose of the study is therefore to assess the place of intellectual property protection through public administration mechanisms in the economic development of the country. The aim can be achieved through the following tasks: investigate the role of intellectual capital in intellectual property; analyse the methodological aspects of assessing the value of intellectual property rights; to implement econometric modelling of the impact of intellectual property protection on the economic development of Ukraine.

Literature review. Recent works by foreign researchers dealing with the problems of intellectual property valuation and protection include B. Daßler, A. Kruck, & B. Zangl (2019) [1], A. Link, & M. van Hasselt (2020) [2], P. Ma (2020) [3] et al. In Ukraine, the problems of assessment and protection of intellectual property in the context of innovation activities have been investigated by M. Kovaleva (2019) [4], I. Kravets (2019) [5], L. Kuzmenko (2019) [6] and others. There are now many academic studies that have developed various methodologies and guidelines for assessing the value of intellectual property rights and the intangible assets created from them. They mainly reveal the indirect effects of intellectual property on the final product. With this in mind, the scientific literature emphasises the lack of a systematic analysis of most of the data that would allow for the necessary complex work of assessing the value of intellectual property rights. However, the problem of the impact of intellectual property protection on economic development, which is the subject of this study, has been overlooked by intellectual property researchers.

Results.

1. Intellectual Capital as the Basis of Intellectual Property

Intellectual property is broadly defined as the statutory rights to the results of intellectual activity in the industrial, scientific, literary and artistic fields. Intellectual activity as a creative activity is a purposeful mental work of an individual, the result of which is something qualitatively new, distinguished by uniqueness, originality, uniqueness [7, p. 59].

Some aspects of the theory of intellectual capital have been dealt with since the classical school of political economy, which argued that human knowledge is capital, which, like physical capital, forms the wealth of a country. The Marxist theory was based on the idea that the sphere of material production played a determining role in the development of science, thus diminishing the role of the intellectual factor in socio-economic development. Representatives of the neoclassical school analysed how "mental capital" affects the economic life of society. A. Marshall defined a person's personal wealth, which encompasses her strengths, abilities and skills, directly serving to ensure productive efficiency. If a person applies the accumulated asset of education in an economic activity, then the knowledge and skills acquired become intellectual capital. J.-B. Say was the first to identify entrepreneurial talent as a special factor of production that enables additional profits to be made. J. A. Schumpeter referred to entrepreneurs as economic actors whose function is to perform new combinations (innovations) as an active element. M. Tugan-Baranovsky proved that innovations cause cyclical fluctuations, so the intellectual factor determines economic development.

A new stage in the development of intellectual capital theory can be associated with the emergence of concepts that characterise the future development of civilisation. In particular, in the mid-twentieth century, representatives of the new institutional trend developed the conceptual foundations of the theory of post-industrial society. Scholars have focused particularly on the technological aspects of production, distribution and exchange. In the early 1960s, the concept of the information society emerged. Scientists regarded information and knowledge as a significant strategic asset for any enterprise, a source of social and economic progress. The concept of human capital, which emerged in the 1960s, has greatly enriched intellectual capital theory. Researchers have proven that investing in education ensures that individuals acquire new knowledge, skills and abilities that affect their future productivity and therefore have an impact on their income growth. There are different approaches to valuing intellectual capital at both micro and macro levels.

In a transitional national economy, attitudes to intellectual capital in general and to intellectual property in particular have changed dramatically. It should be noted that under the command economy, there was no intellectual property market in Ukraine. Assessment of intellectual products was mainly reduced to determining the economic efficiency of intellectual property objects. It was conducted for the purpose of buying or selling licenses abroad. The calculations covered only certain types of intellectual property, mainly those related to patents and licenses for inventions and know-how. In addition, while during the USSR era the exclusive right to intellectual property belonged to the state, during Ukraine's independence, it has become the property of its creators or authors, according to the Constitution of Ukraine.

Given the proliferation of privatisation processes in the Ukrainian economy, the purchase and sale of enterprises, the creation of joint ventures, investment in innovative facilities, etc., the problem of assessing and protecting

intellectual capital has become relevant. An urgent need for assessment of the value of intellectual property rights (inventions, trademarks, industrial designs, etc.) has arisen, taking into account their introduction into the statutory fund of newly created enterprises to determine the remuneration of their creators or authors, as well as the persons who implement them. Privatisation of science and technology covered both intellectual property and intangible assets that were used in economic activities for profit.

