DOI: https://doi.org/10.30525/978-9934-26-500-6-7

Larysa Savyuk
Candidate of Technical Sciences, Associate Professor,
Corresponding Member
Academy of Economic Sciences of Ukraine

MATHEMATICAL MODELS, ALGORITHMS AND METHODS OF DETERMINING THE QUALITY OF EDUCATIONAL SERVICES IN THE CONDITIONS OF MARKET RELATIONS

Summary

Modern global trends in improving the quality of education in the structure of the knowledge economy require a deep study of the world experience in assessing added academic value. The methodology for assessing added academic value has found wide practical implementation in the European educational space, but has not yet received recognition among the Ukrainian educational community. This methodological tool can become an innovative platform for transformation processes in the Ukrainian educational system under martial law and in the post-war period. Assessing added academic value will help determine the effectiveness of each educational institution as a player in the educational services and labor market. When assessing added academic value, a complex vector of internal academic and external social factors is taken into account. After a thorough study of the practical experience of implementing the methodology for determining added academic value in the global educational space, this vector of influencing factors should be adapted to modern Ukrainian realities. Regression models of this methodology should be based on tools of independent external assessment, modern systems for assessing the level of education and intellectual growth of each educational entity. The careful, gradual and planned implementation of this educational toolkit should contribute to increasing motivation to improve the educational process, strengthening mutual ties between government agencies, educational institutions, business and society.

Introduction

In the context of the globalization of labor markets and educational services, the problems of improving the quality of educational services provided by educational institutions, which become full participants in the process of formation of national economies based on knowledge (Knowledge Economy), are of particular importance.

Stability, economic growth and reforms in the Ukrainian industry in the context of aggravation of the political and demographic situation related are to

the efficiency of the activities of higher education institutions, which should act as full members of the labor market. In this sense, universities considered are as enterprises to produce a high quality and competitive product, namely, specialists in the most advanced training areas.

Innovative processes in the global world society have brought modern universities from the field of academic and fundamental training of specialists to the sphere of market relations. Globalization trends have forced the leadership of higher education institutions to understand that the time has come for hard competition in the educational services market. This type of service must meet quality standards, requirements for cross-border cooperation and meet the needs of modern society, state and industry.

Foreign experience of university education, including engineering education, proves the expediency and effectiveness of economic approaches to the management of the activities of educational institutions. The practice of Ukrainian universities should include such fundamental and practical approaches as management and marketing. This will allow our state to enter into market relations, preserve the human resources and intellectual capital of our country and prevent the dramatic outflow of youth abroad in search of high-quality professional education. On the other hand, this approach will preserve the best traits and will ensure the evolution of traditional administrative-state practice in the management of education.

Chapter 1. Modern university as a competitive enterprise

Information search of the results of scientific research in the field of the management of the activities of educational institutions, their pilot testing and practical implementation shows that most of the world's best universities act as educational, scientific and practical complexes. This allows universities to actively integrate as a competitive player in regional and world labor markets and bring them into the category of successful business institutions. The indicated transformational changes in the field of educational services allowed well-known researchers in the field of economic development problems of society to combine their efforts to develop innovative management tools for higher education institutions, based on the combination of key management, marketing and business-related ideas in education. These innovative approaches implemented are with the preservation of the best pedagogical and fundamental principles of the educational system in a context of rapid reorientation to social needs.

Should be it noted, pedagogical studies of recent years are based on such fundamental and economic concepts as a systematic approach to the management of higher education institutions. Researchers actively define the criteria for assessing the quality of managerial activity of educational

institutions and institutions based on education management and Added Value Academic (AVA).

The world is on the threshold of the sixth technological order on the platform of the economy and knowledge society (KS). Its contours are just beginning to take shape in the developed countries of the world (the USA, Canada, Japan and the PRC). The knowledge economy (hereinafter referred to as the KE) is the heir to the post-industrial and innovative economy and is considered the last stage of development of global economic restructuring. The transition to the KE should ensure that the countries of the world reach a fundamentally new level in the systems of state, society and economy management, that is, the transition to the knowledge society. As a result of the generalization of various scientific approaches and views, it can be proposed to define the KE as a technological order in which the majority of the gross domestic product is provided by activities for the production, processing, storage and dissemination of information and knowledge. The KS is a mature community that defines knowledge and innovation as key values and recognizes the personal contribution of each individual to satisfying their own legitimate material and spiritual needs, as well as to finding ways to solve the problems facing society.

Education and science are the theoretical basis and structurally – forming factor of ensuring stable economic development of the state. Dynamism and level of education are responsible for ensuring intensive economic growth in the conditions of transition to an economy based on knowledge (neoeconomics). The key to such growth is human potential and, above all, education, competence, creativity of people and conditions for their implementation. In the 21st century, knowledge becomes the main source of competitive advantage of the state. In order to form a highly developed structure of the KE structure in Ukraine, it is necessary to qualitatively change the sphere of educational services, which is an important tool and innovative engine for increasing the competitiveness of Ukraine in the context of globalization of economic processes in the world and the formation of a knowledge economy with market relations and the transfer of innovative technologies [1, p. 79].

