Environmental Kuznets Curve Hypothesis in Eurasian Economic Union Validity: Panel Data Analysis

Avrasya Ekonomik Birliğinde Çevresel Kuznets Eğrisi Hipotezinin Geçerliliği: Panel Veri Analizi

Galip Afşın Ravanoğlu*

Abstract: Global economies demand for energy has increased rapidly with the starting of industrial revolution. Energy has become a meta which is constantly being needed in all areas of life in addition to its role as an input being used in production. Energy consumption is also an important indicator of economic development. Accordingly, it is seen that economically developed countries have higher energy consumption. However, while ensuring their economical development, the countries are also damaging the ecological balance. A rapid consumption of energy increase results in increased emissions of harmful carbon and sulfur to the environment. Whilst economies have to consume energy to make themselves grow, on the other hand this damages the environment and disrupts ecological balance and harm the ecological sustainability. In this study, the relationship between economic growth and carbon emissions of Eurasian Economic Union members; Armenia, Russia, Kazakhstan, Kyrgyzstan and Belarus are analyzed by panel data analysis method. In the current period, the relationship between carbon emissions and economic growth was found statistically insignificant, hence it is agreed that the Environmental Kuznets Curve hypothesis is not valid. In addition, it was observed that energy consumption and population density variables used as control variables positively affect carbon emissions. According to the results; Environmental norms should be applied and the use of renewable energy sources should be increased in order to prevent the union members from harming the environment.

Structured Abstract: The Environmental Kuznets Curve hypothesis (EKC) takes its name from the Kuznets curve theory put forward by Simon Kuznets in 1955. It is the adaptation of Simon Kuznets' theory that he describes the relationship between per capita income and inequality in income distribution, and the relationship between economic growth and carbon emissions. According to the theory; Since the energy required for economic growth is provided from primary energy sources, there is a linear relationship between economic growth and the release of environmentally harmful gases at the beginning. With the increase in per capita income, environmental awareness develops and environmental pollution decreases by implementing

* Dr. Öğr. Üyesi, Karamanoğlu Mehmetbey Üniversitesi, Uygulamalı Bilimler Yüksekokulu, Uluslararası Ticaret ve Lojistik Yönetimi Bölümü

Asst. Prof. Dr., Karamanoglu Mehmetbey University, School of Applied Sciences, International Trade and Logistics Management

ORCID 0000-0001-5485-4384

afsinravanoglu@gmail.com

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supervisory public norms to maintain ecological balance (Dinda, 2004, 432-434). In the literature it is generally symbolized as an inverted U or called as EKC. But it can also be shortened as U, N or an inverted N.

In the literature, there are many studies related to the EKC hypothesis. In these studies, the relationship between carbon and sulfur emissions and economic growth was examined. The EKC is usually symbolized as an inverse U-shape. However, there are also U, N and inverted N forms. In addition, EKC is declined in some of Koçak's studies in 2014 about Turkey between the years 1960 - 2010.

In this study, the relationship between environmental degradation and economic growth for Eurasian Economic Union countries was investigated within the framework of Environmental Kuznets Curve Hypothesis. For that purpose,

* Belarus

* Kyrgyzstan

* Kazakhstan

* Russian Federation

* Armenia,

available data are examined for the period 1992-2014 in

* Carbon emission per person (mt / person), (CO2_PC)

* Gross domestic product per capita in US dollars in 2010 fixed prices (thousand USD), (GDP_PC)

* Energy use (ton oil equivalent / person), (Annex)

* Population density (km² area / person), (PD)

Starting from the studies of Grossman and Krueger (1991), Shafik and Bandopadhyay (1992), polynomial regression model has been used in many applied studies on the Environmental Kuznets Curve Hypothesis. In general, polynomial regression can be shown as follows:

$$y_{it} = \alpha_i + \beta_1 x_{it} + \beta_2 x_{it}^2 + \beta_3 z_{it} + \varepsilon_{it}$$

This presentation symbol y_{it} , of the country, carbon emission per capita, symbol x_{it} , the national income per thousand people at the time, symbol x_{it}^2 , the square of the national income per thousand people at the time and symbol z_{it} , shows other variables that are thought to affect carbon emissions per capita at the time. In this study, it is thought that energy use and population density may affect carbon emission per capita.

