Section ECONOMETRICS

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Analysis of the impact of high-tech exports and industrial scale on employers in Azerbaijan

Abstract
Modern technologies accelerate and change the economic activity of both developed and developing countries. The application of technologies in a wide range of fields, from production processes to the service sector, increases macroeconomic competitiveness. It is for this reason that employers' high technology export and connection with industry can be considered as one of the main components of economic success in the modern era.
The study mainly assesses the impact of employers on high-tech exports and changes in the size of industry. This assessment provides optimized data for the study of the relationship between employers and potential export and the impact of employers on growth in the industrial sphere.
The aim of the study is to examine the interaction between employers and the following variables: domestic loans provided by banks to the private sector (% of GDP), Industry (including construction) with value added (annual % growth), High-tech exports (% of manufactured exports), and GDP. The task of the study is to determine the role of employers in the development of high-tech exports and industries. High technology export is the sale of technological products and services to other countries. This is usually associated with innovative technology products. These products include more automated information technology, production technology, biotechnology, etc. High technology export represents a very important situation for the employer parties. Because these products can be sold at a higher price in the world market and earn more profit.
The statistical annual data used in the study are taken from the database of the World Bank and the State Statistics Committee of Azerbaijan. Technological exports and employers developed in Azerbaijan between 2007-2023 and other macroeconomic indicators were analyzed using the Granger causality analysis method. As a result of the analysis, it is concluded that employers are related to high-tech export technologies and industry.
Keywords: employer, high technology, industry, Granger Causality Tests.

Introduction

The high-tech export sector of Azerbaijan is more important in the development of the country's economy and its sustainability, in adapting to its aspirations for a technology-based future. It can be emphasized that employers create a complex ecosystem that both supports and challenges the development of high-tech industries. This analysis also assesses employers' impact on industry development, focusing on workforce development efforts and collaborative initiatives. In this study,

the general characteristics of the influence of employers on economic growth in recent times are examined from a theoretical point of view. A key feature of modern employers is their adaptability. This adaptation a willingness to embrace change and manage uncertainty with flexibility and innovation. Employers who can adapt to emerging technologies, evolving market trends and workforce needs are more likely to succeed in the fast-paced modern workplace.

Investment is at the center of the influence of employers on high-tech export and industry in Azerbaijan. High-tech industries require a workforce that is not only technically skilled but also adaptable to rapid technological change. This, in turn, increases the competitiveness of high-tech exports.

While previous studies have mainly focused on theoretically examining the role of entrepreneurs in employment and industrial development, this study's in-depth practical analysis clarifies the provisions that can contribute to economic growth.

Literature review

In their joint study, K. Lee and L. Wang emphasize the importance of intellectual capital management in the global high-tech export sector, as it provides companies with resilience to uncertainties (such as COVID-19) and competitive advantage through dynamic and risk management capabilitiesThe Chinese case suggests strategies for companies in emerging markets to combine intellectual capital with opportunity- and risk-oriented capabilities to compete with developed countries such as Europe and the United States. The results recommend that companies adopt a two-way mediation model for sustainable growth in rapidly changing global environments (Lee & Wang, 2023).

In an article coauthored by Navarro Zapata et al., they showed that strong export potential is essential for long-term economic growth and that technological advances improve export performance. Factors affecting international trade flows in the manufacturing sector in OECD countries are analyzed. Investments aimed at high-tech exports are important for industrial policy. The study concludes that high-tech export-oriented investments have significant implications for industrial policies (Navarro et al., 2024).

The article, jointly prepared by T.Suvalova, R.Ashurbekov, O.Zhuravleva and O.Suvalov, analyzes the special role of the labor market as a universal factor in the economy, discusses the dynamics of supply and demand, the impact of migration processes, and unemployment levels at both the macro and micro scales. This study proposes a macro-micro level analysis model for managing migration and unemployment in global labor markets, linking regional statistics (the case of Russia) with global trends (e.g., digitalization and pandemics), supporting sustainable economic development (Suvalova et al., 2023).

