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ANALYSIS OF STARTUP PROJECT ECOSYSTEM FACTORS IN THE MODERN ECONOMY (THE CASE OF CHINA)
АНАЛІЗ ЕКОСИСТЕМНИХ ФАКТОРІВ СТАРТАП-ПРОЄКТУ В СУЧАСНІЙ ЕКОНОМІЦІ (НА ПРИКЛАДІ КИТАЮ)

Логінова К., Миронова О., Язлюк Б. О. Аналіз екосистемних факторів стартап-проєкту в сучасній економіці (на прикладі Китаю). *Український журнал прикладної економіки та техніки.* 2025. Том 10. № 1. С. 65 – 70.

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The article considers the specifics of the development and implementation of startup projects in the context of the modern startup ecosystem, which is an important factor in enterprises' innovative development and competitiveness. The primary attention is paid to the analysis of interrelationships between key components of the startup ecosystem, such as business models, financial resources, and strategic planning of products and services. The research methodology is based on causal analysis, correlation, and regression analysis, as well as the Granger and Dickey-Fuller tests to assess the impact of external and internal factors on the development of startups. In particular, the relationship between unemployment, inflation, the producer price index, the COVID-19 pandemic, and the number of new startups and venture capital investments were investigated. The results showed that most external factors, such as the COVID-19 pandemic, negatively impact the startup ecosystem, although some indicators, such as venture capital investment, correlate with the development of new enterprises. Studying the specifics of the development and implementation of startup projects is an important aspect of the startup ecosystem that directly affects the efficiency and competitiveness of young, innovative enterprises. The need to analyze business models, attract financial resources, and determine the strategic development of products and services is becoming critical to ensure market survival. In this context, the purpose of this research is to study the relationship between the elements of the startup ecosystem that illustrate the specifics of startup implementation and identify key features of their development. The results obtained may be helpful for scientists and practitioners involved in developing effective models for supporting startups and optimizing their functioning in the current economic environment. The proposed models allow for a deeper understanding of the causes and consequences of changes in the startup ecosystem, which will help create favorable conditions for sustainable development.
Keywords: *startup, startup ecosystem, unemployment, venture capital investment, COVID-19 pandemic.*

У статті розглянуто специфіку розробки та реалізації стартап-проєктів у контексті сучасної стартап-екосистеми, яка є важливим чинником інноваційного розвитку та конкурентоспроможності підприємств. Основну увагу приділено аналізу взаємозв'язків між ключовими компонентами стартап-екосистеми, такими як бізнес-моделі, фінансові ресурси, стратегічне планування продуктів та послуг. Методологія дослідження базується на застосуванні причинно-наслідкового аналізу, кореляційно-регресійного аналізу та тестів Грейнджера і Дікі-Фуллера для оцінки впливу зовнішніх і внутрішніх факторів на розвиток стартапів. Зокрема, досліджено залежність між рівнем безробіття, інфляцією, індексом виробничих цін, пандемією COVID-19 та кількістю нових стартапів і венчурних інвестицій. Результати показали, що більшість зовнішніх факторів, таких як пандемія COVID-19, мають негативний вплив на екосистему стартапів, хоча деякі показники, зокрема венчурні інвестиції, демонструють кореляцію з розвитком нових підприємств. Дослідження специфіки розробки та реалізації стартап-проєктів є важливим аспектом стартап-екосистеми, що безпосередньо впливає на ефективність та конкурентоспроможність молодих інноваційних підприємств. Потреба в аналізі бізнес-моделей, залученні фінансових ресурсів та визначенні стратегічного розвитку продуктів і послуг стає критично важливою для забезпечення виживання на ринку. У цьому контексті метою проведеного наукового дослідження є вивчення взаємозв'язку між елементами стартап-екосистеми, які ілюструють специфіку реалізації стартапів, а також виявлення ключових особливостей їх розвитку. Отримані результати можуть бути корисними для науковців і практиків, які займаються питаннями розробки ефективних моделей підтримки стартапів та оптимізації їх функціонування у сучасних економічних умовах. Запропоновані моделі дозволяють глибше зрозуміти причини та наслідки змін у стартап-екосистемі, що сприятиме створенню сприятливих умов для їхнього сталого розвитку.
Ключові слова: *стартап, екосистема стартап-проєктів, безробіття, венчурне інвестування, пандемія COVID-19.*