- $\beta_1 > 0$ ve $\beta_2 < 0$, There is an inverse U-shaped relationship between x and y . In other words, the CEE hypothesis is valid and can be calculated by the turning point of the curve $-(\beta_1/2\beta_2)$.

- $\beta_1 < 0, \beta_2 > 0$, There is a U-shaped relationship in between x and y .

In this study, panel data model is used because it provides a wider data set compared to time series and cross-sectional models, provides more reliable predictions and advantages of controlling individual heterogeneity. In the panel data model to be established in order to investigate the Environmental Kuznet Curve Hypothesis, all series should be stationary. Panel unit root tests to be performed for this purpose differ depending on the presence of horizontal cross-section dependence in the model.

Table 5: Panel Data Model Results

CO2_PC	Standart Model			Driscoll		
	Coefficien	Std	p-value	Coefficient	Std. Error	p-value
D_GDP_PC	-0.3011	0.3322	0.3670	-0.3011	0.3214	0.3590
D_GDP_PC	0.0122	0.0225	0.5890	0.0122	0.0177	0.4980
EK	3.0012***	0.0878	0.0000	3.0012***	0.1167	0.0000
NY	0.0433***	0.0139	0.0020	0.0433***	0.0152	0.0090
Constant	-	0.6273	0.0000	-2.5913***	0.7722	0.0030
R ²	0.7827			0.9364		
F Test	371.9400*		0.0000	298.9000***		0.0000
Wald Testi	12916***		0.0000			
Wooldridge	105.0510*		0.0005			
Pesaran CD	0.9350		0.3500			

* Must be in 90% confidence interval

** Must be in 95% confidence interval

*** Must be in 99% confidence interval

Table 5 shows the results of the panel data model established for the study of the Environmental Kuznets Curve Hypothesis. In this context, panel data model results, which were first created with stationary variables, are stated as standard model. In this model, variance according to Wald test results and autocorrelation problems according to Wooldridge test results are shown in Table 5. Therefore, the solution of these problems was re-estimated by using the Driscoll Kraay standard defective model. Autocorrelation and changing variance problems were solved in the model. Both D_GDP_PC and D_GDP_PC2 were found to be statistically insignificant. For this reason, it was concluded that the Environmental Kuznet Curve hypothesis was not valid for the Eurasian countries in the period under consideration. On the other hand, energy use and population density variables used as control variables had a positive effect on carbon dioxide emissions.

As a result, as stated above, the basic condition for the validity of the Environmental Prediction Curve Hypothesis is to meet the conditions $\beta_1 > 0$ ve $\beta_2 < 0$. In other words, the coefficient of D_GDP_PC variable should be positive and significant and the coefficient of D_DGP_PC2 should be negative and significant. The corrected model results indicated in Table 5 do not meet these conditions. Therefore, it can be said that the Environmental Kuznet Curve Hypothesis is not valid for the period under consideration.

The relationship between economic growth and emissions of environmentally hazardous gases due to energy consumption is analyzed in the literature with the help of the Environmental Kuznets Curve hypothesis. In this study, the validity of the EKC hypothesis was investigated in the member countries of the Eurasian Economic Union between 1992-2014.

According to the results of the research, no statistically significant relationship was found between the carbon emissions and per capita national income in the Eurasian Economic Union member countries. Therefore, in the period between 1992 and 2014, the EKC hypothesis was rejected in the Eurasian Economic Union. In addition, according to the research results, it was concluded that population density and energy consumption increase carbon emissions in a positive way.

In the case of reducing the consumption of fossil fuels in the EU countries, increasing the use of renewable energy sources and developing environmental awareness in the society, carbon emissions will decrease, that helps us to have an ecological balance, sustainable economic growth.

