

Study of the correlation between the growth rates of interregional trade and GDP of the EAEU member countries

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Abstract. Integration processes generate so-called "spillover effects", which have an impact on the welfare of the population of the countries involved in integration processes. Russia, as the largest economy of the Eurasian Economic Union (EAEU), acts as the main generator of economic impulses / "shocks" for the other member states of the economic association. The purpose of the study is to verify the existence of a statistically significant relationship between the mutual trade turnover dynamics of the EAEU member states and the economic growth rates of the integrating states using regression analysis. We used regression analysis to validate the hypothesis put forward in this paper (changes in the volume of mutual trade in the EAEU area have an impact on the GDP of the EAEU member countries). The use of regression analysis helped to exclude the Armenian economy from the list of countries where there is a statistically significant relationship between the volume of mutual trade within the EAEU and GDP growth rates (previously, the use of correlation analysis allowed to identify such a relationship for three of the five integration economies). The obtained results indicate that the GDP of the economies under study is generally insignificantly affected by the volume of mutual trade within the EAEU.

Keywords: interregional trade, spillover effects, regression analysis, GDP, EAEU.

JEL codes: F15, O14

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Introduction

This paper is the second stage of research by members of the research team investigating the spillover effects of integration in the EAEU area. At the first stage of the study, the growth rates of trade turnover within the EAEU and GDP growth rates of the EAEU countries were compared; the growth rates of foreign trade turnover of the EAEU countries and the growth rates of the world economy. The study considered two hypotheses: the growth rate of trade turnover within the EAEU will be inferior to the development dynamics of the EAEU member states' regional economies; the growth rate of EAEU member states' foreign trade with third countries will outpace the dynamics of the global economy. The results of the correlation analysis did not provide an unambiguous response to the hypotheses put forward in the paper: a) it was found that there is a direct statistically significant relationship between the dynamics of mutual trade turnover within the EAEU and GDP dynamics for the three member countries of the integration association, except for Kyrgyzstan and Kazakhstan; b) it was found that there is no correlation between the dynamics of foreign trade of EAEU countries and the dynamics of global GDP (Shkiotov, 2023).

At the second stage of the study, we use regression analysis to verify the existence of the identified statistically significant relationship between the dynamics of trade turnover within the EAEU and GDP growth rates of the EAEU member countries.

The existence of such a relationship (between the rate of mutual trade and GDP) is confirmed by a number of earlier studies:

Zoidov & Zoidov (2021): the main idea of authors approach is a gravitational econometric model of foreign trade and foreign trade turnover, which directly depends on the economic capabilities of trading countries (GDP) and inversely depends on the distance between these countries. Based on the results of

the gravitational econometric model of foreign trade, it is established that in the future the growth of trade turnover between the EAEU+ countries are possible taking into account the GDP growth of these countries. The EAEU+ countries have significant economic potential to increase mutual trade flows and further integration into world trade.

Terletskiy & Madiyarova (2023): the authors applied the methods of correlation and comparative analysis to identify the main ways to increase foreign trade flows between integration countries under the conditions of foreign trade barriers. After using the analysis of the correlation relationship between the mutual foreign trade turnover of the EAEU countries, covering the commodity group “mineral products”, and other main statistical indicators, the authors identified the main drivers of mutual trade in mineral products. Among such methods of enhancing mutual merchandise trade are GDP growth, strengthening of revealed comparative advantages, cargo tracking mechanisms, the quality of logistics services and the level of organisation of international shipments. Transport infrastructure, timeliness of delivery and the share of domestic R&D expenditures in GDP have a less positive impact on the mutual trade of integration countries, while geographical distance and customs checks, on the contrary, have a negative impact on trade flows.

Orudzhev & Alizade (2021): this article studies the integration processes between Azerbaijan and Ukraine by using the indicators of the integratedness of the GDPs of these countries and of the trade turnover between them. The annual data from 1994 to 2018 are studied as the period of monitoring. The article uses the econometric methodology of the gravity modelling of the correlation between non-stationary time series. Based on the constructed model, econometrically sound recommendations that enable a dynamic analysis of effective regulation of the export and import transactions between these countries by the governments to balance the mutual trade have been developed.