The formation of a national intellectual property market required the assessment of intellectual property rights. Its need was also necessitated by the fact that Ukraine switched to an international accounting system in 2001. Accounting standard 8 “Intangible assets” specifies that trademark rights for goods and services, industrial property rights, copyright and related rights, and goodwill are intangible assets that must be valued and recorded in the accounts. The value of intangible assets of an enterprise or firm depends on the industry of production and in some cases can be as high as 30–50 % of the value of fixed assets [8].

According to the current legislation, the objects of assessment of intellectual property rights include:

- industrial property rights protected by patents and certificates;
- know-how rights, which are confirmed by the documents of the enterprise (organization);
- rights protected by license, copyright or other agreements for the acquisition of intellectual property, concluded in the manner prescribed by applicable law;
- objects of copyright and related rights;
- design, technological, design, economic, legal, other documentation intended for use in the production and sale of goods and services;
- other results of research, development, design and production work.

Assessment of the value of intellectual property rights provides:

1) providing calculations of the value of different types of intellectual property objects entering the Ukrainian and international markets of intellectual property in the form of goods or used by business entities in various economic situations;

2) the need for a systematic approach to the valuation of intellectual property objects and the conditions of their use, taking into account the principles and specifics of pricing [9].

The value of intellectual property rights is assessed on the basis of a written agreement between the appraiser and the client or by court order. A survey of the material carrier containing the information on the intellectual property objects is carried out. Identification of rights to intellectual property involves the verification of documents confirming the legality of property rights, in particular:

- security documents (patents, certificates);
- license agreements for the transfer of the right to use intellectual property (patent and non-patent licenses);

- agreements on alienation of rights;
- constituent agreements on the transfer of property rights to the authorized capital of enterprises;
- contracts of the order (financing) for creation of objects of intellectual property by the third-party organizations with fixing on the enterprise of the rights to it;
- orders for the creation of intellectual property at the enterprise in the course of official duties, contracts or copyright agreements between the enterprise and the developers of intellectual property;
- acts of acceptance-transfer for free transfer of rights to intellectual property;
- decisions of public authorities adopted on intellectual property in case of reorganization, bankruptcy, privatization of the enterprise, etc. [8].

The valuation of intellectual property rights is also based on the technical, use, operational, environmental and economic performance of the product made with the intellectual property.

2. Methodological Support for Assessing the Value of Intellectual Property Rights

The study of the process of transformation of intellectual property into a commodity allowed us to identify a number of their inherent characteristics and features. Economic terms such as “price”, “cost”, “market value”, “efficiency”, “cost price”, etc. have been used to describe them [10 p. 56]. On this basis, we have developed a comparative characterisation of the main methods for assessing the value of intellectual property rights (Figure 1).

Figure 30 shows the main methodologies used to estimate the value of intellectual property rights, in particular:

1) the cost (investment) method, based on the accounting of all costs that arise during the creation, acquisition and use of intellectual property;

2) analogue method, which involves comparing the market value of rights to intellectual property that are close in effectiveness and takes into account relevant statistical data on the prices of similar products, if available;

3) income-based (financial) method, based on the future profitability of the intellectual product, taking into account the functional properties of intellectual property objects.

Each of these methods has its own advantages and disadvantages. In spite of this, it is impossible to name a single universally recognized methodology today. The calculated price of an intellectual product according to one of them can only serve as a basis for determining its final price. However, they are widely used for the evaluation of real estate abroad, they are taken into account when developing domestic legislation on real estate valuation in Ukraine. Taking this into account, each method should be thoroughly analysed.

METHODS FOR ASSESSING THE VALUE OF INTELLECTUAL PROPERTY RIGHTS

Cost (investment) method: Actual cost method; planned cost method; method of replacement cost; method of replacement cost; method of coefficients.	**Analogue method:** Comparative sales method; intellectual property market method; method of expert evaluations.	**Income-based (financial) method:** Economic effect method; royalty method; discount method; capitalization method; commercial weight method; profit method.
Advantages: ability to use accounting records; accuracy in calculating the price; realistic estimation of costs. *Disadvantages:* Does not account for commercialization profits; does not reflect success in the marketplace. *Examples of applications:* software; corporate methodology, etc.	*Advantages:* takes into account market conditions; reflects the relationship between buyers and sellers. *Disadvantages:* Difficulty in obtaining necessary information does not take into account future benefits. *Examples of applications:* Manufacturing software; franchise rights, etc.	*Benefits:* Accounts for future earnings; reflects the contribution of intellectual property to the company's capital. *Disadvantages:* Difficulty in predicting benefits; subjectivity. *Examples of applications:* Patents and technology; copyrights; trademarks, etc.