Keywords: Environmental Pollution, Economic Growth, Environmental Kuznets Curve, Eurasia Economic Union, Panel Data Analysis

Öz: Sanayi devriminin başlamasıyla birlikte ekonomilerin enerjiye olan talepleri hızlı bir şekilde artış göstermiştir. Enerji, üretimde kullanılan girdilerden birisi olmasının yanında, aynı zamanda hayatın her alanında sürekli olarak ihtiyaç duyulan bir meta haline gelmiştir. Enerji tüketimi ekonomik kalkınmanın da aynı zamanda önemli bir göstergesidir. Dolayısıyla enerji tüketimi yüksek olan ülkelerin aynı zamanda ekonomik olarak daha kalkınmış ülkeler oldukları görülmektedir. Ancak ülkeler ekonomik büyümelerini sağlarken bir yandan da ekolojik dengeye zarar vermektedirler. Enerji tüketiminin hızlı bir şekilde artması, çevreye zararlı karbon ve sülfür salınımlarının artması sonucunu da doğurmaktadır. Ekonomiler bir yandan büyümelerini sağlamak için enerji tüketmek zorundayken, diğer taraftan çevreye zarar vererek, ekolojik dengeyi bozmakta ve ekolojik sürdürülebilirliğe zarar vermektedirler.

Bu çalışmada 1992-2014 yılları arasında Avrasya Ekonomik Birliğine üye ülkeler olan Rusya, Kazakistan, Ermenistan, Kırgızistan ve Beyaz Rusya'da ekonomik büyüme ve karbon salınımları arasındaki ilişki panel veri analizi yöntemi yardımıyla incelenmiştir. Geçerli dönemde üye ülkelerde karbon salınımları ve ekonomik büyüme değişkenlerinin arasındaki ilişki istatistiksel olarak anlamsız bulunmuş, dolayısıyla Çevresel Kuznets Eğrisi hipotezinin geçerli olmadığı sonucuna ulaşılmıştır. Ayrıca kontrol değişkenler olarak kullanılan enerji tüketimi ve nüfus yoğunluğu değişkenlerinin karbon emisyonlarını pozitif yönde etkilediği görülmüştür. Sonuçlara göre; birlik üyelerinin çevreye verdikleri zararları önlemeleri için çevre normlarının uygulanması ve yenilenebilir enerji kaynaklarının kullanımının artırılması gerekmektedir.

Anahtar Kelimeler: Çevre Kirliliği, Ekonomik Büyüme, Çevresel Kuznets Eğrisi, Avrasya Ekonomik Birliği, Panel Veri Analizi.

Introduction

The Eurasian Economic Union was established with the treaty signed in 2014 Russia, Kazakhstan and Belarus the countries that left the Soviet Union. Later, Kyrgyzstan and Armenia joined the union (Denizci and Marangoz, 2019,414).The Eurasian Economic Union, consisting of 5 countries, is a gigantic organization, with a surface area of 183 million people and over 20 million square kilometers, making up 14 percent of the world's territory (<http://www.eurasiancommission.org/en/Pages/default.aspx>). Among the Union countries, especially Russia and Kazakhstan have an important place in the world in terms of having energy resources. In addition, these countries are the leading energy exporters. It is seen that achieving the sustainable economic growth target has two conditions. It's defined as growth rates starting with at least 2 %, lasts at least eight years and have an average growth rate above 3.5 %. In the Brundtlan¹, sustainability is defined as a process that will meet today's needs without compromising the capacity to meet the needs of future generations(Ay ve Karaçor, 2006, 79).

Union countries have to consume more energy for the continuity of economic growth and at the same time not to ignore the harm caused by the energy consumption. Therefore, it has to transfer some of the increase in welfare to controlling public institutions and precautions that saves ecological balance.

Figure 1. Environmental Kuznets Curve

Source : Yandle v.d. (2004)

The Environmental Kuznets Curve hypothesis (EKC) takes its name from the Kuznets curve theory put forward by Simon Kuznets in 1955. It is the adaptation of Simon Kuznets' theory that he describes the relationship between per capita income and inequality in income distribution, and the relationship between economic growth and carbon emissions. According to the theory; Since the energy required for economic growth is provided from primary energy sources, there is a linear relationship between economic growth and the release of environmentally harmful gases at the beginning. With the increase in per capita income, environmental awareness develops and environmental pollution decreases by implementing supervisory public norms to maintain ecological balance (Dinda, 2004, 432-434). In the literature it is generally symbolized as an inverted U or called as EKC . But it can also be shortened as U,N or an inverted N.

¹ Brundtlan Report: This is a report which was prepared in 1987 by the United Nations Environment Development Commission.