Ali, Huang & Xie (2022): China is making large investments in Pakistan’s transport infrastructure under the China-Pakistan Economic Corridor. This study aims to quantitatively analyze the bilateral impacts of these investments through several policy scenarios in 2025 using a global economic model. Our results show that due to transport infrastructure development, the GDP and welfare of both Pakistan and China will improve, with a maximum of 0.3% and 0.01% increase in GDP, and USD 2.6 billion USD 1.8 billion gains in welfare for Pakistan and China, respectively. Regarding mutual trade, Pakistan’s total and agricultural exports to China will increase in the range of USD 9.6-13.7 billion and USD 4.7-6.6 billion, respectively. The percentage increase in Pakistan’s net exports of agricultural commodities to China will be higher than that of non-agricultural products. Pakistan will tap into China’s import demand for fresh fruits and vegetables and other perishable food products. Due to changing trade relations, Pakistan’s production structure will undergo slight structural adjustments. For Pakistan’s agriculture sector, the rice and fruit sectors will be top gainers, with 2.1-2.6% and 1.2-1.7% output expansion, respectively. Pakistan will also experience some leveling of income due to a relatively higher increase in wages of unskilled labor than skilled labor. The output of China’s rice sector will drop the most (-1- -1.3%). Overall, the effects on China’s economy are minimal.

Khan (2019): The United States of America (USA) and People's Republic of China are waging a war against each other in the field of mutual trade. If the erstwhile open mutual trade gets replaced by a somewhat restricted trade, the economic consequences for both the countries will be disastrous and it will also affect the world trade negatively. The same will happen with EU, Mexico and Canada if the trend continues. The effect of this war will be a cause of concern for world growth too. If this modern day commercial war keeps itself limited to US and China only still the negative impact on the global economy will be almost - 0.5% on world GDP, but if other countries also start playing the same tune and the trade war moves forward than the world GDP is likely to get reduced by not less than 3%. This may lead to a major recession in the global economy.

Drapkin, Sidorov & Mariev (2022): The authors analyze the influence of sanctions on bilateral trade flows between the European Union and the Russian Federation during 2015-2019. Despite trade sanctions and counter-sanctions being imposed against particular groups of commodities, their influence affected trade flows between Russia and the EU in all sectors. The augmented gravity approach is used to construct an econometric model, while the Poisson pseudo maximum likelihood method is applied to derive unbiased estimates. It is shown that during 2015-2019, due to EU sanctions Russia lost USD 41.3 billion in export

revenues annually, comprising 2.5 percent of its GDP. Russian exports to Europe declined in all basic industries, but the petroleum industry took 91.2 percent of the total losses. European aggregate exports to Russia have not suffered from mutual sanctions: Although the European food industry lost USD 2.7 billion annually, these losses were compensated for by export growth in other industries.

The purpose of the study is to verify the existence of a statistically significant relationship between the mutual trade turnover dynamics of the EAEU member states and the economic growth rates of the integrating states using regression analysis.

Methods

Figure 1 shows that correlation coefficients for three of the five EAEU economies are significant, which means that there is a strong relationship between the variables under study (dynamics of mutual trade of EAEU member states and GDP). This may indicate that the linear model is a good fit to describe the data and can be used for predictions. However, it is important to remember that the presence of significant coefficients does not guarantee the accuracy of the predictions, additional data analysis is required to ensure the quality of the model.

We chose regression analysis to solve this research task (significance level 5%, data were processed in the software package "Statistica" from StatSoft).

Therefore, we use the simplest model and the assumption that changes in the volume of mutual trade in the EAEU area affect the GDP of EAEU member countries.

