ОСОБЛИВОСТІ РОЗВИТКУ СВІТОВОГО ГОСПОДАРСТВА ТА МЕВ

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STOCHASTIC ANALYTICAL APPROACH TO THE TIME FACTOR CONSIDERATION IN ASSETS VALUATION

СТОХАСТИЧНИЙ ПІДХІД ВРАХУВАННЯ ЧАСОВОГО ФАКТОРУ У ВАРТІСНІЙ ОЦІНЦІ АКТИВІВ

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Abstracts. *This paper emphasizes the important role of assets valuation in assuring the transparency and stability of financial system as underlined by the international Basel Accord on banking supervision. One of the main aspect in this respect is necessity to take into account time factor influence that is especially important for secured lending operations, insurance processes, and in general for investment purposes where duration is essential.*

Existing approaches for accounting this factor in assets valuation processes are based on empirical analyses of historical data followed by forecasts for the future time period. In this respect two main streamline of approaches are formed: based on smoothing the cyclicity of value change over time or "through cycle" type and skirting of market value evolution trend or "under cycle" type, respectfully.

In the paper, a new stochastic analytical model to consider time effect is proposed, which is based on the rational theory of warrant pricing developed by Samuelson. Analytical solution for estimation of proposed time factor Δ *is presented. The influence of market value volatility, tendency of market future evolution and required level of certainty on this parameter is analyzed. General methodology of time effect assessment based on this "follow-the-cycle" type model is described.*

Testing of the model applicability was demonstrated using the available information data set for the residential apartments market evolution in 2019-2021 in Ukraine which is monitored by consulting-engineering group "Veritex".

Key words: *assets valuation, prudent value assessment, secured lending, market value, Samuelson's model, stochastic modelling, time factor.*

Анотація *У статті підкреслюється важлива роль оцінки активів у забезпеченні прозорості та стабільності фінансової системи, як це визначається у Міжнародній Базельській угоді з банківського нагляду. Одним із головних аспектів у цьому відношенні є необхідність врахування впливу чинника часу, що особливо важливо для операцій із забезпеченням кредитування, процесів страхування та загалом для інвестиційних цілей, де тривалість має істотне значення.*

Існуючі підходи до врахування цього чинника у процесах оцінки вартості активів базуються на емпіричному аналізі історичних даних, з подальшим прогнозом на майбутній період часу. У цьому відношенні сформовані два основних підходи: на основі згладжування циклічності зміни вартості у часі, або типу «через цикл» на нижній кривій тенденції розвитку ринкової вартості, або типу «під циклом», відповідно.

У статті пропонується нова аналітична стохастична модель для врахування ефекту часу, яка базується на раціональній теорії варрантного ціноутворення, розробленій Самуельсоном. Представлено аналітичне рішення для оцінки запропонованого чиннику часу Δ. Проаналізовано вплив волатильності ринкової вартості, тенденції майбутньої еволюції ринку та необхідного рівня визначеності на цей параметр. На основі запропонованої моделі, яка відноситься до типу «слідування за циклом», описано загальну методологію оцінювання ефекту часу при визначенні довгострокової вартості майна.

Тестування застосовності моделі продемонстровано з використанням наявної інформаційної бази даних еволюції ринку житлових приміщень в Україні у 2019-2021 роках, яка підтримується консалтинго-інжиніринговою групою компаній «Верітекс».

Ключові слова: *оцінка вартості, консервативна вартість, заставне забезпечення, ринкова вартість, модель Самуельсона, стохастичне моделювання, часовий чинник.*

Introduction. As underlined by the International Valuation Standards Council, valuations are commonly used across the financial system including but not limited for such purposes as company listings, mergers and acquisition, funds and investments, financial reporting, auditing, secured lending, taxation, insurance, litigation, insolvency. This confirms important role of robust and reliable valuation approaches, methods and practices for the global financial system stable operation.

Summarizing the main causes of the Global Financial Crisis 2007-2009, the Basel Committee on Banking Supervision (BSBC) which operates under the auspices of the Bank for International Settlement (BIS), jointly with all other global financial institutions underlined among most influential and precipitating factors of financial system sustainability the inappropriate standards and practice of subprime mortgage operations.

In response to the deficiencies in financial regulations revealed by the last global financial crisis, the third installment of the Basel Accords (Basel III) was developed. It was intended to strengthen bank capital requirements by increasing minimum capital requirements, holdings of high quality liquid assets, and decreasing bank leverage. In particular it is stated that "…valuation must be appraised … using prudently conservative valuation criteria…" and "… must be adjusted to take into account the potential for the current market price to be significantly above the value that would bt sustainable over the life of the loan" In this respect within the EU, the Basel III recommendations have been implemented through the Regulation 575/2013 on Prudential Requirements for Credit Institution and Investment Companies.

This is one of the clear indications of necessity to consider time effect when estimating the value of assets for such purposes as collateral, insurance as well as any of the investment type in a

future projects, when duration of these projects and possible changes in value is valid being essential for their feasibility and expediency.

Coming from this, the paper's **main objective** is to review current status of time effect consideration in the assets value estimation and propose a new methodology based on Samuelson's Rational Theory of Warrant Pricing [*Samuelson,* 1965: 13-39], with testing of the results achieved using experimental statistical data of assets market evolution.

General importance of the reliable valuation was strongly confirmed by data from US, Europe and Japan, which identify that a half of the fall in the value of banks during Global Financial Crisis and the most recent COVID-19 effect was caused by the level of falls in Real Estate Investment Trust prices [*Kohlscheen, Takats*, 2020].

This item is of special importance for Ukraine financial sector. According to the National Bank of Ukraine data, the level of nonperforming loans (NPL) to total gross loans in national banking system at the beginning of 2021 was 41% that remains a burden for the banking sector, especially for state-owned banks, which accumulated over 70% of the sector's NPLs. At the same time for developed economies and neighbor East-European countries current NPL level does not exceed 6 %.

Review of existing approaches. Among key basis of value which is the fundamental premises, on which the reported values of any assets are or will be based, the International Valuation Standard (IVS) specify the following: market value, equitable value, investment value/worth, synergistic value and liquidation value. Any of them should be determined at a specific valuation date. E.g., a definition of the most widely used market value states that "market value is the estimated amount for which an asset or liability should exchange on the valuation date between willing seller and willing buyer…" It means that assets appropriate value should be determined at a fixed period of time according with the purpose of valuation.

But with market evolution under the influence of broad spectrum of influential factors, this value will violate and for any other time point it might be either higher or lower of the estimated level for this fixed time, being only occasionally at the same level. Such fluctuations of assets values are unavoidable for market economies with stochastic processes of their evolution, creating a problem of estimation a proper level of values for the application in cases where the time effect is essential. As a result, Basel III Accord and European Banking Authority (EBA) emphasize that financial institutions should not be allowed to apply solely market value concept in assets valuation practice.