Interest in the assessment of academic quality of life (AVA) has been driven by the surge in academic rankings for all levels of education, ongoing debates about their outcomes, and the employment of graduates. However, AVA assessments remain procedurally extremely complex. This has led most researchers to use a variety of proxy indicators to assess the difference between the input and output parameters of models of the effectiveness of learning outcomes. Quantitative analysis of academic AVA is complicated by a number of reasons, including the difficulty of defining the necessary benchmarks against which the assessment is conducted, measurement problems, the impact

on the added value of the specifics of specific educational programs and teaching methodologies, along with other latent external factors.

However, the uniqueness of this tool remains undeniable both at the level of the main consumers of educational services and at the national economic level. Among domestic specialists and scientists, there remains distrust in the possibility of economic approaches in the processes of innovative transformation and increasing the competitiveness of the educational system, but this approach should be considered one of the unused sources of increasing the welfare and independence of the Ukrainian state as a whole [2, p. 123].

In the work [3], a higher education institution considered is as a key element in ensuring the training of future specialists in the relevant field of knowledge for a certain qualification in a complex integrated structure of the Higher Education System (HES). A modern specialist must possess a set of systematized knowledge, skills and practical skills, ways of thinking, professional, ideological and civic qualities, moral and ethical values and other competences.

The authors of works [4] consider higher education institutions in accordance with the classical economic concept of an organization that needs effective management. On the other hand, educational institutions must obey the values and laws of survival in the market, the rules of entrepreneurship, adapt to the requirements of the authorities. In this case, researchers rely on classical definition of Chester Bernard: "An organization is a group of people whose activities are deliberately coordinated to achieve a common purpose and common goals. According to this definition, an organization is a dynamic social system in which both formal and informal processes can occur simultaneously. Thus, the institution as an organization must be effective in fulfilling common and private tasks that meet the individual needs of its members. These two aspects are mutually complementary".

The transition to the consideration of the university as a special organization – enterprises for the production of goods and services, which demanded are by society and the state, leads to the need to recognize their relative economic independence, legal rights, the availability of resources and property necessary for their activities. On the other hand, the efficiency of management of such an enterprise is determined by the parameters set by the normative acts of state bodies, requires appropriate management decisions, management and monitoring. At the same time, the main feature of the company is the presence of a labor collective, organized for entrepreneurship and profit, which received for higher education institutions the foreign name the academic value added (AVA) of the university.

According to classical economic models and schemes, the quality of products and services determined is by the internal and external quality of the

enterprise or organization. The effectiveness of higher education institutions based is on the innovative concept of the AVA.

Higher educational institutions, as formal organizations, are groups of people created by the leadership to achieve a common goal, whose activities are deliberately coordinated. In the theory of management, the formal organization is defined as a model of behavior and relationships, which is foreseen in advance and legally planned for members of the organization. Creation of an organization begins when there is an agreed and generalized procedure for legitimizing the organization's activity plan (behavior). The management creates a group in connection with the production necessity and performs the division of labor horizontally (at the subdivisions) and vertically (at the management level) [5].

All formal types of organization have common characteristics and features. If you assume that a university is a special form of organization for providing educational services and training of competitive specialists in a particular field, university institutions should have the following features:

1. The availability of resources: people, capital, materials, technologies, information.
2. The dependence on the external environment (economic conditions, civil society, international events, legislative acts, competitors, the mentality of society, etc.).
3. The horizontal division of labor (the division of specific tasks), subdivisions arising because of the horizontal division of labor.
4. The vertical division of labor aimed at coordination of work, that is, implementation of the management process.
5. The need for management.
6. The presence of formal and informal groups.
7. The implementation of certain types of activities (production, financial, investment, trade, research, etc.).

According to the author, the formation of effective university activities based on a model of the AVA should be based on the adaptation of university activities to such well-known components of the organization's success as [10–12]:

1. Survival is a priority task for most organizations. In order to survive, most organizations periodically change goals and select them according to changes in the external economic environment (the market conditions, the level of competition, the possibility of integration) and conditions of their own functioning (financial, material or production opportunities).
2. Performance and efficiency. The performance is a consequence of the fact that "The necessary things are done". The efficiency is a consequence of the fact that "These very things are created correctly".

3. Productivity – is the ratio of the number of units at the output (produced products or services) to the number of units at the input (spent resources).