Figure 30. Methods for assessing the value of intellectual property rights

Source: Generated by the authors.

The cost method is based on the assumption that the buyer, having the necessary information, will not pay more for the relevant goods than the cost of a similar object in the intangible assets of the same utility.

The cost method is based on the assumption that the buyer, having the necessary information, will not pay more for the relevant goods than the cost of a similar object in the intangible assets of the same utility. To apply this method, firstly, all actual costs associated with the creation, acquisition or commissioning of intellectual property must be taken into account. Secondly, adjust the costs to the price index value available at the time of the assessment. Thirdly, determine the amount of depreciation of intellectual property. Finally, calculate the difference between the adjusted costs and the depreciation accrued to obtain the value of the intellectual property items. The more costs are factored into the calculation, the more accurate the estimate is.

The advantage of this method is the ability to use accounting records, which ensures accuracy and objectivity in calculating the price of intellectual property, as well as regulatory and legal clarity. The disadvantages of the cost method are the inability to take into account the profits from commercialisation and the

inability to reflect the success of the enterprise in the market that uses the intellectual property.

The analogue method of valuing intellectual property rights is based on a comparative sales analysis. Despite the simplicity of the analysis, there are difficulties in using this approach. This is primarily due to the individual characteristics of intellectual property, the variety of ways in which it is commercialised, and the confidentiality of the commercial agreements entered into. In view of this, it is preferable to use the following methods of applying this method. Firstly, a database is formed based on the systematisation of information on the terms of licensing agreements for the transfer of rights to these items in the global and domestic markets on a sectoral basis. It is used to determine the parameters used to compare commercialised intellectual property objects with their counterparts, which serve as a basis for determining their price. Secondly, this method can be used to determine the market price of goods that are produced using intellectual property. The comparison is made on the basis of analysis and comparison of the commercial conditions and technical level of the intellectual property which is assessed against existing counterparts.

The use of the analogue method makes it possible to determine economic indicators such as market value and residual value. However, as in the previous case, this method has certain advantages (taking into account market conditions, reflecting the relationship between buyers and sellers) and disadvantages (difficulty in obtaining information, not considering future benefits).

The income-based (financial) method is based on the recognition that business entities will invest in the acquisition of an item of intellectual property only if the income they obtain exceeds the income they would have obtained by any other means. In this case, the present value of the object in question is determined for future periods of reproduction. The use of income-based assessment methodology makes it possible to determine the share of each intellectual property object in the total profits of the enterprise. Various methods are used for this task, the main ones being discounting and capitalisation methods [11].

The assessment of intellectual property rights using the financial method is based on the mathematical apparatus developed by J. Friedman, & N. Ordway [12]. However, its application requires clarification: the value of an intellectual property asset is identified with the capital that, through the use of that asset, is capable of generating surplus value. The inverse formulation allows the monetary value of intellectual property rights to be determined by a known incremental gain. To realise this, consider first the discounting method, taking into account that the value of today's money tends to decrease in the future.

The present value of an intangible asset is defined as the ratio of total future cash flows (profits or excess surplus value) to the discount factor. The discount rate for risky capital investments is minimal, and the discount rate for risky investments associated with the instability and contradictions inherent in production processes is maximum.

Another method on which the income approach is based is the capitalisation method. Capitalisation, in our case, is seen as the transfer of profits from the use of some property to its value.

The application of the capitalization method to assess the value of intellectual property rights involves taking into account the average value of surplus value added over a period of up to three years, depreciation of fixed assets and other indicators.

The capitalisation method is more applicable to businesses with stable and predictable future cash flows from the use of intellectual property. It also gives objective results in cases where the objects of intellectual property are used in their production, in the investment process, that is, when these objects are not related to the sale of products. This is due to the fact that the refinancing rate of the National Bank of Ukraine does not reflect the risks associated with government obligations.

In this context, we should consider the method of "royalty", which is widely used in international practice in the sale of licenses. Thus, P. Krainiev considers this method as a combined method that takes into account sales and income methods [13]. The disadvantages of this method are:

1) from the proposed formulas it is unclear what kind of profitability (product profitability or production profitability) is used to calculate royalties;

2) industry average profitability figures are used in the calculations when intellectual property generates income in excess of these figures.

The method of assessing the value of intellectual property rights by income, as well as other analysed methods, has its advantages and disadvantages. The price calculated with the help of one of the methods serves as the basis for the formation of the final price of the intellectual product.