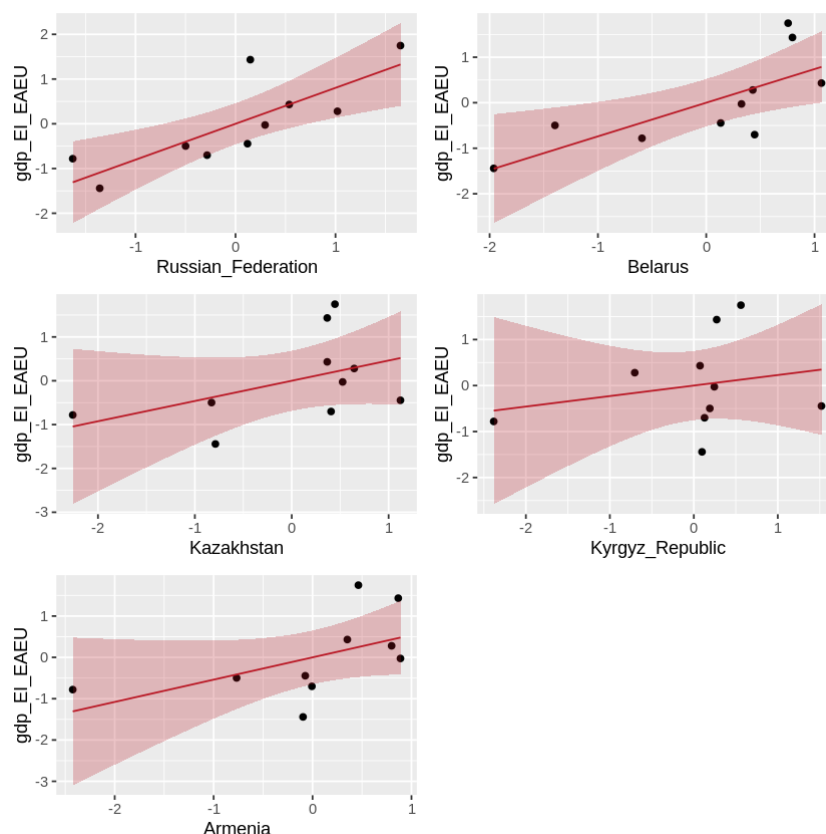


Figure 1. Scatter diagram between the growth rate of mutual trade within the EAEU and the GDP growth rate of EAEU member countries

Source: composed by the author

Results

To analyse the dependence of GDP growth rates of the EAEU member countries on the mutual trade volumes, we will use a model with a general form:

$$GDP \text{ of the country} = \beta_0 + \beta_1 * \text{Mutual trade growth rate} + e$$

The results of estimating the regression model for Russia are as follows:

$$GDP \text{ of RF} = 0,8032 * \text{Mutual trade growth rate}$$

```

Residuals:
  Min   1Q   Median   3Q   Max
-1.0033 -0.1751  0.2183  0.3073  0.7948

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.388e-16  1.998e-01  0.000  1.00000
gdp_EI_EAEU  8.032e-01  2.106e-01  3.813  0.00514 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6319 on 8 degrees of freedom
Multiple R-squared:  0.6451, Adjusted R-squared:  0.6007
F-statistic: 14.54 on 1 and 8 DF, p-value: 0.005141

```

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance = 0.05

Call:
gvlma(x = M)

	Value	p-value	Decision
Global Stat	2.60420	0.6261	Assumptions acceptable.
Skewness	0.91438	0.3390	Assumptions acceptable.
Kurtosis	0.12908	0.7194	Assumptions acceptable.
Link Function	1.53233	0.2158	Assumptions acceptable.
Heteroscedasticity	0.02842	0.8661	Assumptions acceptable.

Regression analysis provides information on how each variable affects the dependent variable. In this case, we have data for Russia on the GDP value and the volume of mutual trade with EAEU countries. The analysis of regression analysis coefficients shows the following: the coefficient value of the variable "Growth rate of mutual trade" is 0.8032 and has a standard error of 0.1998. This means that every one unit change in the value of the variable "Mutual Trade Growth Rate" results in a 0.8032 unit change in the value of the dependent variable. This coefficient is statistically different from zero at the significance level of 0.01.

