The national system of higher education and government procurement for its services as activators of the development of IT entrepreneurship

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Abstract

The IT sector in today's digitalized world plays the role of a driver of social progress and a factor in increasing the competitiveness of countries. This leads to the intensification of scientific research, which is devoted to this area. In this article, the authors analyze the features of the development of IT entrepreneurship in Ukraine. Particular attention is paid to the study of regional differences in the volumes of government procurement for the training of IT specialists. To do this, the authors use cluster analysis, assess the extent of localization and concentration of government procurement for the training of IT specialists in individual clusters. To study the dynamics of indicators, the authors use trend models. The authors substantiate that the growth of volumes and the concentration of government procurement for the training of IT specialists by higher education institutions in the regions of Ukraine activate the development of IT entrepreneurship in these regions.

Keywords 1

IT-sphere, IT entrepreneurship, higher education institutions, government procurement for specialist training, clustering, localization, concentration, development trends

1. Introduction

The trends of the current stage of the evolution of national economies, global trends in the world economy, and integral attributes of the innovative potential of the competitiveness of countries are as follows:

1. Progress in the use of information technology.
2. Informatization spread to ever wider spheres of public life.
3. Increase in the demand for IT products.

The production of IT products (services, technologies, technological means of work, information messages, databases, etc.) is carried out by business entities of the IT-sphere. The strengthening of the IT-sphere social significance is due to the growing needs that have arisen thanks to the active process of the economy's digitalization. Adapting the behavior of market participants to new realities of the digital age has led to an increase in the contribution of the IT sector to the GDP. As a result, governments that strive for progress create attractive conditions for the IT business. The scientific and expert environment responds to such changes by intensifying research aimed at forming a system of knowledge of the IT-sphere development. One of the current areas of research is related to the factors that stimulate IT entrepreneurship development. As part of this work, the authors will focus on studying the special features of the IT entrepreneurship development in Ukraine and investigate the impact of higher education (including government procurement for the training of IT specialists) on the development and localization of IT entrepreneurship.

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2. Related Works

In modern scientific works, the phrase IT is used quite often. Thus, L. E. Dovgan, A. V. Kozynets [1], operate with this phrase, studying the ways to increase the competitiveness of enterprises; P. Kutsyk, A. Protsykevych [2], characterizing the features of state regulation of the IT services market; A. Shukan, A. Abdizhami, G. Ospanova, D Abdakimova [3], analyzing crime in the field of information technology. The same phrase in the scientific literature is also used in studies examining the problems of women's employment in the IT-sphere (L. H. Skalli [4]); labor relations in the context of digitalization of the economy (O. Khandii [5]); transformational changes in the region's economy under the influence of IT development (I. B. Shevchuk [6]). The terms IT technology, IT services, IT export, IT knowledge, IT schools, IT specialties, IT infrastructure, etc. are used in this connection. The term "Information Technology" is used to mean:

1. The science and activity of using computers and other electronic equipment to store and send information [7].
2. A set of information processes using computer technology that provides high speed of data processing, fast information retrieval, data dispersion, access to information sources [8].
3. A set of methods, production processes, and software and hardware integrated to collect, process, store, distribute, display and use information in the interests of its users [9].

The Ukrainian terms "IT-sphere", "IT field", "IT sector" are used synonymously. A similar meaning to these terms is embedded in the term "software industry", which occurs in the Resolution of the Cabinet of Ministers of Ukraine [10]. The authors emphasize the special feature of the IT-sphere, which means that the products created by it (services provided) are the result of a combination of software and hardware, hardware information, databases, and intelligent human resources. In the market of IT products, producers can include individual IT companies, IT services of non-specialized companies, IT outsourcing entities, IT consultants, specialists who independently develop IT products; e-information data storage devices.

The formation of an intellectual component of human capital is significantly ensured by the functioning of higher education institutions (L. I. Galkiv [11]), Sunil Mithas, M. S. Krishnan [12] argue that firms pay IT professionals much higher bonuses if they have earned an MBA degree.