In addition, modern university institutes, from the point of view of domestic and foreign scientists, considered are as open systems with the possibility of more effective access to external information and resources. An open system is a system that has access to external resources and interacts with the external environment (suppliers, consumers, competitors, institutions, information, etc.). Systems of this type have at least ten specific properties:

1. The Additivity that it turns out that the effect of such systems is not constant in time and does not always equal to the arithmetic sum of the influences of the subsystems included in it.

2. The Emergence this is not the coincidence of the goals of the organization with the objectives of the subsystems that are part of it.

3. Synergy, which involves action-oriented, integration of efforts in the system, which contributes to the improvement of the result.

4. The Multiplicatively is to increase the system's efficiency by any control actions or spontaneous processes.

5. The Stability of the system, which depends on the justification of the organizational structure, the degree of centralization of power and management.

6. Adaptability – the ability to adapt to new external working conditions, self-regulation, restoration of work stability.

7. Centralization is the ability of the system to manage by a single center.

8. The Insularity is the desire of the system for autonomy, isolation.

9. Compatibility is a property that shows the mutual suitability and adaptation of parts of the system.

10. Feedback that manifests itself in the fact that the information, resources, energy at the output of the system (or its subsystem) returned is to the input of this system (or subsystems that are part of it).

The main source for the effective functioning of higher education institutions and the provision of the AVA is the human capital (management and teaching staff), its intellectual level and professional abilities that can significantly expand or, conversely, reduce the potential and capabilities of the relevant educational institution.

Figure 1 shows the model of interaction of the organizational internal and external environment of a higher educational institution, taking into account the influence on this interaction of the human factor – consumers of educational services and stakeholders. Stakeholders in foreign literature understand individual legal entities or organizations that are interested in the effective operation of an educational institution or can actively influence this activity [9, c. 121–123].

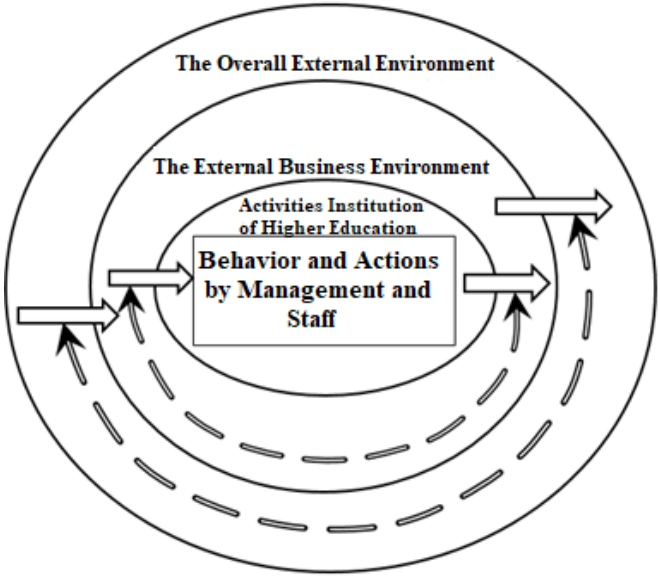

Figure 1. Model of interaction between the internal and external environment of the university

Source: generated by the author

When adapting the model of the open system and the concept of the organizational environment to the specifics of educational activities, one can conclude that the external environment of the higher educational institution goes beyond its boundaries and is located on the other side of the internal organizational environment.

The External Business Environment includes everything that is directly related to the achievement of the organizational goals of higher education institutions. For example, it is the introduction of modern teaching methods and technologies, potential competitors and the structure of the educational services market, the network of clients for the education of graduates, the source of logistics from government agencies and various sponsors, the non-formal educational institutions and the staffing agencies, institutions for defining the rules of operation and information provision.

The Overall External Environment less is specifically related to the purpose or objectives of a higher education institution and includes the laws of the country, general state policy, public institutions, political relations, social stratification of society and anything else that can indirectly affect the activities the university.

Chapter 2. Academic Value Added as an effective tool for improving the competitiveness of educational service providers

Unfortunately, in the Ukrainian literature and scientific publications, the concept of AVA not highlighted today. The provision of internal and external quality of professional education, the development of models, methods and algorithms for its evaluation remain the actual problems of domestic education. A National Agency for Quality Assurance in Higher Education established was in Ukraine. On the initiative of the Ministry of Education and Science of Ukraine (MES) of Ukraine a Public Council created is – a temporary advisory body to facilitate public participation in the formation and implementation of state policy in the field of education and science.

Participants of the portal of public experts "Educational policy" are actively discussing the issues of effective interaction between the MES of Ukraine and civil society institutes, ensuring the quality of vocational education and competitiveness of Ukrainian universities. By this time, there is no complete understanding and consensus on the question: Which universities be can considered competitive? An open problem remains the classification of universities in the category of organizations that may qualify for the status of organizations with academic AVA. These is it universities that have the right to survive and develop in conditions of fierce competition with well-known European and other world educational institutions.