With respect to the cyclical mode of value change, there are two main concepts of time effect consideration [*Crosby, Hordijk, 2021*: 18]. The first one is "through-the-cycle" type which averages or "flattens" the value pattern fluctuations through the time period, aiming to identify a fair economic or equilibrium value. The main application of such models covers mostly investment type of financial analyses and decisions with time effect concern.

The second one is "under-the-cycle" concept which intends to find lower "skirting" line of market value fluctuation over a given period of time. This second type of concepts is reflecting more precisely the Basel III requirements to implement prudent assessment of assets value with respect to a long-term effect. This prudent or long-term value should not exceed the market value at any time under consideration.

The most common "through-the cycle" type of approaches for the time effect consideration are those described by Nordlund [*Nordlund*, 2008] and Cardozo [*Cardozo et al,* 2017], being named as "reference value model" and "adjusted market value-AMV", respectively. Both of them are purely grounded on the previous statistical data through the identification of long-term trends based on past data available, assuming that the future would look like the past.

More recent AMV-approach is grounded on comparing asset's current market value, as reflected in an appropriate capital value index, to a long-term trend line. The regression-generated, long-term trend line is drawn dynamically rather than with historical hindsight through an inflation-adjusted capital value index [*Cardozo et al*, 2017].

More sophisticated "through-the-cycle" models include some consideration of the trend extension to the future with reference to the current value, with forecast of its change in coming years. This forecast is mainly based on conventional discounted cash flow (DCF) models [*Burston, Burrel*, 2015, *Crosby, Hughes*, 2011].

Among "under-the-cycle" approaches, the longest history of development belongs to the Mortgage Lending Value (MLV) approach developed primarily in Germany as far back as the beginning of this century [*Grimman*, 2017]. The MLV concept development and implementation was mainly driven by the Association of German Mortgage Banks (German Pfandbrief Banks-VDP) in a close cooperation with the Federal Financial Supervisory Office. Being most well established, this approach came into force in 2005 through the adoption of the German Pfandbrief Act, which regulates the determination of the mortgage lending value.

From that time this approach plays a central role in the property valuation for lending purposes in Germany, reflecting the long-term and sustainable characteristics of the collateral property disregarding any speculative elements and economically induced fluctuations in value. European countries, which to some extent follow the Germany experience in this respect, are Austria, Czechia, Hungary, Luxemburg, Poland, Slovenia and Spain.

The definition of the Mortgage Lending Value is set out in the EU Capital Requirements Regulation (CRR) No.575/2013 as: "the value of immovable property as determined by a prudent assessment of the future marketability of the property taking into account long-term sustainable aspects of the property, the normal and local market conditions, the current use and alternative appropriate uses of the property".

In its essence MLV model is principle based. When deriving the property mortgage lending value, current transaction databases available could be accompanied by a broader analysis from the past as well as a reasonable forecast analysis to be added to arrive to the prudent sustainable value. Hence it is based on a combined consideration of available historic empirical data, current market values and future assessments, using analyses and forecasts that ignore short-term price volatility to arrive to a realistic lowest possible level of market value, which is expected in a future time horizon under consideration.

Despite of the fact that MLV is the only long-term value concept that has been developed and adopted for the secured lending purposes, its principle base led to the fact that application of the concept in different jurisdictions vary [Crosby, Hordijk, 2021; 17]. It requires development of more analytically grounded models for assessing the prudent assets value with consideration of time effect, including a stochastic nature of value change. The necessity of developments in this area was strongly underlined in a recent review manuscript steered by the international group of experts from the most recognized international valuation bodies [*Crosby, Hordijk*, 2021].

As any analytical approach which is oriented to be practically used, such model should be from one side based on the historical data sets available and the forecast for the reasonable period of time needed. From the other side, such data should be used for testing of the model efficiency and clarification of limitations if any.

Analytical model. The main concept of the model appeared from the fact, that the problem to find certain level of stochastically progressing processes of value change can be represented as an analytical task to find a border of this process, which will not be reached with given level of probability during the time period requested.

Denote by S_t the median market value V_{av} at moment *t* of the square meter of residential apartment's area (Fig. 1). We suppose that time *t* is measured in months and the value $t = 0$ corresponds to the present moment of time. Based on a widely used for the description of financial markets dynamics Samuelson's stochastic, Markov processes grounded, rational model of warrant pricing, we can write [*Samuelson*, 1965; *Shiryaev, et al*, 1994]:

$$S_t = S_o \exp\left\{\left(\mu - \frac{\sigma^2}{2}\right)t + \sigma W_t\right\}, t \geq 0. \quad (1)$$

Here, $S_0 > 0$ is nonrandom and known, $\mu \in \mathbb{R}$ is growth factor, $\sigma > 0$ is process volatility, and $\{W_t\}$ is a Wiener process with continuous paths.

In the present case of time factor assessment in assets valuation, a rationale for the model (1) is as follows. Rewrite (1) in terms of log-values

$$X_t := \ln S_t, t \geq 0, \tag{2}$$

to obtain

$$X_t := X_0 + at + \sigma W_t, t \geq 0; \tag{3}$$

$$a := \mu - \frac{\sigma^2}{2}, t \geq 0. \tag{4}$$

Based on log-normal distribution of S_t as discussed below, it holds that $\{X_t, t \geq 0\}$ is homogeneous Gaussian process with independent increments (Fig.1). But any homogeneous Gaussian process with independent increments has a form (3) with parameters $a \in \mathbb{R}$ and $\sigma > 0$. Thus, relations (3) and (1), respectively, are reasonable in the considered problem.

With given the current value S_0, a probability *p* and a time horizon $T > 0$, our goal is to find $\Delta > 0$ such that

$$P(\min_{0 \leq t \leq T} S_t \geq S_0 - \Delta) = p. \tag{5}$$

The quantity $S_0 - \Delta$ can be interpreted as a median market value S_0 of the square meter apartment's area corrected by the time factor Δ, i.e., corrected according to possible future long-term values of S_t. Thus,

$$S_t = S_0 - \Delta. \tag{6}$$

Relation (5) is equivalent to the following:

$$P(\min_{0 \leq t \leq T}(at + \sigma W_t) \geq x) = p, \tag{7}$$

$$x := \ln(S_0 - \Delta) - X_0, \tag{8}$$

with *a* introduced in (4).