The results of estimating the entire regression equation show that the regression model fits the original data well because:

- R-squared value is 0.6451. This value indicates how much of the total variation on the dependent variable can be explained by the model. The closer the R-squared value is to 1, the better the model explains the variation of the dependent variable;
- the Adjusted R-squared value is 0.6007. This value indicates how much of the total variation on the dependent variable can be explained by the model after accounting for outliers or missing values. The closer the Adjusted R-squared value is to 1, the better the model explains the variation on the dependent variable after accounting for outliers or missing values;
- The F-statistic value is 14.54 with p-value equal to 0.005141 indicating a significant level of explanation by the equation for the behaviour of the data.

Hence, the results of estimating the entire regression equation show that the regression model fits the data, explains a significant proportion of the variation on the dependent variable and is statistically significant.

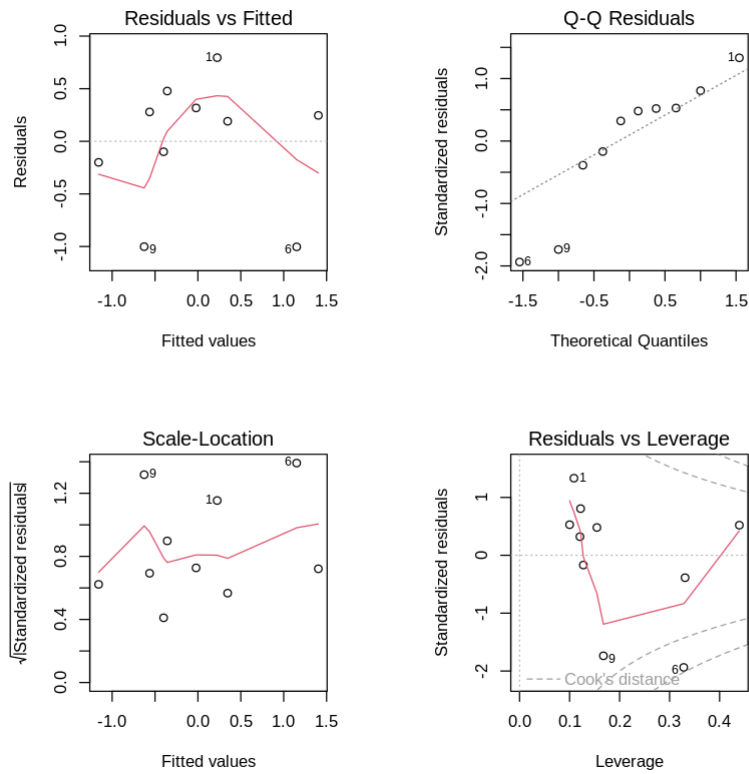


Figure 2. Results of the residual regression analysis on the economy of Russian Federation
 Source: composed by the author

The results of estimating the regression model for Belarus are as follows:

$$GDP\ of\ RB = 0,7387 * Mutual\ trade\ growth\ rate$$

Residuals:

Min	1Q	Median	3Q	Max
-1.0292	-0.4671	0.1032	0.4331	0.9648

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-2.593e-17	2.261e-01	0.0	1.0000
gdp_EI_EAEU	7.387e-01	2.383e-01	3.1	0.0147 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7149 on 8 degrees of freedom
 Multiple R-squared: 0.5457, Adjusted R-squared: 0.4889
 F-statistic: 9.608 on 1 and 8 DF, p-value: 0.01467

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
 USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
 Level of Significance = 0.05

Call:

gvlma(x = M)

	Value	p-value	Decision
Global Stat	4.58632	0.3324	Assumptions acceptable.
Skewness	0.06596	0.7973	Assumptions acceptable.

Kurtosis	0.55055	0.4581	Assumptions acceptable.
Link Function	3.72835	0.0535	Assumptions acceptable.
Heteroscedasticity	0.24147	0.6231	Assumptions acceptable.

The analysis of regression analysis coefficients show the following: the coefficient value of the variable "Growth rate of mutual trade" is 0.7387 and has a standard error of 0.2261. This means that every one unit change in the value of the variable "Mutual Trade Growth Rate" results in a 0.7387 unit change in the value of the dependent variable. This coefficient is statistically different from zero at the significance level of 0.05.