In his article, N. Abbasov examines the impact of innovation on economic growth in Azerbaijan, Türkiye, and Georgia, comparing statistical data (GDP), GDP per capita, labor productivity, R&D expenditures, patents, high-tech production and exports, and sources such as the World Bank, IMF, OECD, and the Global Innovation Index for 2015-2024. This study emphasizes economic diversification through innovation in developing countries, especially resource-dependent countries (e.g., the post-Soviet region), and shows that investments in R&D and human capital provide long-term growth (Abbasov, 2025).

In his article, X. Abbaszadeh evaluates the interplay between economic growth and the labor market in the Republic of Azerbaijan, analyzing data on GDP, unemployment rate, labor productivity, employment, and wage indicators for 2005–2023 using the Granger causality test, ordinary least squares (OLS) method, and ARDL models. The study finds that wages drive productivity, unemployment affects productivity, and employment influences economic outcomes, while GDP and productivity exhibit a bidirectional relationship. This research proposes an econometric framework for analyzing the economic growth-labor market nexus in resource-dependent countries (e.g., the post-Soviet region) (Abbaszadə, 2025).

The article by authors P. Budhwar, A. Malik, M. Thedushika De Silva and P. Thevisuthan

analyzes the integration of artificial intelligence (AI) into human resource management (HRM) practices over the past 10 years, especially in international companies. The article synthesizes 70 scientific articles using a systematic literature review (SLR) method and examines the application of AI in HRM functions (organizational planning, recruitment, training, performance appraisal) and its impact on employee and business outcomes (positive: productivity, job satisfaction; negative: job uncertainty, ethical issues) (Budhwar et al., 2022)

The study, written by authors Zhanna A. Ermakova, Natalia V. Speshilova and Vyacheslav N. Shepel, analyzes the impact of the digitalization of the economy on the labor market and justifies the formation of personnel supply in accordance with the specialization of regions (agriculture in the Orenburg region). Using statistical analysis, comparison and cause-and-effect analysis methods, the main determinants of personnel supply are identified: the management system, the availability and movement of labor resources, the vocational education

system (the role of local universities). The article also emphasizes the global importance of personnel strategies in accordance with the specialization of regions in the conditions of the digital economy (Ermakova et al., 2023).

Important aspects of employers in modern times

Nowadays, employers play a crucial role in forming the work environment and employee experience. Employers today are expected to have a unique set of characteristics that promote a positive and productive workplace. They are responsible for creating job opportunities, shaping workplace cultures and driving economic growth.

In order to achieve sustainable economic growth and reduce dependence on oil and gas exports, it is important to create and implement development mechanisms aimed at promoting innovative economic growth (Abbasov, 2022). In this regard, the impact of employers on economic growth cannot be overemphasized. The main goals of employers are programs aimed at strengthening local capitalism, focusing on job creation, income growth, poverty reduction, economic diversification and improvement of the quality of life (Besser et al., 2009). One of the main characteristics of employers in modern times is adaptability. In a rapidly changing business landscape, employers must be flexible and open to new ideas and approaches. It requires the ability to embrace change and approach uncertainty with tolerance and creativity. Employers who can adapt to new technologies, market trends and employee needs are better positioned to succeed in today's dynamic work environment.

The role of exporting high technologies today

Application of innovative technologies has the power to improve the macroeconomic situation and create new opportunities for production (Abbasov, 2022). High technology is becoming a more important field nowadays. The relevance of high technologies in countries is the main source of future development.

High-tech products are usually characterized by a combination of research and development (Sandu et al., 2014). High-tech refers to innovative products or services that are at the forefront of scientific and technological advances. These may include electronics, robotics, artificial intelligence, biotechnology, and others. High technology is characterized by complexity, rapid innovation, and the potential to significantly impact various industries and daily life. This includes helping businesses use these advances to grow and succeed.

The level of innovative and technological progress of the country can be determined by its ability to produce and export high-tech products (Usman, 2017). High technologies play a crucial role in driving economic growth and creating new opportunities for businesses and individuals. The development of high-tech products and services not only increases productivity and competitiveness, but also fosters innovation and entrepreneurship.

Moreover, high technologies have the potential to solve pressing global problems such as climate change, resource scarcity and public health crises. For example, the use of advanced renewable energy technologies and smart infrastructure can help mitigate the impact of climate

change and build more sustainable societies.

In conclusion, high technology represents the pinnacle of human invention and creativity, offering endless possibilities for forming the future. As we continue to apply the power of high technology, we can expect to see even greater advancements that will continue to change our world for the better.