Based on Lemma, given in [20], the value $x = x(a, \sigma, p) < 0$ can be estimated numerically from the equation

$$F(x; a; \sigma) = p, \tag{9}$$

where the left-hand side of the equation (9) for any $T > 0$, $a \in \mathbb{R}$, $\sigma > 0$ and $x \leq 0$ is given in [*Shiryaev et al*, 1994] as:

$$F(x; a, \sigma) := P(min_{0 \leq t \leq T}(at + \sigma W_t) \geq x) = -exp\left(\frac{2ax}{\sigma^2}\right) \Phi\left(\frac{x + aT}{\sigma\sqrt{T}}\right) + \Phi\left(\frac{-x + aT}{\sigma\sqrt{T}}\right). \tag{10}$$

Here, Φ stands for standard normal cumulative distribution function. Equation (9) has a unique solution for x, since the F function (10) is strictly decreasing and continuous in x, and moreover F tends to 1 as $x \to -\infty$, and $F = 0$ for $x = 0$. In applications we find an approximate solution x_p to (9), such that

$$\left|F(x_p; a, \sigma) - p\right| \leq \delta, \tag{11}$$

where δ is a given precision. This can be done by a simple dichotomy approach. After finding x_p as an approximation to x, we can evaluate parameter Δ as a time factor based on equation (7) as:

$$\Delta = S_0(1 - e^{x_p}). \tag{12}$$

Experimental data set and model testing. Initial data for the developed model parameters assessment have been taken from the information-analytical data base of Ukrainian residential market evolution, created and fed on a constant basis by the consulting-engineering group of companies "VERITEX®". The creation of a primary database is carried out by monitoring and accumulating information flows from the existing real estate market and their subsequent in-depth statistical processing. The use of modern methods of database management (PostgreSQL), geo-information systems (QGIS) and scripting library (Python) allows performing this initial analysis most efficiently.

Time range covered by this primary data base of residential apartments used for the assessment of the parameters was 30 months from July 2019 till December 2021. This period includes also two COVID-19 pandemic outbreaks fixed in Ukraine in spring 2020 and autumn 2021. Overall monthly size of the market available for Ukraine totally and tailored in this data base fluctuated between 175, 000 to 210, 000 sales propositions.

A statistical analysis of representative samples was performed first of all in relation to the main financial indicator, the cost of 1 sq. m. of the apartment's area. Application of powerful Pearson's statistical agreement criteria demonstrated the closest compliance of the general statistical sample of this financial indicator with log-normal distribution law.

Testing of this important conclusion for a large number of statistical samples including individual cities and their price clusters, as well as for different time intervals, confirmed its validity. Based on this, all further processing of the primary information database was based on determining the parameters of the log-normal distribution law adopted as theoretical law, for the whole general population of information databases of the distribution of the value of the square meter area of apartments. This general conclusion is essential also for the theoretical model proposed above keeping in mind that log-normal distribution was used initially as the basic one in the original rational theory of warrant pricing developed by Samuelson.

The overall picture of the median value V_{av} and the coefficient of variation ν_v of the square meter apartment's area demonstrate evolution of those parameters in time (Fig.1). Fluctuations of the median value are quite evident with general tendency to growth, whereas the volatility of this parameter measured through the coefficient of variation is more stable in time.

In our practical case, $\tau = 1$ month, $n = 30$, and $T_0 = 30$ months. Based on data set available, we estimate μ and σ using log-returns

$$y_k := \ln\left(\frac{U_{k\tau}}{U_{(k-1)\tau}}\right),\ k = 1, \dots, n. \tag{13}$$

It holds

$$\frac{y_k}{\sqrt{\tau}} = a\sqrt{\tau} + \sigma\gamma_k,\ k = 1, \dots, n, \tag{14}$$

where $\gamma_k = \tau^{-\frac{1}{2}}(B_{k\tau} - B_{(k-1)\tau}), k \geq 1$, are independent standard normal variables.

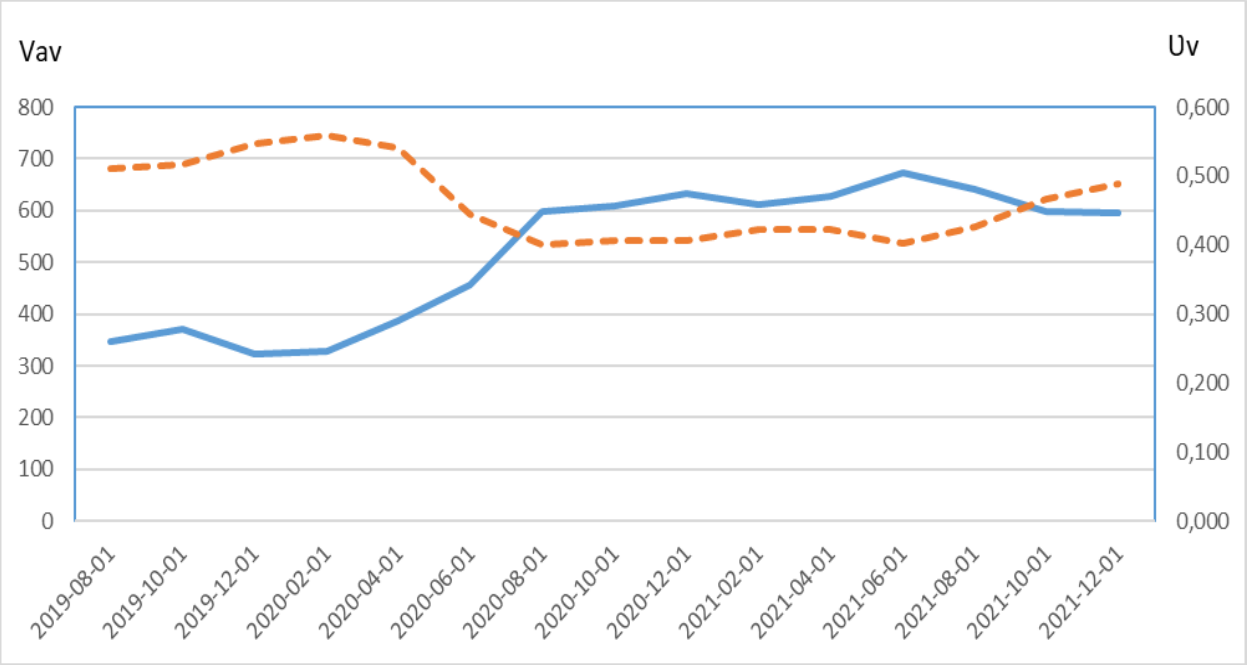

Fig 1. Time evolution of the median value V_{av} and the coefficient of variation v_v of the residential apartment's area square meter in Ukraine in 2019-2021.