It is well known that the price of a commodity is formed under the influence of the laws of supply and demand.

The price of mass-produced goods depends on the quantity and price of goods purchased, as well as on the quantity of goods offered on the market. The supply of intellectual products is absolutely elastic, given their uniqueness and uniqueness.

The demand for this product also has its own characteristics. Firstly, it will be bought by those business entities that are technically and technologically prepared to introduce the intellectual property object into production. Secondly, the demand for an intellectual product may be determined by the personal qualities of the buyers, especially as far as literary and artistic products are concerned. Thirdly, the financial factor is also triggered, as single intellectual products are mostly priced at monopoly prices, which may be determined by the author's name, brand, etc. Consequently, in the case of intellectual production, the number of buyers willing to purchase such a product is reduced, or there may be a single buyer's demand.

At the same time another example is possible when there is only one seller and one buyer in the market. Then the supply and demand curves coincide, and

the price of the intellectual product is formed as a result of negotiations between the seller and the buyer.

The price of an intellectual product is determined not by supply and demand, but by other factors that primarily affect market conditions, competition and indirectly on the price of products in conditions of absolute competition ("black box" factor). In addition, a significant influence on the price of such a product have the conditions in which the seller and buyer. Therefore, it can be argued that the price of intelligent products is determined by negotiations between seller and buyer. Its formation is a long-term process, which may include a system of expert assessments, a mechanism for concluding license agreements and more.

The seller of an intellectual product can make various decisions on its use: sell it, apply it in its own production, export the product or capital to the country of the intellectual property rights licence holder.

So, a single, universal methodology of assessing the value of intellectual property objects as an element of intellectual capital has not yet been created, despite their peculiarity, such as virtuality, which is difficult to quantify. Taking this into account, the pricing mechanism in the intellectual property market should take into account not only specific calculation methodologies, but also the purpose of valuation and the specifics of specific intellectual property items.

Note that there is also currently no generally accepted methodology for studying intellectual capital at the macro level [14]. The Global Competitiveness Index, for example, is used to characterise the intellectual component of Ukraine's socio-economic development. One element of this index is health care and primary education, as well as higher and vocational education. It is positive that the indicators of individual components, which partly characterise domestic human capital, have not changed, if not increased, in recent years. At the same time, the indicators of the components of the Global Competitiveness Index reflecting Ukraine's innovative development (technological readiness, business competition, innovativeness) have slightly decreased in the same year.

An integral indicator of human capital development as a component of intellectual capital can be considered the Human Development Index, which has been calculated since 1990. The main goal of the United Nations Development Programme (UNDP) is to eradicate poverty and promote sustainable human development.

The concept of human development presupposes a development of society in which there is an optimum relationship between economic growth and human development; increased investment in education, health care and vocational training; and the widespread use of developed human capabilities in the production and distribution of economic wealth.

The Human Development Index covers three components:

1) the longevity indicator as life expectancy at birth;

2) the education indicator, which is a composite of the adult literacy rate (2/3 of the Index) and the average number of years of schooling (1/3 of the Index);

3) standard of living, which is estimated on the basis of real GDP per capita in USD at purchasing power parity.

For each of these indicators, fixed maximum and minimum values are defined, which in further analysis allow to determine the ranking of each country. In particular, the limit values are 25 and 85 years for the longevity indicator, 0 and 100 % for the education indicator; 100 and 40 000 USD for the standard of living indicator [15].

Existing methodologies for assessing intellectual capital are complex to implement, requiring the processing of a significant amount of information [16]. In particular, the intellectual capital map, allows to measure the intellectual capital of a firm, including 192 indicators, which are grouped according to 33 criteria, highlighting each component of intellectual capital [17].

It should be noted that the leading countries in terms of intellectual capital development in 2020 show high index scores, both overall and for individual components of intellectual capital. This is particularly true of human and structural capital, as shown by the high proportion of workers upgrading their qualifications in knowledge-intensive sectors, exports of high-tech products, and high expenditure on education, science and health among the investigated countries.

The use of part of the income for the development of human capital (further training, material incentives for personnel) and structural capital (acquisition of patents or creation of new intellectual property) ensures the accumulation of intellectual capital.

Today there is a large amount of scientific work on pricing of intellectual products at the micro level [18]. Three main methods are used to determine the basic price of an intellectual product: cost (investment), analogue and income-based (financial). However, none of them is optimal. To determine the final price of an intellectual product, the following factors should be considered:

1) qualitative characteristics of the intellectual product;

2) legal factors, in particular intellectual property rights;

3) economic factors (for example, the type of market structure, the size of the market for intellectual products, inflation, etc.).