Importance of exporting high technologies

In modern times, the development of technology plays an important role in the management of economic growth, in addition to strengthening the high-tech export capabilities of a country (Şahin et al., 2021). The concept of high-tech exports provides a foundation for the development of relations between regions and the improvement of technologies. This foundation helps to define the export strategy of high-tech products. In general, the concept of high-tech export refers to the strategy of a country or company to sell high-tech products abroad. This strategy is often based on factors such as innovation, quality and competitive advantage.

Exports play an important role in the economic growth of rapidly developing countries. In the global space, states try to increase the export of high-tech products in order to have superior opportunities (Usman, 2017). The export of high-tech products is generally aimed at increasing economic growth and competitiveness. This often requires a focus on producing and marketing products that require knowledge and skills.

The main goal of this concept is to ensure important development in the field of high technologies. In this context, the main principles of high technology export are as follows:

1. Innovation and research: Research should be invested in the continuous innovation and development of high-tech products. Innovation provides a competitive advantage and ensures that products are constantly updated.

2. Quality and standards: It is important that high-tech products comply with international quality standards and meet customer expectations. Quality products increase customer satisfaction and strengthen brand reputation.

3. Market research and customer demand: Detailed market research should be done to develop products that meet the needs of target markets. The design and features of products should be determined taking into account customer feedback.

4. Global networks and cooperation. It is important to expand market coverage by establishing international collaborations and partnerships. Strategic cooperation facilitates technology transfer and accelerates access to new markets.

5. Export incentives and supports. Governments should provide various supports and incentives to promote high-tech exports. Measures such as research funding and trade support encourage companies to increase their international competitiveness.

6. Continuous improvement and adaptation. Because market conditions and technological trends are constantly changing, high-tech export strategies should be constantly reviewed and improved. Flexibility and adaptability are key to successful competition.

The status of employer influence in relation to high-tech exports

In the post-industrial period, the importance of raw materials, materials, energy resources and labor force in production was replaced by the increasing importance of intellectual resources in the information society (Qurbanova, 2021). For this reason, high technological development can be associated with an intellectual product. Exporting high technology can increase business efficiency and speed up business processes. This allows employers to generate more profits and manage their workforce more efficiently. But this does not directly affect the employees to be more productive and successful in their work.

The productivity of the production process is related to the level of professionalism demonstrated by the employees, that results from their work experience, skills and motivation. Investments in labor force play an important role in ensuring the dynamically sustainable

development. Improving the quality of personnel contributes to the growth of labor productivity and development of innovative activity. These innovations ensure continuous updating of the technical and technological base of production, development of new competitive products, effective penetration of goods and services into world markets. It is fair to conclude that by creating an environment conducive to innovation and technological advancement, employers encourage the development of cutting-edge products and services that can be exported to the world markets. Employers play a key role in forming the high-tech export environment by investing in research and development and in their ability to attract and retain the best talent.

The competitive environment influences the potential productivity growth of employers. In other words, intense competition between employers forces them to increase production efficiency and hire highly productive workers, albeit at a higher cost. (İsmayilov et al., 2021). Consequently, employers may have opportunities to influence the export of high-tech products. Employers can also help create a more favorable environment for global trade and investment in the high-tech sector by advocating for trade agreements and policies that support the export of high-tech goods.

Research method and results

Research method

A Granger causality test is a statistical hypothesis test used to determine whether one time series can change another. The test was developed by Clive Granger (1969), a Nobel laureate in economics, and it has become a key tool for analyzing causal relationships between time series data (Altıntaş et al., 2008).

The research used data from 2007-2023.

Data:

- World Bank database (World Bank, 2025) (employers as a percentage of the employed population and high-tech exports (as a percentage of total exports))
- Data base of the Azerbaijan State Statistics Committee (Azerbaijan State Statistics Committee, 2025) (industry, additional volume and number of employed population).

Research results

Granger causality analysis

The variables used in the analysis are described in the table below with their abbreviations.

Variable name	Variable abbreviation
Number of employers	ISS
high technological demand	YTI
Domestic loans granted by banks to the private sector (% of GDP)	BOSVK
İndustry (with added value)	SED
Gross Domestic Product	UDM

Table 1. Variables used in the analysis

Source: Compiled by the author

Before conducting Granger causality analysis, it is important to test the stationarity of the variables. This was achieved by applying the Augmented Dickey-Fuller (ADF) test, with results presented in Table 2.