Literature Search**Table 1:** Literature Search

Author	Year	Period	Country	Method	Results
Zoundi	2017	1980-2012	25 African Countries	Panel Cointegration	The findings of the environmental Kuznets Curve hypothesis could not be reached. However, it has been determined that carbon dioxide emissions increase economic growth. It was also found that the use of renewable energy sources increased economic growth.
Danish v.d.	2017	1970-2012	Pakistan	ARDL	Strong evidence has been reached to prove the existence of EKH hypothesis in the related time in Pakistan.
Özokcu & Özdemir	2017	1980-2010	26 OECD Countries	Panel Data and Driscoll-Kraay Standart Errors	They found an inverse U-shaped relationship between economic development and environmental degradation. They also stated that economic development will not contribute to the solution of environmental problems.
Bozkurt & Okumuş	2015	1966-2011	Turkey	Hatemi-J Cointegration Test	A co-integration relationship was found between CO2 emission and economic growth, energy consumption, commercial openness rate and population density. As a result, It is found that EKH is valid for Turkey.
Mulali v.d.	2015	1981-2011	Vietnam	ARDL	They found that the Environmental Kuznets Curve hypothesis is not valid in Vietnam.
Apergis	2015	1990-2011	Asian Counties	Panel GMM	Bölge ülkelerinde Çevresel Kuznets Eğrisi hipotezinin geçerli ve ters U şeklinde olduğuna dair istatistiksel olarak anlamlı bulgulara ulaşılmıştır.
Koçak	2014	1960-2010	Turkey	ARDL Border Test	In the long term, it is found that energy consumption increases carbon dioxide emissions. However, the findings of the existence of the Environmental Kuznets Curve hypothesis could not be reached.
Farhani v.d.	2014	1990-2010	10 Middle East and North Africa Countries	Panel Data	They have found the validity of the EKC hypothesis in inverse U-Shape
Rawashdeh v.d.	2014	1960-2010	22 MENA Countries	Panel Data	They found that sulphur emissions of Environmental Kuznets Curve Hypothesis in Algeria, Tunisia, Yemen , Morocco , Turkey and Libya and carbon dioxide emissions in Turkey, Lebanon, Morocco and Tunisia are valid in terms of inverse u-shape model.
Arı & Zeren	2011	2000-2005	Mediterranean Countries	Panel Data	They found that the N-relationship between CO2 emission and per capita income would increase environmental pollution at high levels of economic growth. They also found that population density increases carbon dioxide emissions.
Saatçi & Yumrul	2011	1950-2007	Turkey	Cointegration Test	They extrapolate that there is an inverse U-shaped long-term relationship between environmental pollution and economic growth.
Fodha & Zaghdoud	2010	1961-2004	Tunisia	Error Recovery Model	Long-term co-integration between sulfur and carbon dioxide emissions and national income per capita has been found. EKC hypothesis is valid in inverse-u shape.
Perman & Stern	2003	1960-1990	74 Countries	Panel Data	They found a long-term and statistically significant relationship between sulfur emissions and economic growth. In addition, the Environmental Kuznets Curve hypothesis was found to be valid.

In the literature, there are many studies related to the EKC hypothesis. In these studies, the relationship between carbon and sulfur emissions and economic growth was examined. The EKC is usually symbolized as an inverse U-shape. However, there are also U, N and inverted N forms. In addition, EKC is declined in some of Koçak's studies in 2014 about Turkey between the years 1960 - 2010.

Analyses

In this study, the relationship between environmental degradation and economic growth for Eurasian Economic Union countries was investigated within the framework of Environmental Kuznets Curve Hypothesis. For that purpose,

* Belarus

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- * Kazakhstan
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- available data are examined for the period 1992-2014 in
- * Carbon emission per person (mt / person), (CO2_PC)
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 - * Energy use (ton oil equivalent / person), (Annex)
 - * Population density (km2 area / person), (PD)

Starting from the studies of Grossman and Krueger (1991), Shafik and Bandopadhyay (1992), polynomial regression model has been used in many applied studies on the Environmental Lambnet Curve Hypothesis. In general, polynomial regression can be shown as follows:

$$y_{it} = \alpha_i + \beta_1 x_{it} + \beta_2 x_{it}^2 + \beta_3 z_{it} + \varepsilon_{it}$$

This presentation symbol y_{it} , of the country, carbon emission per capita, symbol x_{it} , the national income per thousand people at the time, symbol x_{it}^2 , the square of the national income per thousand people at the time and symbol z_{it} , shows other variables that are thought to affect carbon emissions per capita at the time. In this study, it is thought that energy use and population density may affect carbon emission per capita.