Thus, there are different approaches to the study of intellectual capital, which assess it differently, both at the micro and macro level. With this in mind, different tools are used to characterise and analyse its individual components. However, the methodologies developed in developed countries are sometimes difficult if not impossible to apply to Ukrainian realities, which requires additional fundamental research.

3. Econometric Modelling of the Impact of Intellectual Property Protection on Ukraine's Economic Development

The previous paragraphs analysed the main approaches to the assessment of intellectual property at the micro level, involving the determination of the value of

the right to a particular new development and the formalisation of intellectual capital. It is clear that the process of monetary valuation of intellectual capital is relevant primarily to the owner, individual or legal entity. Also, monetary assessment of intellectual capital is the basis for investigating the performance of the owner of intellectual property rights.

If the aim is to assess the impact of intellectual property protection on macroeconomic growth, the following steps are necessary:

1) finding available sources of public information;
2) identification of the study period;
3) identification of the independent and dependent variables;
4) selection of the form of relationship (econometric model)
5) testing the presence and elimination of multicollinearity between independent variables;
6) econometric modelling of the impact of intellectual property protection indicators on economic development
7) statistical estimation of significance of model parameters;
8) checking the model for adequacy and economic logic.

Regarding the search for sources of public information, it should be noted that in Ukraine all statistics on intellectual property protection are kept by the State Enterprise "Ukrainian Intellectual Property Institute" (Ukrpatent), which is an institutional component of the state system of legal protection of intellectual property. It is from the official website of this organization that official statistics on the annual number of registrations of the main types of intellectual property protection are taken: patents for inventions; utility model patents; industrial design patents; certificates of trademarks for goods and services (Table 15).

Table 15. Input data for modelling the impact of intellectual property protection on economic development in Ukraine

Years	Number of registered intellectual property protection documents				Gross domestic product, mln USD
	Patents for inventions	Utility model patents	Industrial design patent	Certificates of trademarks for goods and services	
2000	5,772	222	1,044	7,785	31,261.5
2001	2,307	422	1,186	8,675	37,972.3
2002	3,038	440	1,267	12,374	42,351.6
2003	3,113	672	1,474	12,809	50,084.2
2004	2,838	1,853	1,436	15,236	64,819.7
2005	3,433	7,467	1,569	11,645	86,057.9
2006	3,698	8,268	2,061	13,134	107,648.0
2007	4,058	9,215	2,213	15,375	142,580.0
2008	3,832	9,282	2,503	15,357	179,817.0
2009	4,002	8,391	1,754	15,137	117,113.0
2010	4,308	9,405	1,431	16,686	136,013.0
2011	4,132	10,291	1,337	16,677	163,160.0
2012	3,707	9,951	1,541	15,459	175,781.0
2013	3,699	10,137	2,010	14,981	183,310.0

2014	3,455	9,196	2,464	14,698	133,503.0
2015	3,014	8,153	2,521	12,388	91,031.0
2016	2,813	9,044	2,469	13,618	93,356.0
2017	2,590	9,442	2,390	15,248	112,190.0
2018	2,469	8,620	2,297	15,877	130,902.0
2019	2,255	8,412	2,599	17,322	153,781.0

Source: Generated by the authors on the basis of the data [19; 20].

Table 15 summarizes the official statistical data for 2000–2019 (the study period) on the number of annual registrations of patents for inventions, utility model patents, industrial design patents, certificates of trademarks for goods and services, which can be reasonably considered as indicators of intellectual property protection in Ukraine. It is these indicators that form the basis for modelling the impact of intellectual property protection on economic growth in Ukraine (interpreted by the GDP at current USD prices). That is, the dependent variable in the future multifactor econometric model it is advisable to take the indicator GDP at current USD prices, and the factor variables will be the number of annual registrations of patents for inventions, utility model patents, industrial design patent, certificates of trademarks for goods and services.

It should be noted that a simple form of stochastic interaction is straightforward, but it is the least reliable in economic research and econometric modelling because the formalisation of social relations, which are also economic relations, cannot follow linear rules. If we take into account the fact of modelling the impact of 4 factors of intellectual property protection on the dynamics of economic development of the national economy, then the most acceptable and most reliable form of interaction is the power form. The general form of a multiple power regression model would be as follows:

$$\hat{Y}_X = \beta_0 \cdot X_1^{\beta_1} \cdot X_2^{\beta_2} \cdot \ldots \cdot X_n^{\beta_n}, \quad (1)$$

where $\hat{Y}_X$ is the calculated (theoretical) value of the dependent variable;

$X_1, X_2, \ldots, X_n$ are independent variables introduced into the model;

$\beta_1, \beta_2, \ldots, \beta_n$ are the parameters of the regression equation or coefficients of elasticity, which show the percentage change of the dependent variable in the case of growth of the corresponding independent variable by 1%;

β_0 is a constant (the value of the dependent variable when the parameters are 0).