The results of estimating the entire regression equation show that the regression model fits the original data well because:

- R-squared value is 0.5457. This value indicates how much of the total variation on the dependent variable can be explained by the model. The closer the R-squared value is to 1, the better the model explains the variation of the dependent variable;

- the Adjusted R-squared value is 0.4889. This value indicates how much of the total variation on the dependent variable can be explained by the model after accounting for outliers or missing values. The closer the Adjusted R-squared value is to 1, the better the model explains the variation on the dependent variable after accounting for outliers or missing values;

- The F-statistic value is 9.608 with p-value equal to 0.01467 indicating a significant level of explanation by the equation for the behaviour of the data.

Hence, the results of estimating the entire regression equation show that the regression model fits the data, explains a significant proportion of the variation on the dependent variable and is statistically significant.

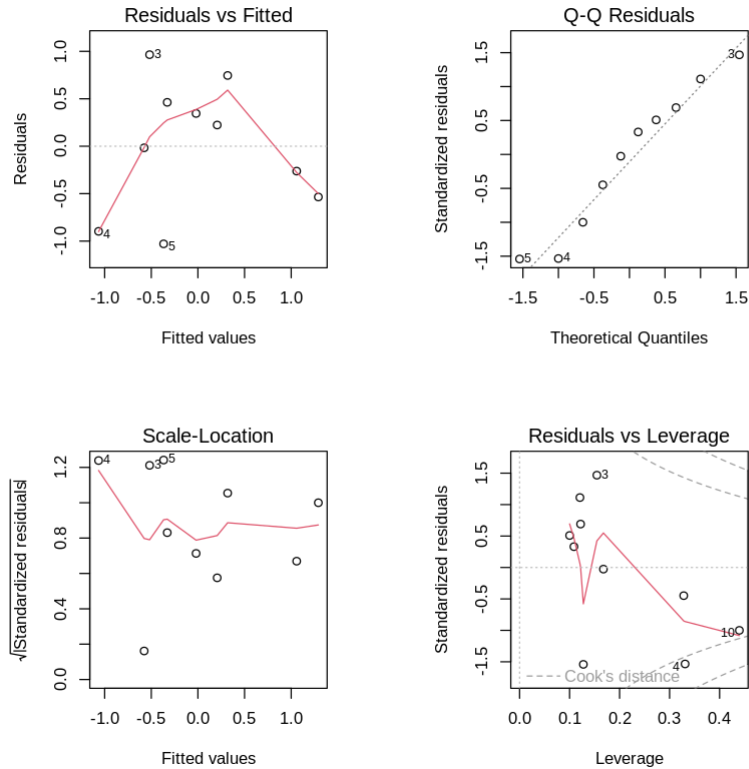


Figure 3. Results of the residual regression analysis on the economy of Belarus¹

Source: composed by the author

In this case, $R\text{-squared}=0.5457$, which indicates that 54.57% of the variance of the Belarus GDP growth

¹ All the obtained diagrams show that the "outliers" among the residuals of the obtained model are quite moderate, and the express test is passed successfully.

rate can be explained by the growth rate of mutual trade within the EAEU (which may also indicate the influence of other factors on the GDP growth rate).

The results of estimating the regression model for Armenia are as follows:

```
Residuals:
  Min    1Q  Median    3Q   Max
-2.0037 -0.3361  0.1425  0.5791  0.9031

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.617e-17  2.825e-01  0.000  1.000
gdp_EI_EAEU 5.393e-01  2.977e-01  1.811  0.108

Residual standard error: 0.8932 on 8 degrees of freedom
Multiple R-squared:  0.2909, Adjusted R-squared:  0.2022
F-statistic: 3.281 on 1 and 8 DF, p-value: 0.1077
```

For the Armenian economy both coefficients of the equation are statistically indistinguishable from zero (as evidenced by the parameters: t-value = 1.811 Pr(>|t|)=0.109), the results of estimation of the whole equation show its statistical insignificance (as evidenced by the parameters: F-statistic: 3.281 on 1 and 8 DF, p-value: 0.1077).