For the model of observations (14), the maximum likelihood estimator of a is evaluated as

$$\hat{a} = \frac{1}{n\tau}\sum_{i=1}^{n} y_i = \frac{1}{n\tau}\ln\left(\frac{U_{T_0}}{U_0}\right), \tag{15}$$

and the unbiased estimator of σ^2 is as follows [19, p.66]:

$$\hat{\sigma}^2 = \frac{1}{(n-1)\tau}\sum_{i=1}^{n}(y_i - \tau\hat{a})^2. \quad (16)$$

According to relation (4), μ is estimated as

$$\hat{\mu} = \hat{a} + \frac{\hat{\sigma}^2}{2}. \quad (17)$$

Now, we are able to put $\hat{a}$ and $\hat{\sigma} = \sqrt{\hat{\sigma}^2}$ instead of a, σ into (11) to obtain the estimator $\hat{x}_p$ of x_p and finally to get estimator of Δ as

$$\hat{\Delta} = S_0\left(1 - e^{\hat{x}_p}\right). \quad (18)$$

Due to calculations based on statistical data set available the moment $t = 0$ corresponding to 2021.12.01, the value V_{av} at that moment is equal to 914.40 USD per sq. m. Parameters μ, σ and a were estimated based on 30 month data period from July 2019 till December 2021 by formulas (15) – (17) with the following result:

$\hat{\mu} = 0.01437613, \quad \hat{\sigma} = 0.02811884, \quad \hat{a} = 0.01297019.$

To calculate the time factor Δ, the following three values of probability p have been chosen: $p_1 = 0.6827,\ p_2 = 0.9545,\ p_3 = 0.9973.$ These probability values correspond to the n sigma rule [20], namely for $\gamma \sim N(m, s^2)$, it holds $P(|\gamma - m| \le ns) = p_n, n = 1, 2, 3$. For each probability p_n, the value of $\hat{\Delta}$ was computed due to (18), with the precision δ in (11) equal to 10^{-4}.

Fig. 2 gives an overall dependence of time factor $\hat{\Delta}$ on the declared growth parameter μ. With the same level of volatility $\hat{\sigma}$, the parameter μ varies between (−0.010) and the previously estimated from historical data set value of (+0.0144), and we set $a = \mu - \frac{\hat{\sigma}^2}{2}$. Here, positive μ corresponds to a growing market, $\mu = 0$ to a stagnated market, whereas $\mu < 0$ to a decreasing or "falling" market. As expected, the general tendency indicates that for larger levels of growth factor μ, the time factor $\hat{\Delta}$ is smaller. At the same time for stronger requirements as for results reliability expressed by the probability level p, the time factor is growing. For clearness purposes along the vertical axis, the values of $\hat{\Delta}$ are plotted in the lg-scale manner.

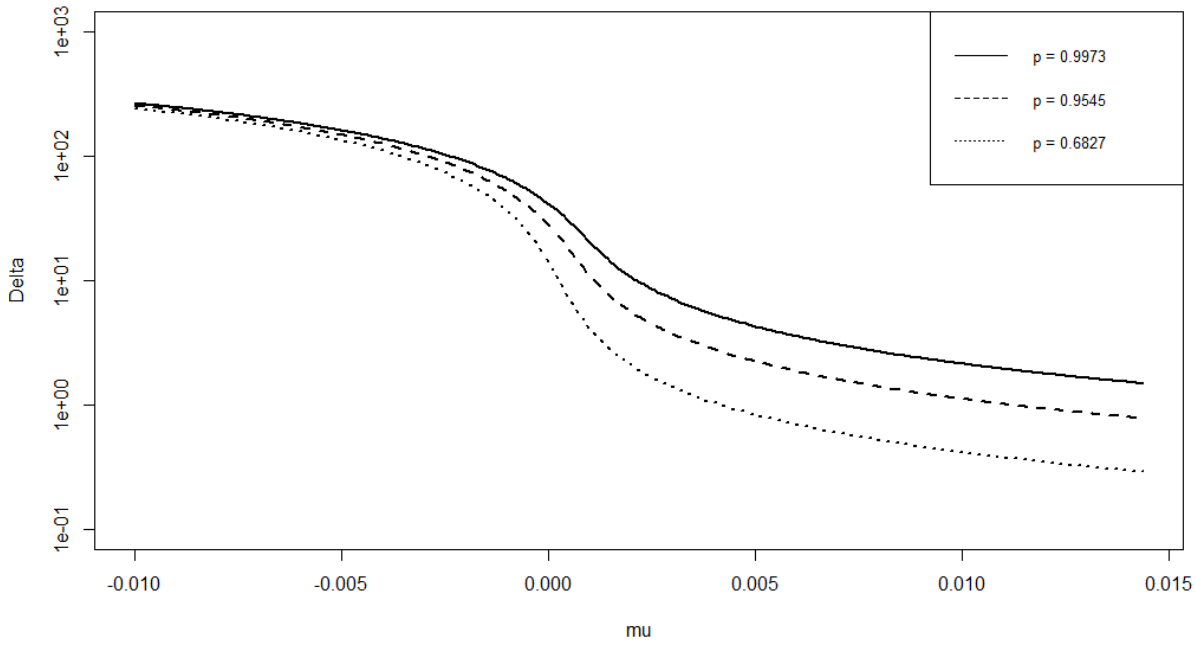

Fig.2. Dependence of time factor Δ on the growth factor m_u for different levels of probability p. Residential apartments value of 1 sq. m.

Several numerical results received for different levels of expected market growth factor μ and accepted probability level *p*, which confirm the general tendency mentioned above, are given in Table below.

Table

Time factor Δ level in USD/sq. m. for residential apartments expected market growth level μ and given level of reliability p.

Reliability level, *p, %*	Growth factor, *μ*					
	(-0.010)	(-0.005)	(0.000)	(+0.005)	(+0.010)	(+0.015)
p=68.27=1*σ*	242.2759	133.7939	14.0451	0.8301	0.4151	0.2767
p=95.45=2*σ*	254.7213	148.2129	27.8288	2.2327	1.1168	0.7446
p=99.73=3*σ*	265.7558	160.9945	41.3407	4.2734	2.1392	1.4255

Strong dependence of time factor Δ from expected growth rate *μ* is clearly seen. For growing markets long-term correction of market rice is not impressive when for suffering economies this correction should be high enough to cover their "falling" markets.

Good indication of time effect correction could be received comparing the results for stagnating markets with growth rate close to $\mu = 0$. For such case long-term correction to get asset prudent

value deviate within the range from 14.05 USD/sq. m. to 41.34 USD/sq. m depending on reliability level required (Table). To compare with median market value of Ukrainian residential apartments data base demonstrated at Fig.1 this range in percentages constitutes from 2.3 % to 6.9 %, accordingly for the year 2021 end results.

Summarizing the stated above, the proposed general approach for time effect consideration in assets valuation process could be demonstrated in Figure 3. The main task is to estimate, based on methodology developed, the level of time factor Δ for individual asset subject of analysis, using volatility level σ from market historical data registered, with expected market growth μ and reliability level p required.

Following the simple equation (6) for the collateral value estimate, this time factor should be deducted from the asset market value established by the conventional valuation methods by the IVSC/TEGoVA/RICS joint research group, underlining that "any prudent value assessment should be accompanied by the market value wherever possible, as this is a necessary benchmark requirement to accord with Basel III definition" [*Crosby, Hordijk*, 2021: 7].