Statement of the problem

The idea of a unified global startup scene is becoming increasingly remote as processes of deglobalization that began several years ago gain momentum. This is not only a result of the COVID-19 pandemic, which has contributed to the disruption of global supply chains. However, the growing geopolitical risks have necessitated a focus on regional markets. Participants in the startup ecosystem are now much more aware of these risks and are changing their approach to innovation, which is increasingly adapted to local conditions. In this regard, regional and state accelerators are key in supporting startup projects. Previously, global ecosystems provided a platform for startup development. Today, the emphasis is shifting to local initiatives that provide flexibility and resilience in the face of increasing isolation and unpredictability in the international environment.

In the context of rapid changes in the global economic landscape, there is a noticeable shift in innovation focus to regional markets, which indicates a deeper awareness of geopolitical risks among startup ecosystem participants. This process of deglobalization is defining new paradigms for startup projects, highlighting the importance of local and state accelerators, which are becoming centers for entrepreneurship development in an environment of growing uncertainty. While before the COVID-19 epidemic, global accelerators prioritized supporting startups; local ecosystems are now coming to the fore, adapting and transforming into specific regional accelerators. The pandemic has become a catalyst for the breakdown of global supply chains, which has highlighted the urgent need to strengthen domestic resources and independence.

One prime example of a regional ecosystem is the Central Asia Regional Economic Cooperation (CAREC) program, in which China is the undisputed leader. Nanchang, along with Quanzhou, Shijiazhuang, and Taiyuan, is showing impressive growth, as reflected in the results of the Startup Ecosystem Report 2023.

An essential factor that contributes to the advantages in the startup ecosystem rankings is the size of the domestic market, as large populations such as those in China, India, Indonesia, Brazil, and Russia provide opportunities for startups to scale up, focusing on addressing local needs without the need to go international. This paper aims to redress the imbalance in previous research by providing a comprehensive assessment of the factors affecting the development and implementation of startup projects, especially in the case of China, particularly in terms of adapting to the changing global environment.

The modern economy is witnessing a rapid development of startup projects, which has become particularly noticeable due to the global COVID-19 crisis [3, 13], which has caused significant changes in the labor market and economic relations. This crisis has caused a high level of uncertainty, in which startups, due to their flexibility and responsiveness, have been able to take a leading role in adapting to new conditions. Studies [1, 12] show that startups contribute to diversifying consumer demand and play a key role in digitalizing business processes and the social sphere. For example, in the United States, new companies account for about 70% of newly created jobs [4, 7], and in the European Union, startups account for 9.5% of GDP. In addition, the total value of the global startup industry has increased by 25.6% in recent years, which indicates its impact on the economic environment [2].

In turn, startups are important drivers of innovation, as they promote institutional change and the creation of new products, which leads to increased productivity. Despite the positive trends, the Global Entrepreneurship Monitor study indicates that the main barrier to the development of startups is the fear of failure experienced by entrepreneurs worldwide [5,7]. In this regard, it is becoming increasingly important to create a favorable entrepreneurial environment, including support from accelerators, as well as a correct understanding of the economic nature of startups, which, in turn, can be achieved through the concept of open innovation, which involves cooperation between different economic agents and specialists to reach common goals.

In the framework of scientific study [8, 9], it is important not only to define startups but also to consider the cultural and institutional aspects that affect their functioning and development. Culture is an important factor of innovation that integrates entrepreneurship, intrapreneurship, and organizational entrepreneurship into a holistic system. Given this, it becomes evident that a comprehensive study of startup projects is integral to analyzing the modern economy and its further development.