- $\beta_1 > 0$ ve $\beta_2 < 0$, There is an inverse U-shaped relationship between x and y. In other words, the CEE hypothesis is valid and can be calculated by the turning point of the curve $-(\beta_1/2\beta_2)$.
- $\beta_1 < 0, \beta_2 > 0$, There is a U-shaped relationship in between x and y.

In this study, panel data model is used because it provides a wider data set compared to time series and cross-sectional models, provides more reliable predictions and advantages of controlling individual heterogeneity. In the panel data model to be established in order to investigate the Environmental Kuznet Curve Hypothesis, all series should be stationary. Panel unit root tests to be performed for this purpose differ depending on the presence of horizontal cross-section dependence in the model.

Therefore, first of all, whether the horizontal cross-sectional dependency exists in the model is determined by Friedman, Breusch Pagan, Pesaran 2004 and Pesaran 2008 tests and the results are given in Table 2.

Table 2: Cross Sectional Dependency Test

Test	coefficient	p-value
Friedman Cross-sectional Dependency	21.8700***	0.0002
Breush Pagan 1980 Cross-sectional	8.8380	0.5476
Pesaran 2004 Cross-sectional	1.3210	0.1865
Pesaran 2008 Cross-sectional	-1.5060	0.1320

* Must be in 90% confidence interval

** Must be in 95% confidence interval

*** Must be in 99% confidence interval

Table 2 shows the Cross-sectional Dependency Test results for the panel data model. As a result of Friedman test, the coefficient was calculated as 21.8700 and the p-value of this coefficient was calculated as 0.0002. Breush Pagan cross-sectional dependency test coefficient was calculated as 8.8380 and p-value was calculated as 0.5476, while Pesaran 2004 test coefficient was calculated as 1.3210 and p-value was calculated as 0.1865. Finally, Pesaran 2008 test coefficient was calculated

as -1.5060 and the p-value of this coefficient was calculated as 0.1320. Since the time dimension T is 23 in the panel data structure, and this time dimension is greater than the number of panel units, N, 5, the condition $T > N$ is provided. In this case, Breush Pagan cross-sectional dependence test gives more consistent results. As a result p value is greater than 0.05, there is no horizontal cross-sectional dependence

H_0 : No cross-section dependency

The null hypothesis was not rejected within the 95% confidence interval and it was concluded that the model had no horizontal cross-sectional dependence. One of the first generation tests considering horizontal cross-sectional dependence among panel unit root tests due to lack of horizontal cross-sectional dependence. Im, Pesaran and Shin panel unit root test (IPS) were applied to the dependent and independent variables in the model. The results are given in Table 3. Makale MS Office Word programında yazılmalıdır.

Table 3: IPS and Fisher Panel Unit Root Test

Coefficient	IPS	p-value
	test stats	
CO2_PC	-1.6133*	0.0533
GDP_PC	3.0870	0.9990
D_GDP_PC	-3.6093***	0.0002
GDP_PC2	4.2075	1.0000
D_GDP_PC2	-3.8308***	0.0001
EK	-2.3092**	0.0105
NY	-1.9907**	0.0233
CO2_PC	-1.6133*	0.0533

* Must be in 90% confidence interval

** Must be in 95% confidence interval

*** Must be in 99% confidence interval

In Table 3, Pesaran 2007 panel unit root test results applied to the dependent and independent variables used in the study are shown for the fixed model and the fixed and trendy model. Accordingly, the variables GDP_PC and GDP_PC2, which are among the variables used in the model, were found to be integrated in the first order. Therefore, the first order differences of these variables were taken (D_GDP_PC and D_GDP_PC2, respectively). The model suitable for the series was selected with the Hausman test. Hausman test results are given in Table 4.