It should be also mentioned that both existing approaches, described above, i. e., "through-the-cycle" type and "under-the-cycle" one, do not consider volatility of individual assets subject of valuation. For symmetric, for instance normal distribution of this volatility, both approaches give results with 50 % of reliability because they are based on analysis of medium or average assets market values. In contrast to this, the proposed approach includes consideration of individual asset's volatility with possibility to get a long-term prudent value with different results reliability as required.

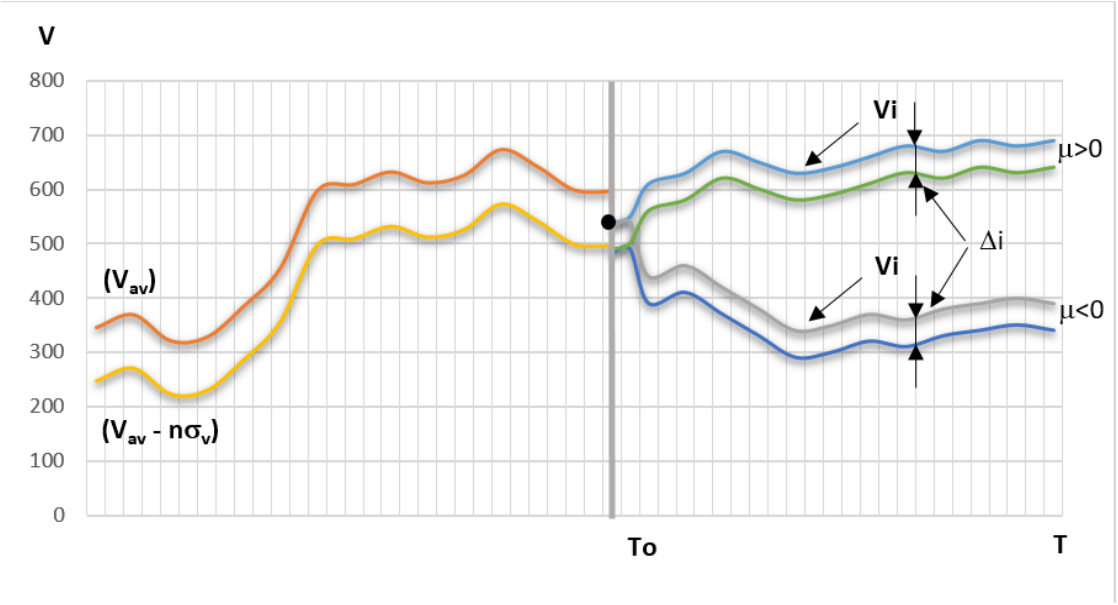

Fig.3. Schematic view of long-term prudent value estimation based on the "follow-the-cycle" approach proposed.

To demonstrate this advantage, Fig. 3 at time point T_0 starts from the market value point V_i different from median value V_{av} of the overall data set confirming consideration of individual asset market evolution. Different levels of results reliability required lead to differences in time factor Δ level as demonstrated in the Table. Estimation of long-term value within developed approach could be done for different expected tendencies in further market evolution, which is reflected by the level of parameter μ as shown in Fig.3.

In general, with such approach and given assumptions and limitations underlined above as for accepted level of certainty expressed by probability *p,* calculated asset's value at any moment of time horizon will not fall below its market value (Fig.3). Being quite different from existing "through-the-cycle" and "under-the-cycle" approaches, the novel proposed methodology could be referred as "follow-the-cycle" model which provides the estimate of long-term prudent value of the asset.

Concluding remarks. To summarize the main points considered, it could be stated that the problem of reliable and trustable valuation methods should take into consideration the time effect resulted from the property market evolution and volatility under the influence of different factors spectrum. This problem is directly linked with stability and transparency of financial system as underlined by the Basel Accord recommendations, which determined necessity of prudent valuation methods application for lending purposes.

Existing approaches in this sense could be represented by main groups. Those are of "through cycle" type and "under cycle type" which in both cases are empirically grounded. Moreover, any of those methods do not take into consideration the volatility of individual asset subject to its value estimation.

To avoid this drawbacks, a noval stochastic approach to the time factor consideration in assets valuation processes is developed, which is based on Samuelson's rational theory of warrant pricing. Analytical solution for assessment of proposed time factor Δ level was received with reference to the market growth expected and reliability required.

Implementation of developed approach was successfully verified using Ukrainian residential apartments market data set which is monitored by consulting-engineering group of companies "Veritex".

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THE ROLE OF UNIVERSITIES IN THE DISTRIBUTION OF INTELLECTUAL RESOURCES OF THE GLOBAL ECONOMY

РОЛЬ УНІВЕРСИТЕТІВ У РОЗПОДІЛІ ІНТЕЛЕКТУАЛЬНОГО РЕСУРСУ ГЛОБАЛЬНОЇ ЕКОНОМІКИ

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Abstract. *An increase in the world number of applicants for international academic mobility as well as updating of the list and dynamics of indicators of the structure of the world countries that receive the largest flows of foreign applicants has been revealed. The outflow of intellectual resources of the universities of the American continents to the institutions of the regions of Asia and Oceania has been showed in temporal dynamics as well as increasing innovation activity and international influence of institutions in these regions. An increase in the number of countries whose universities are competitive in an intellect-intensive global economy and intensification of competition for intellectual resources between universities within regions and individual countries has been identified. The transformation of university development strategies has been demonstrated in order to improve the competitive position in the global struggle for intellectual resources (in particular, based on the format of online education, increasing the supply of financial support and diversifying services provided to students). Emphasis has been placed on increasing and clearly formulating the requirements of business entities of the intellect-intensive global economy to university graduates as potential employees of companies. It has been argued that modern universities are becoming not only a source of knowledge, but also a motive for international intellectual migration as well as the center for the accumulation and integration of intellectual resources of the global economy.*

Keywords: *global economy, intellect-intensive economy, intellectual resource, uni*versity.

Анотація. *Виявлено зростання світової чисельності здобувачів, що вдаються до міжнародної академічної мобільності; оновлення переліку і динаміку показників структури країн світу, що приймають найбільші потоки іноземних здобувачів. В часовій динаміці показано відтік інтелектуального ресурсу університетів американських континентів до інституцій регіонів Азії та Океанії; підвищення інноваційної активності і міжнародної впливовості інституцій цих регіонів. Виявлено зростання кількості країн, чиї університети є конкурентоспроможними в інтелектоємній глобальній економіці; загострення конкуренції за інтелектуальний ресурс між університетами всередині регіонів та окремих країн. Продемонстровано трансформацію стратегій розвитку університетів з метою покращення конкурентних позицій в глобальній боротьбі за інтелектуальний ресурс (зокрема на основі формату онлайн-освіти, збільшення пропозиції фінансової підтримки та урізноманітнення послуг, надаваних здобувачам освіти). Акцентовано увагу на підвищенні і чіткому формулюванні вимог бізнес-суб'єктів інтелектоємної глобальної економіки до випускників університетів як потенційних працівників компаній. Стверджується, що сучасні університети стають не лише джерелом знань, але й мотивом міжнародної*

інтелектуальної міграції, центром акумулювання та інтегрування інтелектуального ресурсу глобальної економіки.