The problematic nature of the research topic on startups is significant not only at the stage of their economic nature but also at the stage of formulating definitions. The definition of a startup often varies depending on the approach of researchers, which indicates a variety of views on this enterprise category. For example, Blank S. and Dorf B. [9] point to a startup as a temporary structure that effectively uses its resources to find a business model capable of scaling, recovery, and high profitability. At the same time, Graham P. [10] emphasizes that startups are enterprises focused on rapid growth, which is also supported by the definition of the US Small Business Administration, which characterizes startups as technology businesses with high potential for development. Erkko Autio emphasizes that a startup is a new independent firm under six years old. It invests at least 15% of its operating expenses in research and development. These different approaches to defining startups reflect the complexity and diversity of this category of businesses [11].

The purpose of the research

This research paper aims to analyze and evaluate the interconnection of startup ecosystem factors that illustrate the peculiarities of startup implementation and serve as a basis for determining the peculiarities of startup development.

Presentation of the main research material

Three-stage modelling is used to determine the cause and effect relationships, namely model testing by the Dickey-Fuller test, the Granger test, and the correlation and regression dependence assessment. The study is

divided into three stages. The first stage involves testing the stationarity of time series using the Dickey-Fuller test. Its primary purpose is to determine the stationarity of the data since stationary time series are characterized by unchanged mean, variance, and covariance. On the contrary, non-stationary series tend to change the mean or variance with the advent of a new time. The results of the Dickey-Fuller test are critical for selecting appropriate statistical models, as most of them are designed to work with stationary data.

The second stage of the study is to determine the existence of a causal relationship using the Granger causality test. The Granger causality test is applied to the components of a stationary random process and relates to whether one of these variables causes another. However, it should be noted that Granger causality is not causality in the general sense but is related to the definition of the previous variable and the informativeness of the variable in terms of predicting another variable [12]. The test is performed only if the available time series are stationary according to the results of the Dickey-Fuller test.

In the third stage, a regression model is built. The main tasks of regression analysis are to establish the relationship between variables, estimate the regression function, and predict the values of the dependent variable.

The study assumes the presence of the following variables:

The dependent variables are the number of new enterprises and new venture capital investments. These indicators can be considered internal markers that illustrate the state of development and implementation of startup projects in the modern economy.

The external factors used in the study are the unemployment rate, inflation rate, producer price level, and the number of COVID-19 cases. This system of indicators was determined based on an analysis of the relevant literature and supplemented by the intensity of the COVID-19 spread. This parameter has a destabilizing effect on the development of small and medium-sized businesses and the entire economy around the world.

Several selected factors characterize the entire process described here, i.e., the study is limited to those factors included in the model. By default, the number of new businesses is assumed to be startups. The level of significance for the information content should be complete. Establishing the primacy of the cause of the effect in the time sequence requires collecting and evaluating data for several periods. The reliability of the objective nature of the relationship does not depend on the researcher. Causality can be caused by the two-way influence of factors, with the directionality from one factor to another being studied. Relationships can form a pairwise or multifactorial dependence.

Before creating model equations for Granger causality and regression analysis, the first step is to check the data for stationarity using the Dickey-Fuller test. Typically, trend removal, difference, or error-corrected modeling (cointegration) make the series stationary [10]. By default, the alternative hypothesis is that the series is stationary, so if the calculated coefficient is less than the critical one, the series has a unit root and is non-stationary. As a result, the data presented in Table 1 were obtained.

Table 1. Results of the Dickey-Fuller test

Name of the indicator	Coefficient	
	Calculated	Critical
Investment	-0,73	-1,15
Unemployment	-0,211	
Producer price index	-0,069	
Consumer price index	-0,167	
Number of COVID-19 cases	-0,656	
Number of new venture capital investments	-0,82	
Number of new companies	-0,354	

Source: developed by the author.

Based on the results of the Dickey-Fuller test, the calculated coefficient is greater than the critical one, which indicates that the data are stationary. There is no need to convert the data set to a stationary form.