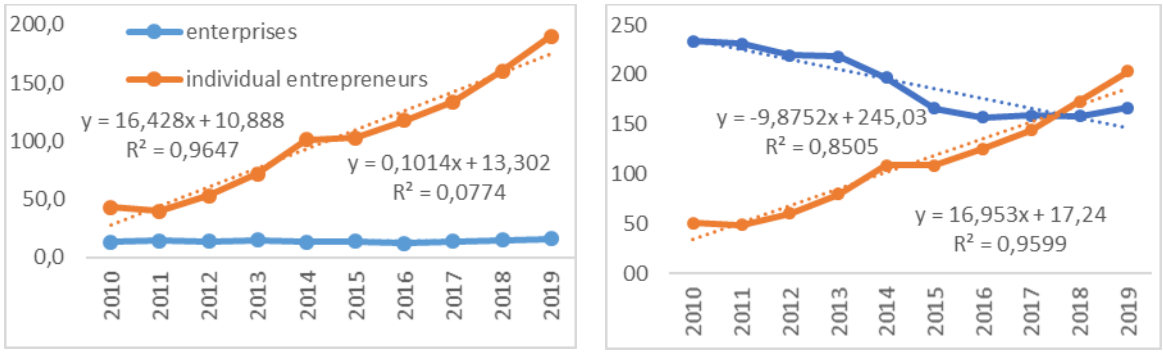
Several studies are devoted to the impact of the introduction of information technology in higher education [13][14][15]. Unlike other scientists, the authors focus on enhancing IT entrepreneurship under the influence of a higher education factor. In Ukraine, it is important to consider not only the system of higher education as such a factor but also government procurement for IT specialist training.

3. Methods

The authors use a set of scientific methods, in particular: content analysis – to substantiate the meaning of the term "IT-sphere" and the practice of its use; dynamics modeling – to build trends in the number of business entities and the number of employees by type of economic activity "Information and Telecommunications", etc.; cluster analysis – to identify groups of regions by the volume of government procurement for the training of specialists in the field of knowledge "Information Technology"; distribution analyses – to evaluate the degree of concentration and localization of individual indicators in clusters; regression analysis – to assess the dependence of the volume of the government procurement on the number of licensed places; tabular and graphical methods – to present and visualize the data.

4. Results and Discussion

The progressive development of entrepreneurship in the IT-sphere of Ukraine is confirmed by an increase in the number of business entities by type of economic activity "Information and Telecommunications" (ITC). Their number increased by 3.7 times (from 55.9 thousand units to 206.1 thousand units) from 2010 to 2019. Such a strong growth was mainly provided by the increase in the number of individual entrepreneurs (FOPs) by 4.4 times (by 16.6 thousand annually). Although the number of enterprises increased by 20.6% during the same period, its growth was not tendentious. Therefore, the dynamics of the number of enterprises, in contrast to the number of individual entrepreneurs, is not approximated by a linear trend (Figure 1:). A more obvious dynamics in terms of business entities is demonstrated by the indicator of the number of employees: declining by 9.9 thousand persons annually at enterprises, it grew annually by 16.9 thousand persons in terms of individual entrepreneurs. The authors also conclude the intensification of business development by type of economic activity of ITC relying on the following fact: the growth rate of the employed by entities the predominant type of economic activity of which is "Information and Telecommunications", annually leaves behind the national indicator.



number of business entities, thousand, units

number of the employed, thousand, people

Figure 1: Dynamics of the number of business entities and the employed by type of economic ITC in Ukraine in 2010-2019.

Source: made by the authors according to the data [16]

The traditional and stereotypical positioning of the IT-sphere as a "male activity" has recently changed: the number of women in the IT-sphere is growing from year to year. At the same time, the development of women's entrepreneurship in the field of IT in Ukraine demonstrates positive dynamics. From 2016 to 2020, the number of individual enterprises founded by men increased by 80.6% in this area, while that of women more than tripled (by 216.0 %). In 2017-2020, these figures were 75.3% and 95.7%, respectively. In IT-sphere this indicator increased by 102.2%. As a result, the share of individual entrepreneurs in the IT-sector founded by women has tended to grow: in 2016 it was 16%, in 2017 and 2018 – 23%, in 2019 – 24%, in 2020 – 25%. From 2016 to 2020, the share of women in the IT sector increased from 16% to 25% [17]. Among those who have been working in the IT sector for less than a year, this share is 36%. Currently, the largest number of women are employed in non-technical positions – HR, marketing, and administrative activities. In recent years, women are becoming more active in technical positions.