Null Hypothesis: the variable has a unit root						
	At Level					
		ISS	YTI	BOSVK	SED	UDM
With Constant	t-Statistic	-0.6763	-3.2543	-1.4741	-3.2975	-0.7634
	Prob.	***0.8258***	***0.3980***	***0.5165***	***0.3270***	***0.7982***
		n0	*	n0	*	n0
With Constant & Trend	t-Statistic	-4.6834	-2.2404	-1.2904	-3.1642	-2.7322
	Prob.	***0.1360***	***0.4386***	***0.8463***	***0.1261***	***0.2392***
		*	n0	n0	n0	n0
	At First Difference					
		d(ISS)	d(YTI)	d(BOSVK)	d(SED)	d(UDM)
With Constant	t-Statistic	-3.2236	-3.5840	-3.8147	-3.8208	-4.3012
	Prob.	***0.0440***	***0.0243***	***0.0141***	***0.0150***	***0.0059***
		**	**	**	**	***

Table 2. Unit Root Test Results (ADF)

Source. *Compiled by the author using EViews 10 software based on World Bank (2025) and Azerbaijan State Statistics Committee (2025) data*

As shown in Table 2, it presents the results of the ADF test and provides information about the unit root hypothesis tested for five variables (ISS, YTI, BOSVK, SED, UDM) at level and in first difference, considering constant and constant & trend. In the tests conducted with constant at level, the t-statistics of all variables have absolute values less than the critical values and the probability values (p-values) are greater than 0.05, therefore, it is not possible to reject the unit root hypothesis, i.e., the variables are not stationary. In the tests conducted with a constant in the first difference, the p-values for ISS (p=0.044), BOSVK (p=0.014), SED (p=0.015), and UDM (p=0.0059) are less than 0.05, indicating that the unit root hypothesis is rejected. However, for YTI, the p-value in the first difference is 0.20243, which is greater than 0.05, meaning the unit root hypothesis cannot be rejected at the 5% significance level, though it may suggest stationarity at the 10% significance level. Consequently, the table data indicate that most variables are non-stationary at level but become stationary in the first difference, suggesting that the time series are suitable for analysis.

VAR Granger Causality/Block Exogeneity Wald Tests			
Sample: 2007 2023			
Included observations: 14			
Dependent variable: ISS			
Excluded	Chi-sq	df	Prob.
YTI	20.55410	3	0.0001
All	20.55410	3	0.0001
Dependent variable: YTI			
Excluded	Chi-sq	df	Prob.
ISS	3.999107	3	0.2616
All	3.999107	3	0.2616

Table 3. Results of the granger causality estimation of the effect between employers and high-tech exports

Source. *Compiled by the author using EViews 10 software based on World Bank (2025) data*

Hypothesis 1 from Table 3 is as follows:

H_0 -The change in the number of employers is the reason for high-tech exports;

H_1 - The change in the number of employers is not the reason for high-tech exports.

In Table 3, to find out the reason for employers, H_0 is accepted and H_1 is rejected. The result obtained from here can be interpreted as follows:

As technology continues to advance rapidly, the demand for highly skilled workers in the high-tech sector has increased. This has led to an of new companies and startups entering the market. The existing hall shows the relationship influx with the number of employers.

As high-tech exports increase, companies may need to expand their workforce to keep up with production and meet the demands of international markets. Conversely, if there is a decline in high-tech exports, employers may have to decrease their operations and workforce. In general, fluctuations in high technology exports can directly affect the number of employers in the industry.

Hypothesis 2 from Table 3 is as follows:

H_0 - The change in the volume of high-tech exports is the reason for the number of employers;

H_1 - The change in the volume of high-tech exports is not the reason for the number of employers.

In Table 3, to study the reason for high-tech exports, H_0 is rejected and H_1 alternative is accepted. The result obtained from here can be interpreted as follows:

Regardless of the employers involved in the production process, the volume of high-tech exports remains constant. This shows that the demand for high-tech products is not significantly affected by changes in the companies responsible for their production.