Table 4: Hausman Test Result

Parameters	Coefficients		Difference
	SEM	REM	
D_GDP_PC	-0.3011	-0.4780	0.1769
D_GDP_PC2	0.0122	0.0600	-0.0477
EK	3.0012	2.5659	0.4353
NY	0.0433	-0.0172	0.0605

After the panel unit root tests related to the series used in the study, Hausman test was used to choose between fixed effects model and random effects model at the model building stage. For this purpose;

H_0 : Individual effects are random

H_a : Individual effects are constant

As a result, the null hypothesis was rejected at 99% confidence level since the relevant test statistic was calculated as -135.96 with a p-value of approximately 0. Therefore, constant effects model was used in the analysis.

The results of the fixed effect panel data model established in the study are given in Table 5.

Table 5: Panel Data Model Results

CO2_PC	Standart Model			Driscoll Kraay Standart Error		
	Coefficient	Std Error	p-value	Coefficient	Std. Error	p-value
D_GDP_PC	-0.3011	0.3322	0.3670	-0.3011	0.3214	0.3590
D_GDP_PC2	0.0122	0.0225	0.5890	0.0122	0.0177	0.4980
EK	3.0012***	0.0878	0.0000	3.0012***	0.1167	0.0000
NY	0.0433***	0.0139	0.0020	0.0433***	0.0152	0.0090
Constant	-2.5913***	0.6273	0.0000	-2.5913***	0.7722	0.0030
R ²	0.7827			0.9364		
F Test	371.9400***		0.0000	298.9000***		0.0000
Wald Testi	12916***		0.0000			
Wooldridge Testi	105.0510***		0.0005			
Pesaran CD Testi	0.9350		0.3500			

* Must be in 90% confidence interval

** Must be in 95% confidence interval

*** Must be in 99% confidence interval

Table 5 shows the results of the panel data model established for the study of the Environmental Kuznets Curve Hypothesis. In this context, panel data model results, which were first created with stationary variables, are stated as standard model. In this model, variance according to Wald test results and autocorrelation problems according to Wooldridge test results are shown in Table 5. Therefore, the solution of these problems was re-estimated by using the Driscoll Kraay standard defective model. Autocorrelation and changing variance problems were solved in the model. Both D_GDP_PC and D_GDP_PC2 were found to be statistically insignificant. For this reason, it was concluded that the Environmental Kuznet Curve hypothesis was not valid for the Eurasian countries in the period under consideration. On the other hand, energy use and population density variables used as control variables had a positive effect on carbon dioxide emissions.

As a result, as stated above, the basic condition for the validity of the Environmental Prediction Curve Hypothesis is to meet the conditions $\beta_1 > 0$ ve $\beta_2 < 0$. In other words, the coefficient of D_GDP_PC variable should be positive and significant and the coefficient of D_DGP_PC2 should be negative and significant. The corrected model results indicated in Table 4 do not meet these conditions. Therefore, it can be said that the Environmental Kuznet Curve Hypothesis is not valid for the period under consideration.

Conclusion

The Eurasian Economic Union was established in Astana on 29 May 2014 with the treaty signed between Russia, Kazakhstan and Belarus. Later, the union expanded with the participation of Armenia and Kyrgyzstan. The main purpose of the Union is to achieve full economic integration by increasing economic cooperation among the members.

Given that the main goal of countries is to achieve a higher level of welfare, it is an undeniable fact that, like all countries, union members have to produce more and consequently

consume more energy. However, the damages to ecological balance should not decrease the quality of life of future generations.

The relationship between economic growth and emissions of environmentally hazardous gases due to energy consumption is analyzed in the literature with the help of the Environmental Kuznets Curve hypothesis. In this study, the validity of the EKC hypothesis was investigated in the member countries of the Eurasian Economic Union between 1992-2014.

According to the results of the research, no statistically significant relationship was found between the carbon emissions and per capita national income in the Eurasian Economic Union member countries. Therefore, in the period between 1992 and 2014, the EKC hypothesis was rejected in the Eurasian Economic Union. In addition, according to the research results, it was concluded that population density and energy consumption increase carbon emissions in a positive way.

In the case of reducing the consumption of fossil fuels in the EU countries, increasing the use of renewable energy sources and developing environmental awareness in the society, carbon emissions will decrease, that helps us to have an ecological balance, sustainable economic growth.

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