In logarithmic form, the multiple power regression model looks like this:

$$\ln \hat{Y}_X = \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \cdots + \beta_n \ln X_n. \quad (2)$$

Based on the multiple power regression model expressed by formulas (1) and (2), it should be noted that the absolute values of the indicators in Table 1 are

replaced by baseline growth rate indices in order to achieve high confidence. The absolute values of the indicators for the current year should be divided by the baseline value of the indicator for the year 2000 and the resulting ratio should be entered in Table 16. The proposed procedure is carried out to achieve three objectives: firstly, to reduce the indicators to a single unit of measurement; secondly, to provide a uniform formalisation of the dynamics of these indicators; and thirdly, to form algebraic assumptions for the logarithmisation of indicator values to be introduced into the econometric model of the impact of intellectual property protection on economic growth.

Table 16. Baseline indices of growth rates of intellectual property protection indicators and Ukraine's GDP

Years	Patents for inventions (*PI*)	Utility model patents (*UMP*)	Industrial design patent (*IDP*)	Certificates of trademarks for goods and services (*CTGS*)	*GDP*
2001	0.3997	1.9009	1.1360	1.1143	1.2147
2002	0.5263	1.9820	1.2136	1.5895	1.3548
2003	0.5393	3.0270	1.4119	1.6453	1.6021
2004	0.4917	8.3468	1.3755	1.9571	2.0735
2005	0.5948	33.6351	1.5029	1.4958	2.7528
2006	0.6407	37.2432	1.9741	1.6871	3.4435
2007	0.7030	41.5090	2.1197	1.9750	4.5609
2008	0.6639	41.8108	2.3975	1.9726	5.7520
2009	0.6933	37.7973	1.6801	1.9444	3.7462
2010	0.7464	42.3649	1.3707	2.1434	4.3508
2011	0.7159	46.3559	1.2807	2.1422	5.2192
2012	0.6422	44.8243	1.4761	1.9857	5.6229
2013	0.6409	45.6622	1.9253	1.9243	5.8638
2014	0.5986	41.4234	2.3602	1.8880	4.2705
2015	0.5222	36.7252	2.4148	1.5913	2.9119
2016	0.4874	40.7387	2.3649	1.7493	2.9863
2017	0.4487	42.5315	2.2893	1.9586	3.5888
2018	0.4278	38.8288	2.2002	2.0394	4.1873
2019	0.3907	37.8919	2.4895	2.2250	4.9192

Source: Authors' calculations based on the data in Table 15.

The data in Table 2 show that over 2001-2019 the fivefold increase in GDP in actual USD prices was accompanied by a 60% reduction in the number of annual registrations of patents for inventions, a 2.2-fold increase in annual registrations of certificates of trademark for goods and services, 2.5-fold increase in annual registrations of industrial design patents and an increase of about 38-fold in annual registrations of utility model patents.

Based on formula (1) and the notations of the indicators in Table 2, we form a refined equation of the multiple power regression model:

$$GDP = \beta_0 \cdot PI^{\beta_1} \cdot UMP^{\beta_2} \cdot IDP^{\beta_3} \cdot CTGS^{\beta_4}. \quad (3)$$

In order to ensure the adequacy of the multiple power regression model and to prevent distortions of statistical estimates and the nature of interaction between the indicators, it is necessary to implement multicollinearity testing between the predictor variables. The presence of multicollinearity is decided upon when there is a strong stochastic interaction between any of the predictor variables. One from the pair of predictors must be removed or replaced by another until the multicollinearity between all the predictor variables to be entered into the model disappears.

In order to test for multicollinearity, a correlation matrix is first formed in which the pairwise correlation coefficients of all possible combinations of predictor variables pairs are summarised. Excel functionality will be used for this purpose. It is the obtained pairwise correlation coefficients that are tested. The main problem solved in this test is to calculate the critical limits of the interval of values of the pairwise correlation coefficients, between which there is no multicollinearity. To solve this problem, use the formula of the F-test [21, p. 634–635]:

$$F = \frac{r^2}{1 - r^2} \cdot \frac{n - m - 1}{m}, \quad (4)$$

where r is the correlation coefficient;
n is the number of values of the observed indicators;
m is the number of predictive variables in the model.