From the beginning of the XXI century, foreign scientists, including the countries of the former Community of Independent States (CIS), are solving the question of determining the AVA as the main indicator of the efficiency of universities at a serious academic and practical level. The authors of the scientific publication [10] note that in the conditions of increased interest in the efficiency of the education system in conditions of increased transparency to the state and society, being are formed new tools for assessing the efficiency of the system of higher education. Each educational system or institution be can assessed from the point of view of the efficiency of public expenditure, quality and knowledge of alumni skills. The AVA can serve as a tool for assessing the degree in which students enhance their knowledge, skills and abilities during their education, the degree of critical and reflective thinking, and the ability to study throughout their lives (Long Life Learning).

The results obtained based on the AVA will provide an opportunity to compare the quality of educational institutions with different levels of student contingents. The concept of the AVA reflects the impact of external factors that are often unrelated to the educational process, on the level of educational achievement of graduates, raising the more serious issues of accessibility and quality of education in general than its effectiveness. This concept forces researchers in the field of education to move to the assessment of learning

outcomes, rather than input parameters such as the amount of funding and the professional level of the teaching staff of the educational institution.

Scientists from the United States have achieved special theoretical results in determining the Value Added of educational institutions and their employees. The United States has created an E-dictionary portal for educational reforms to help journalists, parents, members of the educational community and all those interested in investing in American public schools to understand the key concepts of school reform. American teachers, researchers and politicians are now actively developing road maps for the implementation of educational reforms. Thus, American society proves that strong schools, progressive journalism and electorate awareness are the most important factor for any well-functioning democracy, and educators are encouraged to use a glossary to deepen understanding of school improvement strategies in their communities. The pages of this portal are actively discussing the possibilities of organizing activities for quantification, forecasting change, ensuring the growth of the Value Added of individual teachers and schools, and studying this influential factor on the results of schoolchildren learning.

The authors of the paper's [10–12] discuss the unique problems of measuring Value Added in the HES, they study the possibilities and limitations of the use of publicly available administrative data at the level of students as the basis for such measures. It is useful to make a contrasting comparison of the HES environment with primary and secondary education. The school education sector characterized is by the practical use of annual standardized tests as the basis for determining the Value Added of individual teachers and educational institutions. According to the authors, significant differences in the systems of school and higher education make inappropriate and ineffective the full integration of the ideas of the school value added model into the HES. The publication also notes that colleges and universities around the world increasingly exposed are to public institutions and society to organize effective take action for the identification and disclosure of value added of educational services they provide to their students. This measurement based is on learning outcomes, taking into account the different levels of initial academic knowledge of students.

Today, government agencies in the United States, the United Kingdom and other countries use or consider the prospects for using the quantitative indicators of institutional activity in higher education to stimulate their achievements and targeted funding. For example, Tennessee (USA) is currently using a university funding formula based on practical learning and research results, while Texas is considering using one of the models of additional academic value. In the United Kingdom, there is a constant interest in using quantitative performance indicators for state colleges and universities to

optimize targeted funding. Unfortunately, there is no systematic research to direct policy makers to the optimal strategy in this area.

Chapter 3. Methodology and mathematical apparatus for measuring additional academic value

As noted earlier, to the best way effectively overcome the crisis phenomena of the Ukrainian HES is to study and apply in practice the proven methodological foundations and tools for improving the efficiency of higher education institutions on the platform of measuring the AVA. In the United States, since 1998, the joint efforts of the American Research Center (RAND Corporation) and the Higher School of Business and Public Policy have developed a common methodology for measuring the AVA in the higher education system with the evaluation of its model for the 30 state-owned universities in Texas [7]. This methodology emphasizes the importance of choosing measures to increase the academic value of universities for both public reporting and stimulating the behavior of their governing bodies in order to increase the efficiency of functioning and ensure the possibility of financial support from the state. Researchers combine and analyze information from various administrative sources in Texas. Thus, they track the evolutionary changes in the contingent of students at state educational institutions since the application for admission (pre-enrollment) until the integration of specialists into the labor market. The main indicators of the model include the persistence and success of student training, the timely and successful completion of their educational institution, and the prestige of the received professional position and the level of wages.

In the report of Education's Commission on the Future of Higher Education "A Test of Leadership. Charting the Future of U.S. Higher Education" says: Student achievement, which is inextricably connected to institutional success, must be measured by institutions on a "value-added" basis that takes into account students' academic baseline when assessing their results. This information should be made available to students, and reported publicly in aggregate form to provide consumers and policymakers an accessible, understandable way to measure the relative effectiveness of different colleges and universities [10].

Let us note that not only in the United States but also in many countries of the world there is a steady tendency towards radical changes in HES based on the introduction of methodology, models, methods and algorithms for evaluating the AVA. The most implemented and interesting are the following approaches:

1. Using standardized test results on cognitive skills for individual student groups (USA).

2. Assessment of the degree of the AVA based on the difference between successful graduates and students who for various reasons did not graduate from university (UK).