The modern Ukrainian IT space has more than 1,600 companies. The locomotive of its development is human capital. In 2020, the 50 largest IT companies in Ukraine employed more than 68.4 thousand IT specialists and put 3.6 thousand vacancies on the labor market. From 2017 to 2020, the number of IT specialists in the TOP-50 IT companies of Ukraine increased by 52.4%. To analyze the same indicator over a longer period, the authors selected the IT companies that operated from 2011 to 2020. These entities have more than tripled the number of specialists. However, only two leaders from the TOP-5 (EPAM Ukraine and SoftServe) strengthened their positions in the ranking of the largest employers. This situation testifies to the effectiveness of market mechanisms in Ukraine, which provide new companies with opportunities not only to enter the market but also to occupy a

high share. In the TOP-50 IT companies of Ukraine, the share of young people (who have been working in the market for less than 5 years) exceeds 50% [18].

In Ukraine, the IT sector provides more than 20% of exported services and sends billions of hryvnias to the Ukrainian budget. Its revenue is growing 4-5 times faster than the global IT industry average [19]. Today, Ukraine is identified in the world as an attractive manufacturer in the field of outsourcing of business processes and IT. The special features of the development of the IT-sphere in Ukraine include, among other things, the presence of a significant gap between the income of its specialists and income in the other areas of economic activity. Therefore, this area is considered an attractive place of employment and attracts young people. According to the representative studies, 50% of IT employees in Ukraine in 2020 were not older than 29 years [20].

The range of products of the IT-sphere of Ukraine has also evolved. If at first the provision of basic services prevailed, later the IT-sphere gradually shifted to the creation of complex research decisions, IT consulting, strategic design, engineering, and support of digital decisions. The domestic IT companies are developing the sectoral field of their activity, moving from the cooperation with customers from abroad, who specialize in software development, to the direct cooperation with international representatives of various fields: medicine, automotive, finance, transport, logistics, etc.

The progress of the IT-sphere in Ukraine is due to a strong educational base, which provides the industry with first-class specialists. Graduates of schools and colleges increasingly choose educational institutions with institutes, faculties, or departments that teach disciplines related to the field of IT.

In the 21st century governments of developed countries, the public, and the business community have recognized higher education as a key driver of social development. The qualitative parameters of the state's higher education system set the vectors and rates of the progress of its human capital. According to the research results of OECD's annual Education at a Glance – 2020 [21], in OECD countries, the average income of masters and bachelors is 89% and 43% higher than the income of people with secondary education, respectively. Higher education provides a wide range of learning outcomes, among which entrepreneurial competence plays an important part. This gives grounds to identify higher education as an activator of business development.

In Ukraine, over the last decade, there has been a tendency to reduce the number of higher education institutions in the form of universities, academies, institutes (HEI), and the number of students (Figure 2:). These indicators reached the maximum value at the beginning of the 2006/07 academic year (351 units and 2,372.5 thousand people, respectively), after which they decreased annually on average by 7.6 units and 106.2 thousand people, respectively.