Additionally, the consistent volume of high-tech exports, regardless of the employers involved, suggests that market forces such as technological advances and consumer preferences play a larger role in determining demand than individual company strategies. This means that the high-tech industry as a whole provides more demand for these products than individual companies competing for market share.

According to the results of the Granger causality test, it was concluded that employers do not influence technological exports. This may indicate that the company lacks potentially innovative technologies or lags behind in technology development. In this case, it may be compounded by some unwillingness of employers to invest in and develop high technology.

The export of high technology is closely related to the import of high technology raw materials from foreign countries (Ekananda, & Parlinggoman, 2017). In this regard, the effect between employers and the export of high technology is ambiguous. There may be several reasons why employers are not affected by high-tech exports:

1. Productive degradation in technology: Employers may choose to work with older technology and equipment because the use of new technology may cause employees to become interested and learn new mechanisms.

2. Financial issues: Buying and providing new technology and equipment is impossible for financial reasons. Employers or business owners may not be willing to spend much time and money to make these investments.

3. Business practices and existing business processes: Employers may struggle to understand how technology changes will affect business processes and employee actions. In such cases, technology change may seem risky and employers should properly analyze and plan before taking this risk.

Such reasons may also cause employers not to accept high-tech exports and, as a result, to face technological development constraints.

VAR Granger Causality/Block Exogeneity Wald Tests			
Sample: 2007 2023			
Included observations: 14			
Dependent variable: ISS			
Excluded	Chi-sq	df	Prob.
SED	4.009094	4	0.4048
All	4.009094	4	0.4048
Dependent variable: SED			
Excluded	Chi-sq	df	Prob.
ISS	22.42068	4	0.0002
All	22.42068	4	0.0002

Table 4. Results of the granger causality estimation of the influence of employers on the industry

Source. *Compiled by the author using EViews 10 software based on World Bank (2025) and Azerbaijan State Statistics Committee (2025) data*

Hypothesis 1, taken from Table 4, is as follows:
H_0 - The change in the number of employers is caused by the industry (including value added).
H_1 - The change in the number of employers is not caused by the industry (including value added).

As shown in Table 4 for Hypothesis 1, H_0 was rejected, and H_1 was accepted, confirming the investigation into the factors influencing employers. The result obtained from this can be interpreted as follows:

The analysis in Table 4 shows that the size of the industry does not play a role in the change in the number of employers in this sector. The main reasons why the size of the industry does not directly affect the number of employers are related to technological development, economic cycles, and labor market dynamics. Modern technologies and automation allow for higher productivity with fewer human resources, which reduces or keeps the need for labor constant. Economic cycles, especially during economic downturns or crises, can lead to industrial layoffs to reduce costs even if industrial volume increases. Global trade dynamics, such as changes in the import-export balance or restricted access to foreign markets, affect the number of local employers by changing production strategies. In addition, structural changes in the labor market, such as shortages of skilled personnel or labor migration, can limit the number of employees regardless of the size of the industry.

Hypothesis 2, taken from Table 4, is as follows:

H_0 - The change in the industry's volume (including value added) is caused by the number of employers.

H_1 - The change in the industry's volume (including value added) is not caused by the number of employers.

Hypothesis 2 in Table 4 shows that H_0 is accepted and H_1 is rejected. In this case, the result obtained can be interpreted as follows:

According to the results of this analysis, changes in the number of employers significantly affect the size of the industry as a whole. Changes in the number of employers have both a direct and an indirect impact on the industry's size. First and foremost, the increase in the number of employers is associated with the emergence of new enterprises in the industry and the expansion of existing ones, which enhances overall production capacity. As new employers enter the market, competition intensifies, leading to increased productivity. This process contributes to diversification in the industry structure and the diffusion of innovations. At the same time, an increase in the number of employers leads to the creation of new jobs in the labor market and an increase in economic activity. This creates conditions for an increase in total turnover and added value in the industrial sector. On

the contrary, a decrease in the number of employers results in the closure or limitation of industrial enterprises, which reduces the overall size of the industry. Scientific studies show that the number of employers is one of the main indicators in the dynamics of the industrial sector, and its change leads to significant changes in the size of the industry. According to Keynes, the private sector alone cannot provide the optimal level of employment, and in order to maintain full employment, it is necessary to regulate aggregate demand through government policies (fiscal and monetary) (Ермакова et al., 2023). In this regard, government intervention in the economy and stimulation of demand are considered essential for increasing employment. In the Keynesian approach, an increase in the number of employers is associated with an increase in aggregate demand and economic activity.