Since the previous test's result indicates that the data are stationary, the Granger causality test can be used for stationary series. The null hypothesis that all coefficients of autoregressive dependence are equal to zero is accepted if the Granger coefficient is greater than 1, with the critical value corresponding to the Fisher distribution with degrees of freedom. The results of the Granger's test are shown in Table 2.

The analysis's results suggest no causal relationship between the factors. To test the model's reliability, we calculated the statistics of Granger's criterion (Table 3).

Considering the above results, we can assert the model's reliability since the R-squared is 0.83, and the Durbin-Watson statistic tends to the ideal value and is 1.35. The results of Herring's test indicate that the independent variables have no causal relationship with each other and no causal relationship with the dependent variable. However, in addition to Granger causality, it is worth conducting a correlation analysis to determine whether there is a correlation between the dependent variable Y and the independent variable X, where:

Y - Number of new companies, pcs;

X1 - Investments, million USD;

X2 - Unemployment, %;

X3 - Producer price index, %;

X4 - Consumer price index, %;

X5 - Number of COVID-19 cases, persons;

X6 - Number of new venture capital investments, pcs.

The results of the correlation calculation are presented in the correlation matrix in table 4.

The correlation matrix shows a high degree of correlation, with all indicators having a correlation value of more than 0.99. After running a set of tests, we can start modelling the impact of the factors. The data for the modelling are shown in table 5.

Table 2. Results of the Granger test evaluation

Name of dependencies	F-statistic	Granger causality test
INVESTMENTS does not Granger Cause CONSUMER_PRICE_INDEX	4.62120	0.1207
CONSUMER_PRICE_INDEX does not Granger Cause INVESTMENTS	1.68733	0.2848
NEW_COMPANY does not Granger Cause CONSUMER_PRICE_INDEX	0.10278	0.7696
CONSUMER_PRICE_INDEX does not Granger Cause NEW_COMPANY	0.00344	0.9569
NEW_VENTURE_CAPITAL_INVESTMENT does not Granger Cause CONSUMER_PRICE_INDEX	1.34262	0.3304
CONSUMER_PRICE_INDEX does not Granger Cause NEW_VENTURE_CAPITAL_INVESTMENT	0.48235	0.5373
NUMBER_OF_COVID19_CASES does not Granger Cause CONSUMER_PRICE_INDEX	1.00073	0.3909
CONSUMER_PRICE_INDEX does not Granger Cause NUMBER_OF_COVID19_CASES	1.24580	0.3457
PRODUCER_PRICE_INDEX does not Granger Cause CONSUMER_PRICE_INDEX	0.22770	0.6658