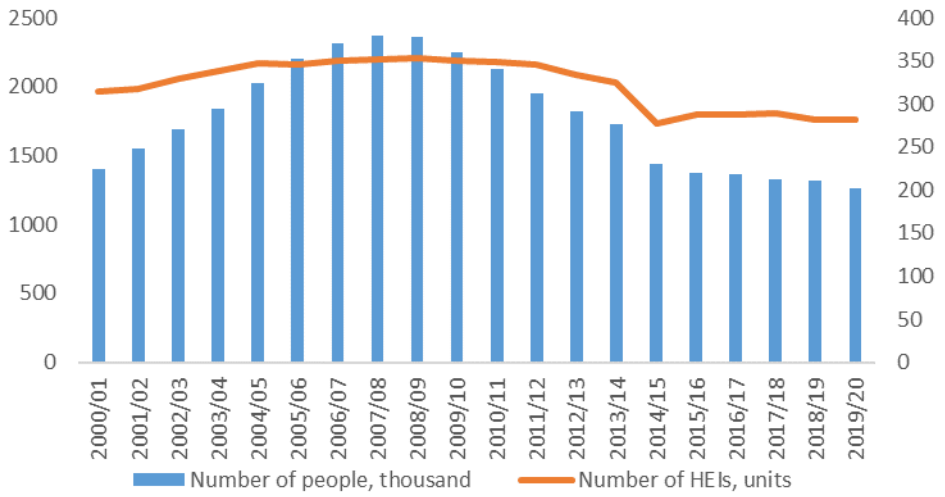


Figure 2: Dynamics of the HEIs and the number of students in Ukraine
Source: compiled by the authors according to the data [22]

Besides, there is a localization of HEIs in the regional dimension. To systematize the information array of initial data, the authors used clustering technology, which was tested in MS Excel. The four clusters were distinguished (Figure 3:). The capital appeared in the first one (A), where the largest

number of HEIs is located. The second one (B) is represented by Kharkiv region, in which the number of HEIs is 49% of the HEIs of Kyiv. The third one (C) includes Dnipropetrovsk, Lviv, and Odesa regions, where 24% of HEIs is concentrated.

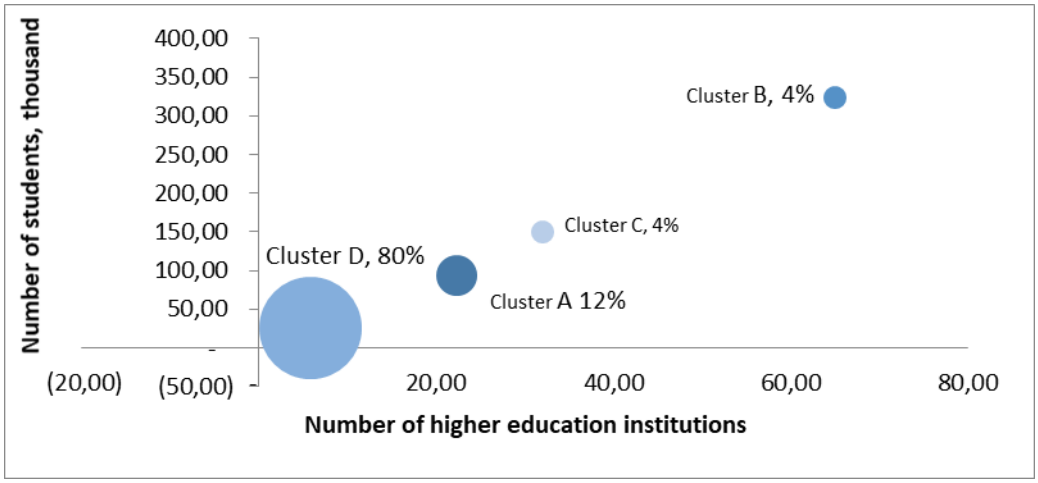


Figure 3: Segmentation map of the regions of Ukraine according to the distribution of HEIs in 2019-2020

Source: calculated by the authors according to the data [22]

For in-depth analysis of the clustering results, averaging methods were used (Table 1), localization (L) and concentration (K) indicators:

$$L_j = \frac{D_j}{d_j} \cdot (100\%); \quad (1)$$

$$K = 0.5\left(\sum_{j=1}^{m} |D_j - d_j|\right) \quad (2)$$

where d_j, D_j is the share by the number of the set elements;
D_j is the share in the volume of values of the feature in the set.

The estimated values of K, calculated for the indicators of the number of HEIs (0.381) and the number of students (0.394), indicate a moderate level of concentration in clusters A, B, C ($L_j > 1$), signaling the presence of regional asymmetries in the higher education in Ukraine.