The observed F-test value is compared with the critical value calculated for the significance level $\alpha = 0{,}05$ and the degrees of freedom $k_1 = m$ & $k_2 = n - m - 1$. In our case, $k_1 = 1$ and $k_2 = 19 - 1 - 1 = 17$. Using the Excel statistical function "F.INV", we find the critical value of the F-test: F.INV(0.95;1;17) = 4.451. Therefore, all values of the paired correlation coefficient for which the observed F-test values will be less than 4.451 will indicate a statistically insignificant relationship between the predictor variables that will be introduced into the model, and therefore we can assume that there is no multicollinearity between them. Find the maximum value of the correlation coefficient pair for which will be implemented this requirement, solving equations with one unknown [21, p. 634–635]:

$$4.451 = \frac{r^2}{1 - r^2} \cdot \frac{19 - 1 - 1}{1} = \frac{17r^2}{1 - r^2};$$
$$17r^2 = 4.451(1 - r^2);\ 17r^2 = 4.451 - 4.451r^2;$$
$$21.451r^2 = 4.451;\ r^2 = 0.2075;$$
$$r = \sqrt{0.2075} = \pm 0.456. \quad (5)$$

Consequently, no multicollinearity between the predictor variable considers when executed condition:

$$r \in [-0.456; 0.456]. \quad (6)$$

Formula (5) shows the range of values that the pairwise correlation coefficient should acquire in order to conclude that there is no multicollinearity between a pair of independent variables. The remaining values inform about the multicollinearity between a pair of independent variables:

$$r \in [-1; -0.456] \cup [0.456; 1]. \quad (7)$$

Therefore, multicollinearity testing is performed according to formulas (6)–(7) and the data of Table 17.

Table 17. Correlation matrix of baseline indices growth rates of intellectual property protection indicators and Ukraine's GDP

	PI	*UMP*	*IDP*	*CTGS*	*GDP*
PI	1				
PUM	0.4010	1			
DP	-0.1486	0.6397*	1		
CTGS	0.3299	0.6595*	0.3721	1	
GDP	0.4666	0.9089	0.5348	0.7772	1

* $r > 0.456$

Source: Authors' calculations using Excel.

In Table 3, the cells in which the pairwise correlation coefficients whose value fell within the range given in formula (6) are shown in grey. Therefore, there is a high stochastic interaction between the independent variables Utility Model Patents and Industrial Design Patents, as well as between Utility Model Patents and Certificates of Trademarks for Goods and Services, which indicates the presence of multicollinearity. To eliminate multicollinearity, Utility Model Patents is derived from independent variables.

Thus, to implement econometric modelling of the impact of intellectual property protection on economic growth using the multiple power regression model, the natural logarithms of the basic indices of annual registrations of patents for inventions, industrial design patents, certificates of trademark for goods and services and annual GDP at current USD prices (Table 18).

Table 18. Natural logarithms of the baseline indices growth rate of intellectual property protection and Ukraine's GDP

Years	ln *PI*	ln *IDP*	ln *CTGS*	ln *GDP*
2001	-0.9171	0.1275	0.1082	0.1945
2002	-0.6418	0.1936	0.4634	0.3036

2003	-0.6174	0.3449	0.4979	0.4713
2004	-0.7099	0.3188	0.6715	0.7292
2005	-0.5196	0.4074	0.4027	1.0126
2006	-0.4452	0.6801	0.5230	1.2365
2007	-0.3523	0.7513	0.6805	1.5175
2008	-0.4096	0.8744	0.6794	1.7496
2009	-0.3662	0.5188	0.6649	1.3208
2010	-0.2925	0.3153	0.7624	1.4704
2011	-0.3343	0.2474	0.7618	1.6523
2012	-0.4428	0.3894	0.6860	1.7269
2013	-0.4450	0.6551	0.6546	1.7688
2014	-0.5132	0.8587	0.6355	1.4517
2015	-0.6498	0.8816	0.4645	1.0688
2016	-0.7188	0.8608	0.5592	1.0940
2017	-0.8014	0.8282	0.6722	1.2778
2018	-0.8492	0.7885	0.7127	1.4321
2019	-0.9399	0.9121	0.7998	1.5931

Source: Authors' calculations using Excel.