CONSUMER_PRICE_INDEX does not Granger Cause PRODUCER_PRICE_INDEX	0.82905	0.4297
UNEMPLOYMENT_RATE does not Granger Cause CONSUMER_PRICE_INDEX	0.91575	0.4092
CONSUMER_PRICE_INDEX does not Granger Cause UNEMPLOYMENT_RATE	2.35701	0.2223
NEW_COMPANY does not Granger Cause INVESTMENTS INVESTMENTS does not Granger Cause	0.08380	0.7911
NEW_COMPANY	14.0312	0.0332
NEW_VENTURE_CAPITAL_INVESTMENT does not Granger Cause INVESTMENTS INVESTMENTS does	0.13714	0.7357
not Granger Cause NEW_VENTURE_CAPITAL_INVESTMENT	1.55130	0.3014
NUMBER_OF_COVID19_CASES does not Granger Cause INVESTMENTS INVESTMENTS does not	1.55501	0.3009
Granger Cause NUMBER_OF_COVID19_CASES	2.12871	0.2407
PRODUCER_PRICE_INDEX does not Granger Cause INVESTMENTS INVESTMENTS does not Granger	2.92856	0.1855
Cause PRODUCER_PRICE_INDEX	0.12143	0.7505
UNEMPLOYMENT_RATE does not Granger Cause INVESTMENTS INVESTMENTS does not Granger	2.59745	0.2054
Cause UNEMPLOYMENT_RATE	1.92644	0.2593
NEW_VENTURE_CAPITAL_INVESTMENT does not Granger Cause NEW_COMPANY NEW_COMPANY	0.01693	0.9047
does not Granger Cause NEW_VENTURE_CAPITAL_INVESTMENT	2.28092	0.2281
NUMBER_OF_COVID19_CASES does not Granger Cause NEW_COMPANY NEW_COMPANY does not	0.13153	0.7409
Granger Cause NUMBER_OF_COVID19_CASES	1.39490	0.3227
PRODUCER_PRICE_INDEX does not Granger Cause NEW_COMPANY NEW_COMPANY does not	0.00137	0.9728
Granger Cause PRODUCER_PRICE_INDEX	2.78487	0.1938
UNEMPLOYMENT_RATE does not Granger Cause NEW_COMPANY NEW_COMPANY does not Granger	0.61674	0.4896
Cause UNEMPLOYMENT_RATE	0.33857	0.6015
NUMBER_OF_COVID19_CASES does not Granger Cause NEW_VENTURE_CAPITAL_INVESTMENT	0.90776	0.4110
NEW_VENTURE_CAPITAL_INVESTMENT does not Granger Cause NUMBER_OF_COVID19_CASES	1.79928	0.2723
PRODUCER_PRICE_INDEX does not Granger Cause NEW_VENTURE_CAPITAL_INVESTMENT	0.16892	0.7087
NEW_VENTURE_CAPITAL_INVESTMENT does not Granger Cause PRODUCER_PRICE_INDEX	0.00726	0.9375
UNEMPLOYMENT_RATE does not Granger Cause NEW_VENTURE_CAPITAL_INVESTMENT	0.31747	0.6125
NEW_VENTURE_CAPITAL_INVESTMENT does not Granger Cause UNEMPLOYMENT_RATE	2.46860	0.2142
PRODUCER_PRICE_INDEX does not Granger Cause NUMBER_OF_COVID19_CASES	1.20839	0.3520
NUMBER_OF_COVID19_CASES does not Granger Cause PRODUCER_PRICE_INDEX	11.9755	0.0406
UNEMPLOYMENT_RATE does not Granger Cause NUMBER_OF_COVID19_CASES	0.19414	0.6893
NUMBER_OF_COVID19_CASES does not Granger Cause UNEMPLOYMENT_RATE	1.91939	0.2600
UNEMPLOYMENT_RATE does not Granger Cause PRODUCER_PRICE_INDEX	5.01887	0.1109
PRODUCER_PRICE_INDEX does not Granger Cause UNEMPLOYMENT_RATE	7.83435	0.0679