3. A direct link between the AVA and the salary level of university graduates (USA, Canada).

4. Methodology based on the control of the difference between government orders and the actual set of university students on a paid and royalty-free basis (USA, UK).

5. Determining the factors of regional components for determining the potential of value added in HES in the context of transforming the educational economy by reducing student contingent under conditions of insufficient financial support to cover the costs of educational services (Russia).

6. Use of natural experiments that provide locally exogenous rules for choosing students in colleges and universities, contrary to the results of state standardized tests (USA), with further study and evaluation of the AVA. In this case, the results of the test submitted are to the university, together with the success of the entrants in the school.

Any methodology and tools for determining the AVA should ensure the interests and benefits of the following participants in the open educational environment:

– to students;
– to university institutions, their management team and teaching staff;
– to external consumers: family, state and society;
– to external and internal stakeholders, that is, stakeholders, natural and legal persons who have a legitimate interest in the activities of the University, to a certain degree depend on it or may influence this activity (interest groups or groups of influence).

The main consumers of educational services are university students. Competitive, successful universities must create a wide range of benefits for their students. First, universities called are upon to increase the value of students, that is, to provide knowledge and skills that increase the economic productivity of students and, consequently, their salary.

On the other hand, universities should promote the intangible benefits of their graduates, for example, advocating a wider choice of future life-style work, improving the ability to make informed decisions about marriage, health care and education of children, enhancing self-esteem for overall satisfaction and dignity useful consumer price of knowledge gained.

Universities should promote positive externalities that benefit society and the state as a whole. The use of external effects makes it profitable for students to use throughout their lives. These external effects are due to an increase in the return on their professional knowledge, and the profit from them grows from contacts with experienced specialists in the workplace, at work in firms

or cooperation with the public sector. Well-informed citizens are more likely to promote public goods that improve the functioning of civil society.

Taking into account all of these factors, a full assessment of institutional efficiency and the AVA requires a wide range of indicators. However, this set of indicators is necessarily limited to the presence of a set of experimental data.

The most advanced methods for assessing the AVA include models at the level of potential outcomes and future professional achievement of students [8]. Each of these methods has its advantages and disadvantages in terms of complexity, accuracy and availability of information in shared administrative databases. These methods include:

1. Standardized test results, as a concise and practical way of assessing the knowledge of entrants, students and graduates of higher education institutions. The use of tests of this kind in the future be may considered as a basis for measuring the added academic value. However, there are problems that complicate their use, which are the impossibility of evaluating former graduates, the complexity of organizing differentiated testing in schools, and the lack of clarity as to how to compare achievement of knowledge in the context of academic disciplines.

2. The grade point average (GPA) of a student as a result of his or her performance, which is included in administrative databases. However, such results are difficult to compare among the specialties of different educational institutions.

3. Persistence and graduation outcomes of students. Reducing the number of graduation papers in relation to the number of university entrants is an indicator of their additional academic value, as the process of granting a degree of the corresponding educational level standardizes the level of knowledge and skills of a future specialist. However, it remains unclear to what extent the degree of education is an informative indicator of the quality of knowledge and skills acquired by students during their studies. Nevertheless, data on graduation and potential prospects of university graduates are usually available in administrative databases in many countries. In the United States, graduation rates are currently included in several models of public funding for higher education.

4. Wages of university graduates are an attractive measure of academic value added for several reasons.

First, a simple theory of competitive labor markets suggests that the level of wages is equal to the marginal product of the worker: the more the worker increases the value of the final product, the higher his or her wage. Higher wages signal high productivity, and productivity increases because of the knowledge and skills acquired by university graduates.

Second, unlike tests, wages are aggregated to reflect the impact of both general and specialized skills according to their importance for the economic

productivity of workers in different occupations. Therefore, in a perfectly competitive labor market, any two workers with the same wage are equally productive, despite their different occupations.

Third, wage levels can be observed and compared for workers with and without higher education. Thus, wages reflect any possible economic effect of university graduates and their academic added value.

However, there are several disadvantages of wages as an indicator of the added value of higher education:

– if employees are intrinsically motivated, as is often the case in the non-profit sector, wages do not fully reflect labor productivity;

– wages are observed only for employed graduates, which excludes, for example, women who take care of children and the home;

– social benefits of higher education, such as civic thinking and action, are likely not reflected in wages;

– administrative databases do not include information on income and earnings of self-employed persons.

It should be noted that the definition and assessment of academic value added is a complex, multi-parametric, ambiguous task with hidden latent qualities and classification features of participants in the educational process.

For example, if we assume that the added academic value of a particular university is determined by the academic abilities and professional knowledge of its graduates, then they can be measured and evaluated. However, if we include the factor of motivation of future students when choosing a university as an indicator of the effectiveness of a particular educational institution, it is impossible to measure it practically due to many hidden latent influences.