Ключові слова: *глобальна економіка, інтелектоємна економіка, інтелектуальний ресурс, університет.*

Problem statement. According to the World Economic Forum experts, the innovation vector has been a trend in the global economy since the late 20th century and it is innovation that will determine 80-90% of the next 40 years of economic growth in both developed and developing countries [*Policy Pathways for the New Economy, 2019*]. Innovative development is increasingly gaining signs of intellectualization: intellectual technologies are a global trend of Industry 4.0 [*World Economic Forum & McKinsey&Company, 2019*]; technological inventions are becoming more intellectually intensive and require more knowledge from various sciences for their implementation (the average number of authors of one patent application in 2014 - 2019 increased by 5.3%) [*Derwent Top 100 Global Innovators, 2020*]; there is an intensification of intellectual migration (almost 2/3 of international migrants go to high-income countries, including for education) [*Global Education Monitoring Report, 2019*]; the number of applicants for higher education is growing (global growth in 2014-2019 was 5.21%, including 8.55% for STEM; global enrollment of young people in higher education - 34%) as well as the labor of science and engineering sector (the number of employees in the United States was 182 thousand in 1950, 5.4 million - in 2009) [*Higher Education Statistics Agency, 2020; A World on the Move, 2017; National Science Board, 2013: 3/5; National Science Board, 2018: 3/6*]. These facts objectively indicate the urgency of the problem of formation, accumulation and distribution of intellectual resources of the global economy in accordance with one of its main sources - higher education institutions or universities.

The purpose of the article. The article aims to determine the role of universities in modern processes of global distribution of intellectual resources based on the analysis of international academic rankings, trends in international academic mobility and initiatives to provide financial support to foreign applicants.

Literature review. O. Adedeji, O. Campbell note that as knowledge becomes important in modern global economy, countries need higher standards of education for their youth, which must be provided by national higher education institutions, taking into account the requirements of international competitiveness [*Adedeji and Campbell, 2013*]. The model of development of modern universities is becoming innovatively active [*Ponomarenko, Rayevnyeva, Yermachenko, 2021*].

Proclaiming the availability of higher education as a sector revolution in the 21st century, P. Altbach identifies two main trends in its development: massification or "academic anarchy" and the focus on the global knowledge economy [*Altbach, 2017*]. Worldwide, more than 200 million applicants study at 22,000 universities and even more other educational institutions. The tendency to complicate processes in the global knowledge economy determines the central role of university research, the participation of universities in international research and development projects. Academic institutions are becoming key points of global communication. According to P. Altbach, there is a differentiation of education systems - the functions and roles of higher education, institutions, systems and organizational structures designed to manage and coordinate the development of the sector are diversifying across countries. The action of Industry 4.0 can be considered as the most obvious factor in the transformation of the role of universities [*Higher Education in the Era, 2018*].

Researchers Kr. Wu and Mt. Wu found that between 1996 and 2019, China, India, Australia, Brazil and South Korea were ahead of developed countries such as the United States, Germany, Canada, and the United Kingdom (UK) in terms of human capital growth [*Wu and Wu, 2022*]. Scientists attribute the significant increase in human capital in China to the positive impact of knowledge growth (due to the number of researchers), increasing the quality of education (number of university graduates in Science and Physics), improving the health of the country's population (number of employees in the field of medicine and sports).

T. Scott and N. Mxunpiew argue that international students are critical to the success and competitiveness of an institution in the higher education market [*Scott and Mxunpiew, 2021*]. The inflow of foreign students to the UK from non-EU countries provided in 2018/2019 academic year almost £ 6 billion in tuition income or more than 30% of the income of all higher education courses. Given the obvious financial advantages, international competition for foreign applicants from non-traditional markets is growing, which introduce English-language programs, provide financial and other types of bonuses. As a strategic perspective for the development of educational institutions of UK T. Scott and N. Mxunpiew see the implementation of more aggressive recruitment campaigns in markets with high growth potential: South America (Colombia, Brazil), European non-EU countries (Russian Federation), African countries (Nigeria, Kenya, Côte d'Ivoire) and Southeast Asia (Vietnam, Thailand).

Despite the availability of scientific developments in some areas, in our opinion, a comprehensive approach to the problem of allocation of intellectual resources of the global economy is needed. In this article, the author tries to reconcile the trends of university rankings, international academic mobility and initiatives to provide financial support to foreign applicants.

Results. The activity of universities has been evaluated and analyzed by many global and national institutions. In this way, in our opinion, the international dissemination of the best practices for ensuring the quality of education and research, the effectiveness of commercialization of scientific results and the aggregation of intellectual resources is occuring. Based on these considerations, the top lists of the following rankings have been analyzed: The Academic Ranking of World Universities (ARWU), QS World University Rankings (QS), Times Higher Education "The World University Rankings" (THE) (Table 1).

Table 1

The structure of the top lists of international rankings of universities by nationality in 2006 - 2019, %

Ranking	Years, country			
	2006	2011	2016	2019
	USA			
ARWU top 20	85	85	75	80
THE top100	“-”	53	39	41
QS top100	“-”	31	“-”	30
ARWU top100	54	53	50	45
	United Kingdom			
ARWU top 20	10	15	15	15
THE top100	“-”	14	16	11
QS top100	“-”	19	“-”	18
ARWU top100	11	10	8	8
	Japan			
ARWU top 20	5	0	5	0
THE top100	“-”	2	2	2
QS top100	“-”	6	“-”	5
ARWU top100	6	5	4	3
	China**			
ARWU top 20	0	0	0	0
THE top100	“-”	5	4	6
QS top100	“-”	3	“-”	11
ARWU top100	0	0	2	4

"-" no data, as the TNE rating has been compiled since 2009, and QS provides access to the last 4 annual ranking lists;

* calculated by the author, based on (*Academic Ranking of World Universities 2006, 2006; Academic Ranking of World Universities 2011, 2011; Academic Ranking of World Universities 2019, 2019; The World University Rankings 2010-11, 2012; The World University Rankings 2016, 2017; The World University Rankings 2019, 2020; QS World University Rankings 2019, 2020; Innovative function of higher education, 2012*). ** The "China" category includes the mainland of China, Chinese Hong Kong, Chinese Taiwan, Chinese Macau

The dynamics of the structure of the analyzed ranking of the top 100 universities by nationality shows a reduction in the share of institutions of the two largest education systems – the United States (US) and the United Kingdom (UK). The US presence in the corresponding THE ranking decreased from 53% in 2011 to 41% in 2019, in ARWU – from 54% in 2006 to 45% in 2019. Similar reduction rates for UK ranged from 14% to 11% in TNE ranking and from 11% to 8% in ARWU. It is interesting to note that in 2006-2011, Chinese universities were not even included in the top 100 ARWU ranking: their representation was limited to three educational institutions in the top 200.