Source: developed by the author.

Table 3. Results of the calculation of statistics according to the Granger test

Average	5888794	Standard deviation	126510,5
Sum of squares of residuals	1,63E+10	S.D. of regression	127564
R-square	0,830546	Adjusted R-squared	-0,01672
Log likelihood ratio	−85,41650	Akaike's criterion	182,833
Schwartz criterion	182,5085	Hannan-Quinn criterion	178,8218
rho parameter	0,123615	Durbin-Watson statistic	1,351818

Source: developed by the author.

Thus, after building the models, the best type of regression for further manipulations was chosen - the linear type. The models are analysed using determination coefficients, t-statistics to determine the significance of the coefficients in the equation, F-statistics, and standard error of the regression. The results of the tests provided that the number of new venture capital investments is determined as the outcome factor, are presented in table 6.

Table 6. Regression statistics

Name	Results
Multiple R	0,939751065
R-square	0,883132064
Normalised R-squared	0,181924449
Standard error	114033,0501

Source: developed by the author.

Based on Table 6, the R-squared is 0.88, which indicates the reliability of the model. Table 7 shows the results of calculating the regression model.

Table 4. Correlation matrix

	Investments	Unemploy-ment	Producer price index	Consumer price index	Number of COVID-19 cases	Number of new venture capital investments	Number of new companies
Investments	1						
Unemployment	0,999994675	1					
Producer price index	0,999998609	0,999998727	1				
Consumer price index	0,999921685	0,999957143	0,999941	1			
Number of COVID-19 cases	0,999884478	0,999887456	0,999887	0,999841	1		
Number of new venture capital investments	0,999835767	0,999850943	0,999845	0,999839	0,999991	1	
Number of new companies	0,997338869	0,997323638	0,997332	0,997235	0,998307	0,998394219	1

Source: developed by the author.

Table 5. Input data for regression analysis

Time period	Investments, mln.	Unemploy-ment, %	Producer price index, %	Consumer price index, %	Number of COVID-19 cases, people	Number of new venture capital investments	Number of new companies
2015	236742	107,8	102,1	102,7	0	3455	6020757,4
2016	237120	107	108,3	105,4	0	3683	5865780
2017	264041	106,6	106	102,5	0	4822	6039216
2018	254392	106,2	117,3	104,3	0	4321	6041195
2019	313224	106,2	97,4	103	0	3455	5916906
2020	261973	104,2	104,7	104,9	87052	3155	5684561
2021	295042	104,3	130,1	108,4	102083	5208	5866703
2022	305189	105,5	129,1	133	430334	4114	5807200

Source: developed by the author.

Table 7. Regression model calculation results

Name of indicators	Coefficients	t-statistics	P-value
Number of new companies (Y)	-5316282,85	-0,73087851	0,59819703
Investments, million USD (X^1)	1,295582662	0,535017461	0,68724934
Unemployment (X^2)	115241,6505	1,25445695	0,42844855
Producer price index (X^3)	4496,753451	0,358462275	0,78087954
Consumer price index (X^4)	-199500,926	-0,4339450	0,73935340
Number of COVID-19 cases (X^5)	0,89693015	0,31210424	0,8074070
Number of new venture capital investments (X^6)	59,5888024	0,47070744	0,7199253

Source: developed by the author.

The interpretation of these results is that the regression equation will be as follows:

$y = -5316282,85+1,29x^1+115241,65x^2+4496,75x^3-19950,09x^4+0,89X^5+59,59x^6$.

This equation means that, provided that x1=x2=x3=x4=x5=x6=0, y=-5316282.85, i.e. the number of enterprises will decrease. Thus, considering the factors of the accelerator's action, we can conclude that the number of new enterprises provided that the accelerator is used to develop a startup will always have a positive result and increase by an average of 61. The impact of the ecosystem on the development and implementation of startups has a more significant impact. However, negative -79761.36, i.e., when all ecosystem factors are changed by one, we have a reduction in the number of new enterprises by 79761.36.

Thus, the peculiarity of developing startup projects in the modern economy, in the example of China, is the startup accelerator's significant impact and the startup ecosystem's negative impact. Such results illustrate the crisis and post-crisis impact of COVID-19 and global geopolitical processes that affect the deglobalization of ecosystems. However, global trends in the development of startup projects are based on the central problem highlighted by the coronavirus and the war in Ukraine, namely problems in the global supply chain, so in 2023, we should expect a rapid increase in the number of AI-based stratagems that address the issue of creating secure supply chains.

Conclusions and prospects for further research

The findings, while correlational rather than causal, provide some guidance for researchers, policymakers, and practitioners wishing to investigate and act on the impact of accelerators. First, we found a strong correlation between the ecosystem and accelerators. However, the regression model is more revealing, as it illustrates more fully the need for changes in the methodology of startup ecosystems. These characteristics can lead to different ecosystem models, each of which will be optimized for the development and realization of startups. For example, the producer price, unemployment rate, and post-COVID-19 impact metrics significantly positively impact the chances of a startup project succeeding in an ecosystem like China.

Accelerators also function in the early stages of startup development and indicate the specifics of their development. Such accelerators may focus on economic and regional development.

Additional decision-making methods can be used, such as selection based on similarity to the ideal solution to increase the reliability of future research trials and evaluation laboratories for decision-making and others. In addition, the results can be empirically verified by using statistical methods such as 'structural equation modelling by the least squares method' (when calculating the Granger causality test).

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