The authors of [12; 14] propose to measure the result of the effectiveness of teaching students of the chosen university on the basis of regression analysis models, which is actively used by scientists in the tasks of recognizing and identifying objects of different nature. According to this method of linear regression, academic performance Yi varies at the student level and is regressed on a set of indicators {E1, E2, ..., En} for enrollment in a university {1, 2, ..., n}:

$$Y_i = \beta_0 + \beta_1 E_1 + \beta_2 E_2 + \ldots + \beta_n E_n + \varepsilon i, \quad (2)$$

where β_0 is the constant component of the regression as the average result for students enrolled in the HEI with indicator number i; $\{\beta_1, \beta_2, \ldots, \beta_n\}$ are the average results for students enrolled in universities {1 , 2, ..., n}; ε_i is the error that captures the deviation of individual student results from the average result of the institution attended by the student. It can be assumed that all other unaccounted for (latent) variables that determine the result of the student (Yi) are included in the error value.

If the factors influencing academic performance are latently unknown and unmeasured, but are included in the error ε_i and correlate with both the set of indicators for university admission {E1, E2, ..., En} and student performance Yi, then the estimates $\{\beta_1, \beta_2, ..., \beta_n\}$ will include not only the differential effect of attending each institution, but also all the latent factors included in ε_i.

In other words, the average student scores $\{\beta_1, \beta_2, ..., \beta_n\}$ will be biased scores, which in statistics are defined by bias functions – the difference between the expected value of this score and the true value of the parameter being estimated.

This regression model was modified to remove the influence of the factor of natural abilities of university graduates. This refers to the fact that students with higher natural abilities can receive higher salaries regardless of which university they studied at.

The modified regression model will look like this:

$$Y_i = \beta_0 + \beta_1 E_{1i} + \beta_2 E_{2i} + ... + \beta_n E_{ni} + X_i \Phi + \varepsilon_I, \quad (3)$$

where Xi is a vector of conditional latent variables; F is a vector of coefficients.

Measuring the added value of higher education to compare the efficiency of educational production of different universities can be based on the following function [14]:

$$Y_{iS} = \delta Y_{i,PRE} + \Phi X_{i,PRE} + \sum_{s=1}^{n} \beta_S E_S + \varepsilon_{iS}, \quad (4)$$

where Y_{iS} is the result for a student who studied at HEI s; E_S is a set of indicators for enrollment in different HEIs; $Y_{i,PRE}$ is a vector of observed student characteristics during study, $X_{i,PRE}$ is a vector of observed student characteristics before studying at HEI; β_S is the coefficients that interpret the university grade point average.

For testing and recommendations for the implementation of this methodology in the practice of determining the academic value of universities and colleges in Texas, the control variables of the linear regression model were selected, which are divided into four main groups and have the content and features indicated in Table 1.

The effectiveness of this approach to determining the additional academic value was tested by a research test on the basis of 30 colleges and universities in the state of Texas, USA.

Based on the use of linear regression models and selected control variables of the efficiency of higher education institutions, their applicants, students and graduates, it is possible to build effective tools for determining the additional academic value, which should be tested in practice, taking into account the critical views on this issue from the state, society and higher education

institutions. This fact has been repeatedly emphasized by the authors of the works mentioned in this article.

Over the past decades, the idea of determining the additional academic level of individual pupils and students and the practical implementation of the indication based on it of the level of competitiveness of secondary and higher education institutions have paved a confident path to the European educational space. The most significant successes in this direction have been achieved by amateurs – educators and researchers from the UK.

Thus, on the basis of the largest state (public) University of Cambridge in the UK, with high national and world ratings, the non-profit educational organization Cambridge Centre for Evaluation and Monitoring (CEM) has been operating since 2019.

The formation and establishment of CEM began in 1982 in the format of a personal small research project. Currently, CEM is one of the largest and oldest centers – providers of services for assessing the level of intelligence for children and schoolchildren of different ages based on test systems, including basic, foundational, diagnostic and entrance tests.

SEM researchers argue that AVA is a fair indicator of the intellectual progress made by students. AVA is understood as the difference between the expected grade and the baseline grade of a student at the beginning of a subject course and the grade actually achieved at its completion. At the same time, when individually determining AVA, researchers do not rely solely on test exam results, but take into account a number of influencing factors [11].

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determining AVA for an individual, researchers do not rely solely on test results, but take into account a number of influencing factors.