The results of estimating the regression model for Kazakhstan are as follows:

```
Residuals:
  Min    1Q  Median    3Q   Max
-1.90032 -0.34507  0.02234  0.53210  1.32794

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 8.911e-17  2.975e-01  0.000  1.000
gdp_EI_EAEU 4.618e-01  3.136e-01  1.473  0.179

Residual standard error: 0.9408 on 8 degrees of freedom
Multiple R-squared:  0.2133, Adjusted R-squared:  0.1149
F-statistic: 2.169 on 1 and 8 DF, p-value: 0.1791
```

For the Kazakhstan economy both coefficients of the equation are statistically indistinguishable from zero (as evidenced by the parameters: t-value = 1.473 Pr(>|t|)=0.179), the results of estimation of the whole equation show its statistical insignificance (as evidenced by the parameters: F-statistic: 2.169 on 1 and 8 DF, p-value: 0.1791).

The results of estimating the regression model for Kyrgyzstan are as follows:

```
Call:
lm(formula = (Kyrgyz_Republic) ~ (gdp_EI_EAEU))

Residuals:
  Min    1Q  Median    3Q   Max
-2.20466 -0.04771  0.20570  0.30013  1.62193

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -4.313e-17  3.265e-01  0.000  1.000
gdp_EI_EAEU 2.285e-01  3.442e-01  0.664  0.525
```

Residual standard error: 1.033 on 8 degrees of freedom
Multiple R-squared: 0.05221, Adjusted R-squared: -0.06626
F-statistic: 0.4407 on 1 and 8 DF, p-value: 0.5254

For the Kyrgyzstan economy both coefficients of the equation are statistically indistinguishable from zero (as evidenced by the parameters: $t\text{-value} = 0.664$ $\Pr(>|t|)=0.525$), the results of estimation of the whole equation show its statistical insignificance (as evidenced by the parameters: F-statistic: 0.4407 on 1 and 8 DF, p-value: 0.5254).

Table 1 summarises the results of the regression analysis for the EAEU countries.

Table 1 – Results of testing regression model assumptions for EAEU countries

Linear regression assumptions	Russia	Belarus	Armenia	Kyrgyzstan	Kazakhstan
Global Stat	Assumptions acceptable	Assumptions acceptable	n/a	n/a	n/a
Skewness	Assumptions acceptable	Assumptions acceptable	n/a	n/a	n/a
Kurtosis	Assumptions acceptable	Assumptions acceptable	n/a	n/a	n/a
Link Function	Assumptions acceptable	Assumptions acceptable	n/a	n/a	n/a
Heteroscedasticity	Assumptions acceptable	Assumptions acceptable	n/a	n/a	n/a

Source: composed by the author

Conclusion

Table 1 shows that the model assumptions are appropriate for two of the five EAEU economies. Hence, the use of regression analysis helped to exclude the Armenian economy from the list of countries where there is a statistically significant relationship between the volume of mutual trade within the EAEU and GDP growth rates (it should be noted that in the first part of the study the use of correlation analysis allowed to identify such a relationship for three of the five economies of the integration association). The obtained results indicate that the GDP of the economies under study is generally insignificantly affected by the volume of mutual trade within the EAEU.

It is important to realize, the results obtained should be interpreted carefully, as they are depending on the sample size and other model limitations.

Research limitations:

- the initial stage of the integration process within the EAEU zone (insufficient data sampling and too short research interval);

- data outliers distorting the overall result, influenced by the coronavirus pandemic and subsequent lockdown in 2019 and 2020; economic sanctions against Russia since 2014; and the start of the Special Military Operation in 2022;

- strong differences in GDP values of the EAEU member countries (which also leads to the problem of data outliers);

- perhaps the use of correlation analysis for the research task was not optimal (the research methodology is being tested and searched for appropriate to the research tasks).

We hope that the data obtained as a result of the study and the problems solved will activate a new wave of applied research related to the evaluation of the EAEU functioning.

FUNDING

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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