Consequently, the formation of Table 18 is the completion of all preparatory activities prior to the direct econometric modelling of the impact of intellectual property protection on the economic development of Ukraine. Next, the add-on "Data Analysis" is used, in the "Regression" function of which data arrays of independent (ln *PI*, ln *IDP*, ln *CTGS*) and dependent (ln *GDP*) variables from Table 18 are filled.

The simulation results are shown in Figure 31.

Multiple R	0.881277896
R Square	0.776650731
Adjusted R Square	0.731980877
Standard Error	0.250142467
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	3.263678243	1.087892748	17.38646231	3.80591E-05
Residual	15	0.938568809	0.062571254		
Total	18	4.202247052			

	Coefficients	*Std Error*	*t Stat*	*P-values*	*Lower 95%*	*Upper 95%*
Intercept	0.387306251	0.339520666	1.14074426	0.271862891	-0.336364918	1.11097742
PI	0.848524295	0.323166439	2.625657222	0.019097261	0.159711335	1.537337255
IDP	0.708601686	0.246460118	2.875117047	0.011563366	0.18328438	1.233918992
CTGS	1.513603082	0.428572151	3.531734569	0.003020319	0.600123165	2.427082999

Figure 31. Results of modelling the impact of intellectual property protection on economic development in Ukraine

Source: Authors' calculations using Excel.

Figure 31 presents the parameters of the three-factor power regression model and the actual values of its statistical estimates. The resulting econometric

model of the impact of intellectual property protection on the economic development of Ukraine, shown in Figure 2, is statistically significant and credible, as it is described by high values of statistical coefficients and criteria. Thus, the multiple correlation coefficient R = 0.88 confirms the presence of a high stochastic interaction between variables. The coefficient of multiple determination $R^2 = 0.78$ means that the dynamics of GDP by 78 % is due to changes in the number of registrations of patents for inventions, industrial designs patents and certificates of marks for goods and services. The influence of other factors is 22 %. The observed value of the F-test is 5.3 times higher than the critical value, which indicates a statistically significant stochastic interaction between the indicators entered into the model. The reliability of the model parameters is confirmed by the actual values of the t-test, which are greater than 1.73 (critical value). Therefore, the obtained model is statistically significant and reliable.

According to Figure 2, the regression equation is formed in logarithmic form:

$$\ln GDP = \ln 0.3873 + 0.8485 \ln PI + 0.7086 \ln DP + 1.5136 \ln CTGS \quad (8)$$

After the necessary algebraic transformations, the final equation of the three-factor power regression of the dynamics of economic growth in Ukraine, taking into account the protection of intellectual property, is as follows:

$$GDP = 1.4730\ PI^{0.8485}\ DP^{0.7086}\ CTGS^{1.5136} \quad (9)$$

The data in formula (9) show that a 1 % increase in patent registrations increases Ukraine's GDP at actual USD prices by 0.85 %. A 1 % increase in industrial design patents registrations is accompanied by a 0.7 % increase in GDP. The increase in the number of issued certificates of trademarks for goods and services by 1% is accompanied by an increase in GDP by 1.5%. A cumulative 1 % increase in all three intellectual property protection indicators is accompanied by a 3 % increase in GDP. Therefore, the resulting model should be considered statistically adequate and one that does not contradict economic logic. That is, strengthening protection of intellectual property rights in the country is an important factor for economic growth.

Conclusion. Thus, the study of the impact of intellectual property protection in innovation on economic development allows us to draw a number of conclusions.

Firstly, the main objects of assessment of intellectual property rights are: industrial property rights secured by patents and certificates; know-how rights confirmed by enterprise documents; rights protected by license, copyright or other agreements for the acquisition of intellectual property, concluded in accordance with applicable law; objects of copyright and related rights; design, technological,

design, economic, legal, other documentation intended for use in production and sales; other results of research, development, design and production work.

Secondly, the existing methodological support for assessing the value of intellectual property rights is represented by: cost (investment) method, which is based on taking into account all costs in the creation, acquisition and use of intellectual property; analogue method, which consists in comparing the market value of similar in efficiency rights to intellectual property and taking into account the relevant statistics on prices for similar products; income-based (financial) method, based on the future profitability of the intellectual product, taking into account the functional properties of intellectual property.

Thirdly, based on the results of constructing a multiple power regression model, it is proved that a 1 % increase in the number of registrations of patents for inventions, design patents and certificates of trademarks for goods and services increases the GDP of Ukraine at actual USD prices by 3 %, so the protection of intellectual property rights in the country is an extremely important factor for economic development.

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