Table 1

Selected control variables of the regression model

Group	Variable	Meaning and specifics of application
Performance	Annual earnings	Logarithm of earnings eight years after high school graduation, adjusted for inflation and macroeconomic changes
	Graduation rate	Graduation rate is the ratio of the number of students who graduated from an institution to the total number of those who enrolled in education six years after graduation.
	Studying for two years	The fact that a student is studying at two universities or colleges at the same time is taken into account
Demographic indicators	Race	White, African American, Hispanic, other races
	Gender indicator	Men
Higher education indicators	Courses and programs	Courses and programs English (as a second language), algebra, biology, physics, chemistry, courses for talented and gifted students
	Student status	Need for free meals
		Threat of not graduating
Results of standardized testing upon admission	Results of state standardized tests, SAT or ACT	Available in the K-12 database, which includes preschool and all levels of secondary education In addition to SAT scores, survey information is used for university admission

Factors that positively affect the achievement of each student and the assessment of individual AVA (residual value), determined by SEM researchers, are presented in Figure 2.

As can be seen from Figure 2, the influences on the residual academic value are closely interrelated. For example, the teaching level factor contains a latent (hidden) element of chance, and the educational factor Intellectual Potential Effort is interrelated with external household factors and factors of the student's health and well-being.

According to CEM staff, the AVA indicators are intended to provide an accurate indication of a student's intellectual growth and a perfect comparative tool for determining the AVA of educational institutions at the national level.

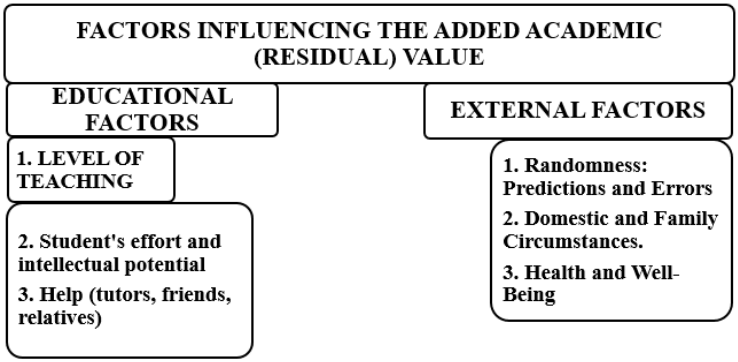

Figure 2. Factor analysis of the AVA structure

Source: generated by the author

The AVA core assessments, which are carried out by the center, are tools for teachers to help their students learn and prepare for success in the mandatory examinations with certificates that are taken in the UK after leaving secondary school. Such exams are GCSEs (General Certificate of Secondary Education) and IGCSE (International General Certificate of Secondary Education). The CEM core assessments cover the categories of secondary education students aged 11–16 (MidYIS and Yellis) and are not exams and do not offer qualifications or certificates.

MidYIS is an interactive, student-friendly middle school assessment for 11–14 students that perfectly complements the intuition and experience of the teacher, comparing students' abilities in vocabulary, mathematics and non-verbal skills.

Regardless of any curriculum, this high school core assessment is divided into four sections that cover:

– vocabulary;
– fluency in mathematics;
– proofreading, speed and accuracy of information perception, which are useful in exam situations;
– non-verbal skills that go well with math, science, geography and art.

School teachers, on the basis of the basic SEM assessments, are given a unique opportunity to get a real assessment of students' strengths and abilities that they need to develop from the very beginning of secondary education. Obtaining indicators of learning effectiveness in the form of AVA, teachers, in the short term, will be able to motivate students in their growth based on objective information about their intellectual potential and hidden talents,

identify areas of educational activity that require support for the implementation of the curriculum

In the long term, determining the total AVA of a secondary educational institution allows you to improve the quality of teaching and learning, build better relationships with students and their parents, and create an optimal learning trajectory for each student, individual groups, and the school as a whole.

The implementation of the AVA center concept can be demonstrated on the example of a nationally representative sample of teenagers aged 14–16 years, after finishing 11th grade of school education, who simultaneously passed the MidYIS SEM tests and the GCSE General Certificate of Secondary Education test in Great Britain Education).

For each subject, a common graph is constructed in the measurements of MidYIS test results against the achieved GCSE – certification achievements. A statistical technique, the so-called simple linear regression, allows you to create a straight line that passes through the middle of the data set. This regression line indicates the average GCSE score – testing a representative sample of data.

At the same time, MidYIS test scores. can be used to calculate a statistically expected score, which is called a predicted score. The vertical distance between the student's actual score and the regression line is called the residual value. If the student's score is above the regression line, then he has achieved a positive AVA. Conversely, results that are below the regression line are a negative added AVA.

If the majority of students in a subject group achieve a positive AVA, this is evidence that this subject is provided with high-quality pedagogical, methodological and information and technical support from the teacher and the management of the educational institution.

However, the results should be interpreted taking into account the corrections for possible latent measurement errors, since negative AVA values can be caused, for example, by illness of the teaching or student staff of the educational institution and other external factors beyond the control of the school. Therefore, management decisions based on the AVA assessment should not be made based on the results of one year, but should be considered in a time frame using special CEM software. This software application interprets data using statistical control charts of the educational process.