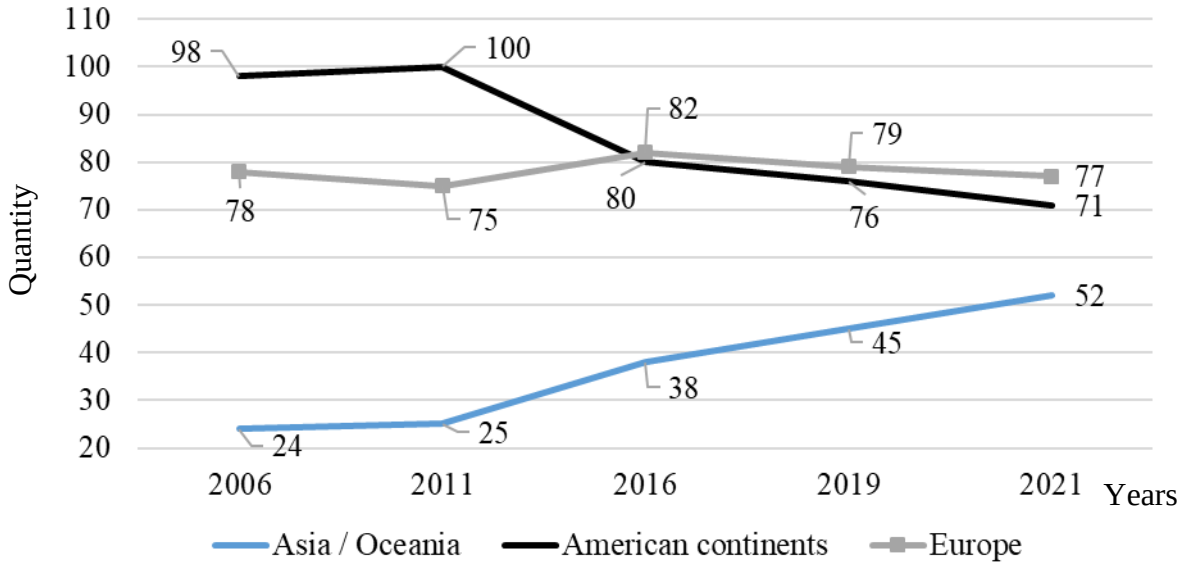
It should be emphasized that the trend of disintegration of China is manifested in the appropriation of intellectual resources of educational institutions by territories and economies. If in 2006 in the ARWU ranking all achievements in the intellectual resources development were combined within one national group "China", in 2019 the statistics of achievements of Chinese institutions have already been detailed by separate elements of their origin: mainland China, Chinese Hong Kong, Chinese Taiwan, Chinese Macau.

The outflow of intellectual resources from the American region is clearly demonstrated by the representation of educational institutions in the ARWU top 200 ranking (Fig. 1).

As we see from Fig. 1, the outflow of intellectual resources from the American region was accompanied by its inflow to the Asia and Oceania region (increase in 2006 - 2021 was up to 116.7%). The overall list of national representations of educational institutions in the top 200 has changed significantly: if in 2006 the ranking included universities from 35 countries, in 2019 this number increased to 61 countries, that is an increase was 74.3% [*Academic Ranking of World Universities 2006, 2006; Academic Ranking of World Universities 2019, 2019*].

Figure 1

Regional representation of universities in the top 200 ARWU ranking, units of institutions*



* compiled by the author, based on [*Academic Ranking of World Universities 2006, 2006; Academic Ranking of World Universities 2019, 2019; Academic Ranking of World Universities 2021, 2021*]

But the flow of intellectual resources to Asia and Oceania was uneven: Japan has reduced its presence in the top lists of ARWU 2019, while there was an increase in presence of Australia, China, South Korea, India and to less extent Singapore (the number of national institutions in the overall ranking increased from 3 to 16). As a result of this trend, the number of institutions from Asia and Oceania in 2019 in the top 501 - 1000 exceeded the number of North American and UK (149 vs. 104), and there were more institutions from China than from America in the ranking (88 vs. 69) [*Academic Ranking of World Universities 2006, 2006; Academic Ranking of World Universities 2019, 2019*].

A comparison of ARWU rankings for 2006 and 2019 of the analyzed universities by regions shows that the representation of Asia and Oceania has increased in the list (Saudi Arabia, Iran, Malaysia, Thailand, Pakistan, Lebanon, Oman, United Arab Emirates, Vietnam) as well as the African continent (Nigeria, Tunisia), the former Soviet republics (Estonia, Romania, Slovenia, Bulgaria, Slovakia), South America (Colombia, Uruguay), "young" EU member states and candidates for integration (Cyprus, Croatia, Turkey). The largest representation among the new participants in the ranking was considered for Iran (14 institutions), Saudi Arabia and Turkey (12 each), Malaysia (6), Thailand, Pakistan and Mexico (4 each). As of 2019, the educational institutions of these countries had low positions in the total list of the 1000 most influential and productive (only 2 institutions of Saudi Arabia were in the top 200), but this trend cannot be ignored.

The integrative role of national universities in the global distribution of intellectual resources can be evaluated on the basis of international flows of academically mobile people (AMP) (Table 2).

Table 2

Countries – world leaders in AMP inflows in 2000-2020*

Years	2000	2014	2016	2018	2020
Top – 9 (%)	USA (28)	USA (22)	USA (25)	USA (22)	USA (20)
	UK (14)	UK (11)	UK (12)	UK (10)	UK (10)
	Germany (12)	China (8)	China (10)	China (10)	Canada (9)
	France (8)	Germany (7)	France (8)	France (7)	China (9)
	Australia (7)	France (7)	Australia (7)	Australia (7)	Australia (8)
	Japan (4)	Australia (6)	Russia (7)	Canada (7)	France (6)
	Spain (3)	Canada (6)	Germany (6)	Russia (6)	Russia (6)
	Canada (2)	Japan (3)	Canada (6)	Germany (5)	Germany (5)
	Others (22)	Others (31)	Others (19)	Others (25)	Others (27)
Total AMP, million people	1,6	4,5	4,1	5,0	5,6

* compiled by the author, based on (*A World on the Move, 2017*; *A World on the Move, 2018*; *Project Atlas, 2015; Project Atlas, 2018; Project Atlas, 2020*)

Analysis of Table 2 shows that in 2000-2020 the number of AMP increased (more than 3 times), the representation of the largest host countries changed (China and the Russian Federation entered the top 9, which in 2020 accounted for a total of 15% of the world incoming flows of AMP), there was a geographical redistribution of the flow of foreign applicants (outflow from the United States and the United Kingdom in favor of Canada, China, Russia and other countries). The largest outflows of AMP in 2016 were formed in Asia and Europe (25% and 23% of the world flow, respectively). Almost half of the global AMP flow to five English-speaking countries: Australia, Canada, New Zealand, the UK and the USA [*Global Education Monitoring Report, 2018*]. About 76% of AMP from Europe who went to study abroad remained in the region. The share of foreigners in the total number of students in Australia, Canada and the UK exceeded 22%, for PhD applicants – 30% [*Global Education Monitoring Report, 2018; Project Atlas, 2020*].