VAR Granger Causality/Block Exogeneity Wald Tests			
Sample: 2007 2023			
Included observations: 14			
Dependent variable: ISS			
Excluded	Chi-sq	df	Prob.
UDM	12.54111	3	0.0057
All	12.54111	3	0.0057
Dependent variable: UDM			
Excluded	Chi-sq	df	Prob.
ISS	5.388014	3	0.1455
All	5.388014	3	0.1455

Table 5. Results of the Granger Causality Test Assessing the Relationship Between Employers and GDP

Source. *Compiled by the author using EViews 10 software based on World Bank (2025) and Azerbaijan State Statistics Committee (2025) data*

Hypothesis 1, taken from Table 5, is as follows:

H_0 - Changes in the number of employers cause changes in GDP.

H_1 - Changes in the number of employers do not cause changes in GDP.

Based on the results for Hypothesis 1 in Table 5, since the p-value ($p<0.05$) is statistically significant, the null hypothesis (H_0) is accepted, and the alternative hypothesis (H_1) is rejected. The result obtained from this can be interpreted as follows:

Changes in the number of employers have a direct impact on the economy, as their growth increases employment and consumption levels. Employers who hire more workers and invest in new projects stimulate economic activity. This, in turn, leads to an increase in GDP and improved social welfare. According to Schumpeter's theory, employers drive economic growth through innovations and new businesses. These innovations transform market dynamics, intensify competition, and expand consumer choice. Simultaneously, this process restructures the economy, leading to the elimination of outdated and inefficient business models. This results in more efficient resource utilization and an increase in the overall productivity of the economy. Consequently, innovation and entrepreneurship not only foster economic growth but also enhance social welfare, positively contributing to societal development.

Hypothesis 2, taken from Table 5, is as follows:

H_0 - Changes in the volume of GDP are caused by the number of employers.

H_1 - Changes in the volume of GDP are not caused by the number of employers.

Based on the results for Hypothesis 1 in Table 5, since the p-value ($p>0.05$) is not statistically significant, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. The obtained results can be interpreted as follows:

The change in GDP is a result of many factors, and this change is not a direct cause of the number of employers. On the contrary, economic growth is mainly due to factors such as

technological innovations, capital investments, productivity growth, and foreign trade. For example, GDP growth sometimes occurs as a result of automation and technological development, which can lead to a decrease in the number of employers, rather than an increase. At the same time, changes in the structure of the economy – for example, changes in industry sectors – can affect the creation of new jobs or the elimination of existing ones. In addition, the number of employers also depends on other factors, such as demand in the labor market, labor migration, and the availability of qualified personnel. Therefore, changes in GDP cannot be considered a direct cause of the number of employers, as the relationship is reciprocal and multifaceted.

Conclusion

Employers should have a reason to invest in the development of high-tech exports. There are a number of key measures that can be taken to encourage and support employers in this work. First of all, employers should create a favorable environment for the development of high-tech exports in management. This includes providing financial incentives such as tax benefits and grants to export-oriented companies investing in research and development. By reducing the financial burden on employers, they are more likely to take risks and invest in new technologies and products that can be brought to international markets.

In addition, it is important to increase the skilled workforce for the development of high-tech exports. Employers should be encouraged to invest in training and education programs to keep their employees ahead of technological advancements and global competition. Governments can also play a role in facilitating partnerships between industry and academia to ensure that the workforce is equipped with the necessary skills and knowledge to support high-tech exports.

Employers can drive positive change in the industry by investing in their employees, promoting diversity and inclusion, and prioritizing sustainability and social responsibility. Employers play a key role in developing industries through investment decisions, innovation and technological advancements, and strategic decisions about mergers and acquisitions. Employers should also focus on creating a positive work environment by attracting skilled personnel. Employers can influence industry growth by offering competitive salaries and opportunities for advancement. In addition, employers can invest in training and development programs to help upskill current employees and equip them to meet the evolving demands of the industry. By prioritizing employee satisfaction and professional growth, employers can not only increase the size of the industry, but also contribute to overall success and innovation.

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