Table 1

Indicators by the clusters of HEIs in Ukraine in 2019-2020

Clusters	Number of regions, units	Average number of HEIs, units,	Coefficient of the localization of HEIs	Average number of students, thousand people	Coefficient of the localization of students
A	1	65.0	5,76	324.30	6,40
B	1	32.0	2,84	150.40	2,97
C	3	22.3	1,98	93.33	1,84
D	20	5.9	0,52	25.57	0,50

Source: calculated by the authors according to the data [22]

The scientific and expert environment, in particular the International Organization for Standardization (ISO) [23], characterizing the market of IT services, focuses on the IT knowledge of its producers. This allows the authors to hypothetically assume that the volume of government procurement for the training of higher education-seeking students for the IT-sector may contribute to the activation of IT entrepreneurship. To verify this assumption, the analysis of government procurement volumes in 2019 and 2020 is performed (Table 2 and Table 3). The following specialties of the field of knowledge "Information Technology" were chosen for the analysis [24]: Software

Engineering; Computer Science; Computer Engineering; System Analysis; Cyber Security; Information Systems and Technologies.

Table 2

Initial data for the clustering of Ukraine's regions by the volumes of procurement for specialist training in the field of knowledge "Information Technology" in 2019

Regions of Ukraine	Licensed procurement volume		Maximum procurement volume	
	full-time education	extra-mural education	full-time education	extra-mural education
Vinnytsia region	690	65	215	5
Volyn region	315	100	92	29
Dnipropetrovsk region	836	254	307	40
Donetsk region	0	0	0	0
Zhytomyr region	330	130	133	27
Transcarpathian region	345	135	110	19
Zaporizhzhia region	769	421	186	45
Ivano-Frankivsk region	383	77	135	10
Kyiv region	0	0	0	0
Kirovohrad region	180	75	38	10
Kyiv	6312	1888	2792	91
Luhansk region	0	0	0	0
Lviv region	2263	292	1128	37
Mykolaiv region	695	150	211	29
Odesa region	1657	470	562	64
Poltava region	335	30	90	5
Rivne region	63	12	13	0
Sumy region	10	0	6	0
Ternopil region	990	435	220	25
Kharkiv region	5469	946	1568	80
Kherson region	580	250	93	5
Khmelnytskyi region	330	15	137	0
Cherkasy region	832	123	130	20
Chernivtsi region	600	45	173	7
Chernihiv region	300	35	124	0

Source: compiled by the authors according to the data [25]

Table 3

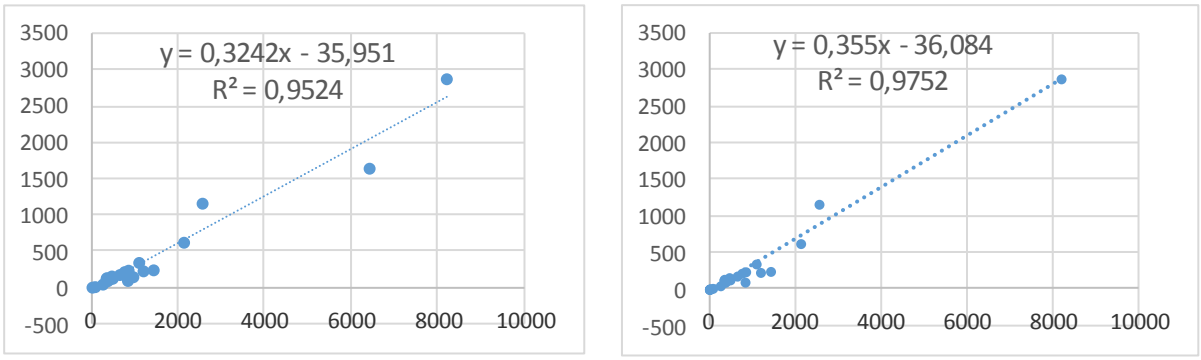
Initial data for the clustering of Ukraine's regions by the volumes of procurement for specialist training in the field of knowledge "Information Technology" in 2020

Regions of Ukraine	Licensed procurement volume		Maximum procurement volume	
	full-time education	extra-mural education	full-time education	extra-mural education
Vinnytsia region	553	42	204	5
Volyn region	305	100	88	20
Dnipropetrovsk region	1827	605	516	84
Donetsk region	235	0	46	0
Zhytomyr region	365	85	132	20