Niall O'Connor, deputy head of CEM, academician, Barnard Castle School, Great Britain, gave the following description of the center's purpose: «We find the value added feedback really useful for conversations with our governors. We can focus on where we can improve, compare our results from the previous year and concentrate on our own journey» [12].

It should be noted that in Great Britain there is an active process of merger of the state, corporate and private sectors in the educational sphere. The diversity, specificity and peculiarities of the national educational sphere necessitated the appearance on the market of educational services of the comprehensive service of Juniper Education (Chelmsford, Great Britain), which provides support for the effectiveness of the personnel, financial and educational policy of more than 7,000 secondary schools, not only in Great Britain, but also in 20 countries of the world.

Juniper Education's core business is the provision of educational technology and specialist expertise to primary, secondary and multi-academic trusts (MATs). Trusts are specific educational institutions funded by local authorities, but managed by a governing board (trust). The activities and responsibilities of trusts include staffing of educational institutions, determining conditions for admission to school, registration of land and premises ownership rights.

Since 2019, the Sisra Analytics WEB platform has been integrated into the Juniper Education service structure to analyze the academic performance of students in schools at the KS3 (Key stage, grades 6-8), KS4 (grades 8–10), and KS5 (grades 11–12).

The software implementation of the Sisra Analytics WEB platform is based on the developers' own algorithm, which is based on the calculation of AVA for individual classes and the educational institution as a whole based on the updated value added (VA) assessments of each student for each subject qualification they receive [13].

To calculate an individual student's AVA assessment, it is first necessary to calculate their "expected outcome". This is calculated using the student's relevant previous achievements at KS4. This is then used to calculate the value of the student's expected outcome (E):

$$E = O_1 + (O_2 - O_1) \times \frac{(KS4 - P_1)}{(P_1 - P_2)}, \quad (5)$$

where O1 /O2 is the lower/upper range of expected results, KS4 is the main baseline data based on the results of testing students in this qualification, and P1/P2 is the lower/upper average of previous results (data based on reports from the Department of Education).

It should be noted that for the effective use of the AVA methodology, it is necessary to involve state structures for the constant and systematic collection, accumulation and processing of information on the results of the activities of educational institutions of various forms of ownership. Information data sets should be the result of a thorough assessment of the achievements of pupils and students of secondary and higher educational institutions.

Conclusions

Thus, it can be concluded that modern universities, as open-type organizational systemic entities, play a huge role in the life of society in terms of such concepts as efficiency, productivity, and cost-effectiveness and require organized management decisions based on modern management and marketing methods.

In order to improve the efficiency, productivity and profitability of higher education institutions, organized management decisions based on modern management and marketing are required. It seems appropriate to use comprehensive indicators of efficiency and competitiveness of higher education institutions as a set of assessments of internal and external quality of education and added academic value when determining the effectiveness of innovative processes of reforming the higher education system in our country.

Such an approach is intended to improve the motivation of university staff to increase the prestige and attractiveness of Ukrainian students' education in their institutions, to motivate school graduates to enter domestic universities and to increase the competitiveness of Ukrainian higher education in the global knowledge and market of labor.

In the period of 2021–2022, on the eve of the large-scale invasion of Ukraine by the Russian Federation (RF), the country's educational system was in a dynamic state of active movement towards implementing reforms of its structure and content.

The sphere of educational services was considered by many scholars to be a decisive factor in the formation of the knowledge economy in Ukraine. Taking into account the world experience, it should be understood that there is no other way to overcome the crisis in the national economy than to move to an economic system with mechanisms for recognizing knowledge as a source of national welfare growth, preserving and increasing the country's human and intellectual capital, increasing the competitiveness of the Ukrainian state in global markets for goods and services, and ensuring its security.

After the large-scale invasion of Ukraine by the Russian Federation, the education system experienced a real shock that it has not been able to adapt to and continues to suffer irreparable losses. During the forum "Ukraine. The Year 2024" forum, Deputy Minister of Education and Science Yevhen Kudriavets that every seventh school in Ukraine has been damaged, more than 3,500 educational institutions have suffered some kind of damage, and almost 400 of them have been completely destroyed. According to the latest World Bank estimates, about $14 billion is needed to rebuild the educational infrastructure. The destruction of educational infrastructure leads to disruptions of access to education for children and youth, and affects the quality of education, socialization, and integration into society.

Starting from 2024, processes of reducing the number of secondary and higher education institutions began at the state level. However, in our opinion, such processes should be carried out with great care and be scientifically based. The methodology for determining AVA, which has been tested by the educational systems of developed countries, can become a perfect tool for the qualitative transformation of the sphere of educational services in Ukraine. However, this methodology must be adapted to Ukrainian realities and undergo a multi-stage approbation for higher educational institutions of different forms of ownership and categories of education.

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