The undisputed leader in terms of the number of involved AMP is the United States: in 2020 they accounted for almost 19.2% of the global flow, and the quality, diversity of educational institutions and programs were positively evaluated by 75% of respondents from 19 countries [*Global Education Monitoring Report, 2018; Project Atlas, 2020*]. The status of English as the most motivating language for international academic mobility is supported by the following facts: the introduction of English-language curricula provides coverage of places in national educational institutions in Japan and South Korea, and their increase in France and Germany has led to an increase in foreign inflows of applicants by 4.3% and 7.1% respectively [*Global Education Monitoring Report, 2018; Project Atlas, 2020*].

The role of universities in the global distribution of intellectual resources can also be determined by intensification of their global talent search, facilitating access to education and expanding the supply of financial support to foreign applicants. According to the statistics of the Scholarship Portal, as of July 23, 2020, the list of registered scholarship programs offered to students at the international level numbered 379 positions [*379 Scholarships to Study in All Locations, 2020*]. Analysis of 178 random units in the list of entities offering scholarship programs allowed to identify the following results (Table 3).

Table 3

Structure of the database of international scholarship programs by sectoral and regional characteristics of the initiators (as of July 23, 2020) *

By Regions	Share, %	By Operations Sector	Share, %
USA and Canada	39.33	Services for applicants, total	55.06
UK	8.43	including educational	31.46
China and Japan	5.06	related	15.73
India and Africa	7.86	those that precede entry	6.74
Australia	1.12	those accompanying the entrance	1.12
EU, total	16.29	Institutions	5.62
Others	21.91	Business practice	39.33
TOTAL	100.00	TOTAL	100.00

* summarized and compiled by the author, based on (*379 Scholarships to Study in All Locations, 2020*)

The offer of a scholarship program is not always characterized by clarity and transparency of information about its initiator, the subject area of its activities, and this increases uncertainty. The vast majority of scholarship programs are offered by initiators (including universities, educational institutions and other entities) that provide services to applicants (55.06% of the total number of analyzed scholarships): educational (offline education, online education, educational courses), related (study assistance, communication with other applicants, educational crediting, rental housing), those that precede entry (recruitment of foreign applicants, regional university reviews) and accompany the entrance of foreign applicants into the territory of the countries of education (registration of visa documents, insurance).

The second largest segment of the researched scholarship database is the segment of programs from business entities that offer business practice (39.33% of the total number of analyzed scholarships). The analysis of such scholarship programs revealed the predominant specialization of initiators in information and IT services, financial, legal and technological consulting services or production activities, which include the provision of digital services (online stores selling manufactured goods, refining oil and secondary raw materials). Medicine and sports, renewable energy, tourism, shipping, and construction have been identified as other sectors of business operations. A significant number of entities in this segment specialize in online advertising and digital marketing, cybersecurity, reviews of intellectual technologies, and blogging.

The third segment of the suggested scholarship programs is formed by institutional entities (5.62%): associations of companies (including energy – in the electricity, gas, oil sectors), international non-profit organizations (foundations, research organizations), government and diplomatic structures.

The analysis of the regional distribution of scholarship initiators revealed that universities that seek global foreign applicants are mainly based in the United States, the EU, the UK and the Asia-Pacific region (Indonesia, Australia, New Zealand). At the same time, online universities (including the University of Essex, Durheim, Brentwood, etc.) are widespread in the UK, specializing exclusively in online education services. American universities provide the greatest opportunities for offline learning for foreign applicants, and are also beginning to implement online education technologies. Characteristically, there are no universities in China and Japan that offer online education services.

Scholarships for educational courses and related educational services are offered mainly by American entities or those whose geographical location is difficult to determine. It is also difficult to determine the regional location of the initiators of scholarship programs in the field of services that precede the entry of foreign applicants into the territory of the countries of education. It can be noted that such initiators most often operate in the markets of the African continent (Nigeria,

Angola, Eritrea), the Middle East (Iraq, Syria), South Asia (India, Pakistan), island states (Philippines, Sri Lanka). It has been found that usually the services accompanying the entrance of foreign applicants into the territory of the countries of education are provided by the same entities that provide services precede the entry, except for services from relevant government agencies (including the production of invitation forms, visa documents, customs and border control, etc.).

There is a significant differentiation of conditions for candidates to participate in programs, the clearest of which are nominated by initiators offering business practices in the sector of information and IT services, financial, legal and technological consulting services or production sector, which include the provision of digital services.

Conclusions. The growth of the intellectual capacity of the global economy again states the main tasks of universities: training qualified specialists, producing innovative technologies and promoting scientific, technical and intellectual development of society. The new conditions transform the activity of the modern university in the direction of strategic planning of its development and integrated perception of the problems of national, regional and global levels. Universities are becoming not only a source of knowledge, but also a motive for international intellectual migration, a center for the accumulation and integration of intellectual resources of the global economy.

The world leading universities are transforming from participants in national innovation systems to participants in global systems, providing countries with competitive advantages in the global intellect-intensive economy. Innovatively active universities determine the global redistribution of the inflow of foreign applicants; show an increase in international activity and influence. These processes identify regions of accelerated intellectual development (including Asia and Asia-Pacific region), which are experiencing a stage of formation, but are now successfully competing with regions of sustainable intellectual development (North America, Europe, Japan).

The intensification of competition in the intellect-intensive economy leads to the transformation of university development strategies: pursuing an aggressive recruitment policy in the markets of developing countries; transition to the model of online universities; expanding the offer of English-language educational programs; initiation of programs of targeted financial support of applicants; expanding the list of services provided to applicants (in particular in the markets of the African continent, the Middle East, South Asia, island states).

The results of the study open up prospects for further research in the direction of evaluating the impact of universities on the intellectual capital of countries.

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ОСОБЛИВОСТІ РОЗВИТКУ СВІТОВОГО ГОСПОДАРСТВА ТА МЕВ

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