Transcarpathian region	345	135	105	14
Zaporizhzhia region	815	400	171	35
Ivano-Frankivsk region	460	0	132	0
Kyiv region	0	0	0	0
Kirovohrad region	170	35	33	10
Kyiv	6515	1935	2825	129
Luhansk region	0	0	0	0
Lviv region	2503	267	1196	38
Mykolaiv region	605	380	137	30
Odesa region	2162	734	531	66
Poltava region	345	20	62	6
Rivne region	300	110	66	30
Sumy region	220	30	140	10
Ternopil region	1040	430	173	10
Kharkiv region	6708	823	1565	70
Kherson region	361	104	66	0
Khmelnytskyi region	360	15	120	0
Cherkasy region	611	44	105	19
Chernivtsi region	590	25	153	5
Chernihiv region	230	25	113	0

Source: compiled by the authors according to the data [25]

In addition to the data on the maximum volume of the government procurement for full-time and extra-mural education, the authors operated with the relevant indicators of licensed volumes [24]. The volumes of the latter significantly affect the places of government procurement (Figure 4:) and vary in the regions of the country.



2019 2020

Figure 4: Dependence of the volume of government procurement on the number of licensed places for the field of knowledge “Information Technology” in Ukraine in 2019 and 2020

Source: calculated by the authors according to the data [25]

As a result of cluster analysis, according to the entry in 2019, four groups were distinguished (Figure 5:). The capital appeared in the first one (A), which has the largest volume of government procurement in Ukraine (8,200 places). The second cluster (B) is represented by Kharkiv region, in which the volume of government procurement was 6,415 places. Cluster C contained 9 regions of Ukraine, in which the government procurement varied from 121 to 1,165 places. In the last cluster (D), which included 56% of the regions of Ukraine, the volume of government procurement did not exceed 220 places.

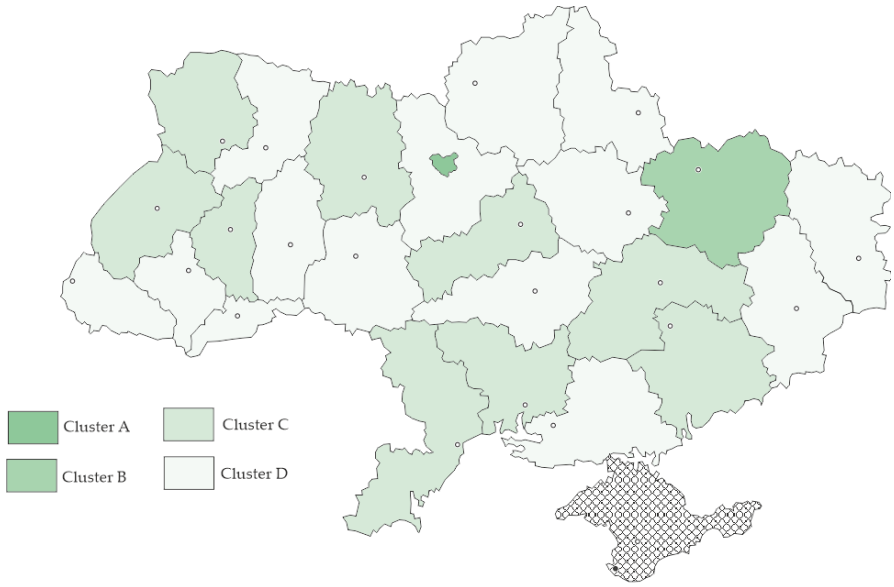


Figure 5: Cartogram of the division of Ukraine's regions into clusters according to the volume of procurement for specialist training in the field of knowledge "Information Technology" in 2019
Source: made up by the authors

After clustering the regions in 2020, the authors also obtained four groups of regions (Figure 6:). However, compared to 2019, there are several changes: Kharkiv region and the city of Kyiv remained in separate clusters, changing positions in favor of Kharkiv region, where there is an increase in government procurement by 16% relative to the capital; the number of regions in the third group (cluster C), which includes Dnipropetrovsk, Lviv, and Odesa regions, decreases threefold; the number of cluster D increases to 20 regions against the background of increasing the average number of licensed government procurement in this cluster from 272 places to 395.

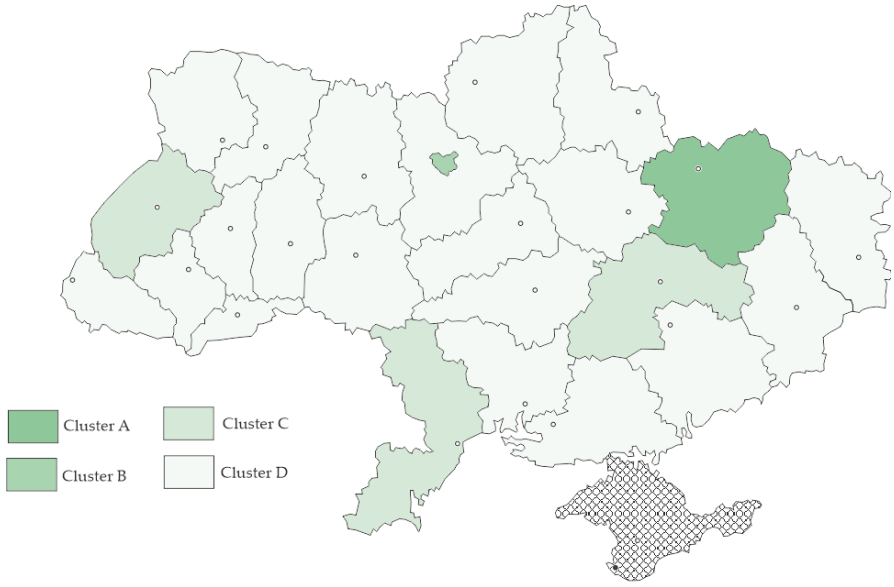


Figure 6: Cartogram of the division of Ukraine's regions into clusters according to the volume of procurement for specialist training in the field of knowledge "Information Technology" in 2020
Source: made up by the authors

The average values of the studied indicators for the formed clusters of Ukraine's regions are given in Table 4. The estimated values of $K_{(2019)}$ = 0.83; $K_{(2020)}$ = 0.78, calculated for the indicator of maximum procurement, show a high level of its concentration. In 2019, the government procurement

was concentrated in two clusters ($L_{(cluster\ A)}$ = 14.5; $L_{(cluster\ B)}$ = 8.3); in 2020 – in three ($L_{(cluster\ A)}$ = 7.4; $L_{(cluster\ B)}$ = 13.4; $L_{(cluster\ C)}$ = 1.2). That is, we can talk about the presence of regional asymmetries in the training of IT professionals at the expense of the state.

Table 4

Clustered procurement volumes for specialist training in the field of knowledge "Information Technology" in Ukraine in 2019 and 2020

Clusters	Number of Ukraine's regions	Licensed procurement volume		Maximum procurement volume	
		full-time education	extra-mural education	full-time education	extra-mural education
			2019		
A	1	6312	1888	2792	91
B	1	5469	946	1568	80
C	9	965	264	330	35
D	14	273	53	81	4
			2020		
A	1	6708	823	1565	70
B	1	6515	1935	2825	129
C	3	2164	535	748	63
D	20	395.5	99	102.3	10.7

Source: calculated by the authors according to the data [26]

The authors emphasize positive changes.

Firstly, the volumes of government procurement for specialist training of the IT-sphere in Ukraine in 2019-2020 increased by 3.0%. This trend has been observed for a long time. Its parameters at the level of a separate institution of higher education, which is represented by the authors of this study – Lviv Polytechnic National University, are shown in Figure 7:.

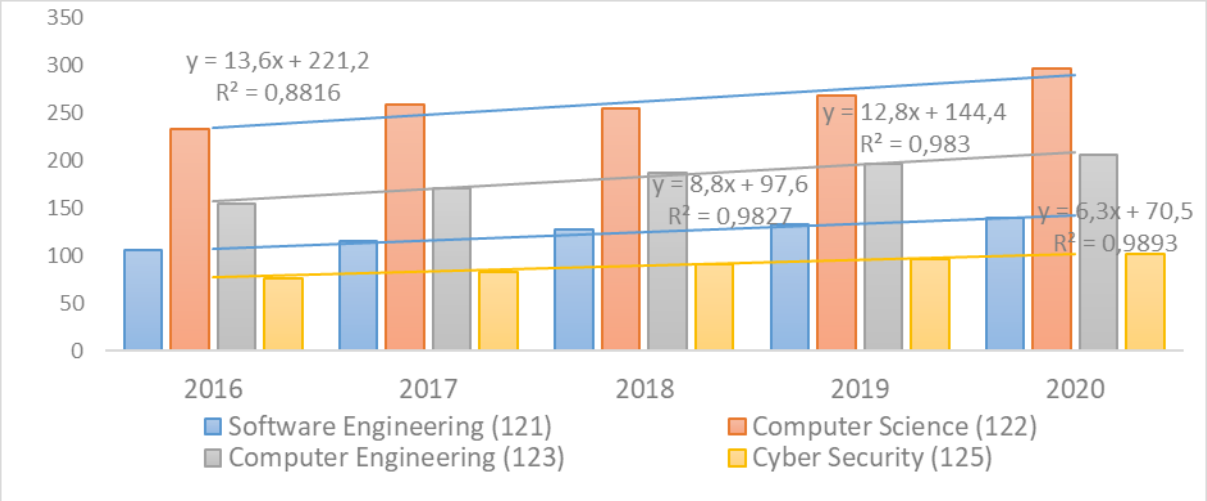


Figure 7: Government procurement for the specialties of Lviv Polytechnic National University
Source: made up by the authors according to the data [26]

Secondly, the regional differences are diminishing. Thus, if in 2019 the localization of government procurement was typical of the city of Kyiv and Kharkiv region, in 2020 it also became typical of Lviv, Dnipropetrovsk, and Odesa regions. The data obtained above harmonize with the data on IT clusters [27]: the ranks of the TOP-5 regions of Ukraine by the number of IT companies, the number of their staff, and the volume of government procurement for the field of knowledge "Information

Technology" coincide (Table 5). This serves as a basis for establishing the validity of this hypothetical assumption.

Table 5

TOP-5 regions of Ukraine by the number of IT companies, their employees, and the volume of government procurement for IT specialist training

Regions	Number of IT companies		Number of IT companies' employees		Volume of the government procurement for IT specialist training	
	units	rank	thousand people	rank	places	rank
Kyiv	1194	1	76	1	2954	1
Kharkiv region	500	2	31	2	1635	2
Lviv region	461	3	25	3	1234	3
Dnipropetrovsk region	378	4	16	4	600	4
Odesa region	150	5	10	5	597	5

Source: made up by the authors according to the data [25][26][27]

It is obvious that the connection between the indicators of business development in the IT-sphere and the volume of government procurement for specialist training in the field of knowledge "Information Technology" cannot be functional. In particular, there is a time lag between the year of entering the HEI and the year of employment. Often, labor activity is already practiced during studying at the HEI. However, there is no doubt that the higher education environment forms the entrepreneurial potential for activating the IT-sphere. In turn, this contributes to the development of entrepreneurship, which is focused on innovation [28].

It is worth noting that in the early 2000s, graduates of Ukrainian universities who studied information technology, started business structures that specialized in creating software. The enthusiasm of student youth gave impetus to the development of the IT-sphere in Ukraine. Coaching has contributed to the development of new types of managers [29]. Starting with small projects, the IT companies started to enter the world market. Accordingly, there was a significant influx of personnel in this area.

Thus, the authors have concluded that the state, by financing the education of students in specialties related to the IT-sphere, stimulates the development of IT entrepreneurship.

5. Conclusions

The progressive development of entrepreneurship in the IT-sphere of Ukraine is confirmed by the accelerated increase in the number of business entities and their employees; a rapid increase in the volume of activity and export potential; improving the image among employers. If these trends continue, its role in the country's economy will increase.

In Ukraine, there are regional asymmetries in the localization of higher education institutions and the volume of government procurement for the field of knowledge "Information Technology". It is substantiated that the volumes of the government procurement for the training of IT specialists by higher education institutions stimulate the development of IT entrepreneurship and influence the localization of IT clusters.

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