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Does Maritime Transport Network Converge? Evidence From EU Countries

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ABSTRACT

The concept of convergence is an important issue that has gained a wide place in the economics literature. The convergence of economies is likely to have an impact on the transportation sector as well, since it is the most important supporter of economic activities, and it is directly affected by economic indicators due to its derived demand structure. However, the possible reflections of economic convergence in the transportation sector have not received sufficient attention in the literature. In this study, we investigated this issue in the European Union (EU) countries, where economic convergence is implemented as a union policy and the existence of convergence is empirically supported in many studies. We select Liner Shipping Connectivity Index (LSCI) as a variable, which indicates the countries' level of connectivity in the liner transportation network mostly used to transport intermediate and finished goods. We have determined that there is a convergence in EU countries in terms of maritime transportation network. This result shows that economic integration leads to improvements not only in the incomes of poorer countries but also in their transportation networks.

INTRODUCTION

Policy makers in European states are implementing policies aimed at reducing income inequalities between member states. To achieve this aim, they conduct practices such as liberalization in the trade of goods and services, facilitating the transfer of financial assets, facilitating the mobility of factors. Thus, they aimed that the poorer regions and countries catch up with the richer ones in terms of income and welfare (Yin et al., 2003). These policies have caused the differences between countries to decrease and the gap between low-income and high-income countries to close over time (Marelli et al., 2019). This situation is called "Convergence" in the literature.

Convergence is a concept that emerged from Solow's (1956) neoclassical growth model. According to this growth model, the income gap between high-income and low-income countries gets smaller over time. The main reason for this structure is shown as diminishing returns to scale. Although the term convergence was originally developed and used for economics, it has also been the subject of research questions in many different fields in the EU region. The subject of convergence in EU countries has been the subject of research in the literature on gross domestic product (GDP) per capita (e.g. Yin et al., 2003; Borsi & Metiu, 2013; Siljak, 2015; Cabral & Castellanos-Sosa, 2019), unemployment (e.g. Cuestas et al., 2015; Monfort et al., 2018), labor productivity (e.g. Doyle & O'Leary, 1999), trade (e.g. Jena & Barua, 2020), energy consumption (e.g. Markandya et al., 2006; Kounetas, 2018; Kasman & Kasman, 2020), CO_2 emissions (e.g. Jobert et al., 2010; Herrerias, 2012; Marrero et al., 2021), life satisfaction (e.g. Welsch & Bonn, 2008). These studies in the literature show that convergence can be

observed not only in the economic sense, but also in many other areas related to the economy.

As it is understood from the studies in the literature, it is possible to talk about an economic and financial convergence in EU countries, and this convergence is especially supported by policy makers. The liberalization of the circulation of goods also causes an increase in the flow rate and amount of these goods between countries. Here, it forms the need for the transportation of these goods to be conducted quickly and systematically. As commercial activities between countries increase and income converges, a similar effect is likely to be seen in the transportation sector, which has a derived demand structure. The main reason for such an effect can be shown as converging welfare levels and developing technology. As countries' level of well-being increases due to income convergence, people may tend to consume more goods, increasing the need and demand for transportation networks (Cowie, 2009). Additionally, thanks to the ongoing technological developments, the share of transportation costs in the final price of the product decreases due to the decrease in absolute transportation costs and increase in fleet productivity (Ma, 2020). This leads to an increase in the demand for the cheaper products and therefore the need for the transportation network. However, the literature mostly concentrates on economic and financial issues and is insufficient to examine the possible convergence issue in the transportation sector.

On the one hand, the transportation sector also differs according to the types of cargo. Because production centers are concentrated in certain centers of geography due to economic concerns, raw material transportation routes and ports are concentrated at certain points. However, since container transportation is used to transport intermediate and final products (OECD/EUIPO, 2021), it has spread in much more general regions, because it is used to deliver products that each individual may need to consume. On the other hand, in the economy, it is important not only to produce but also to ensure that these products are delivered to the relevant markets in a healthy way. Because transportation options make it possible to reach many more customers, and transportation costs affect the price of the final product, affecting the demand for that product. Additionally, in today's era, a global value chain is formed as many companies conduct their production in different countries. Production points are usually located in developing countries due to cost concerns (van Ham & Rijsenbrij, 2012). In this respect, container transportation makes great contributions to the formation of the global value chain as well (Greve et al., 2007). Therefore, the development of transport networks is an important requirement for sustainable economic development. In this study, we determined whether the connectivity of maritime container transport network, which is mostly used in the import and export of final products, converges among EU countries. For this purpose, by using the LSCI variable produced by the United Nations Conference on Trade and Development (UNCTAD), we determined whether transportation connectivity converges, whether economic integration has an effect on the transportation possibilities of countries, and whether the network capacities of countries with weak transportation networks and countries with strong transportation networks converge. As a result of the research, we found that the LSCI variable converges for EU countries and that economic integration also leads to improvement in the transport networks of countries with weak transport possibilities.

In the second section of the study, the method we used for testing the convergence is presented. Additionally, the LSCI variable that we used in the analysis and the descriptive statistics of the index values of the countries are introduced. In the third section, results of the necessary pre-tests for selecting the generation of panel unit root test and the implemented unit root test are presented. In the last section, the results are discussed, and the conclusions are made.

METHODOLOGY AND DATA

The convergence approach can be examined in two types as traditional and stochastic. Stochastic convergence can be analyzed with unit root tests. If it is desired to measure the convergence between two countries, univariate unit root tests are sufficient. However, if convergence is to be analyzed for more countries and regions, panel unit root tests are preferred (Naveed, 2017).

When analyzing the convergence with the panel unit root, it is assumed that there is a steady state for each unit. According to this approach, deviations of units from their long run steady state values should be temporary. The fact that shocks are temporary requires that the values of the units do not contain a unit root and be stationary. Here, the values of the units converge to each other in the long run. On the other hand, if the deviations from the steady state values are permanent, then the values of the units diverge from each other (Guetat & Serranito, 2007). Based on these assumptions and by using panel unit root tests, we tested whether the connectivity values of the container transportation network of the countries in the EU region converge. If the series do not contain a unit root and are stationary, it is concluded that the LSCI values converge. In the opposite case, it is concluded that the LSCI values diverge.

In panel unit root analysis, cross-sectional dependence and homogeneity in the series should be considered. To test

the cross-sectional dependence, we used LM test (Breusch & Pagan, 1980), CD and CDLM test (Pesaran, 2004) and LM adjusted test (Pesaran et al., 2008). To test homogeneity, we used Delta Tilde and Delta Tilde adjusted (Pesaran & Yamagata (2008) tests. Since we detected cross-sectional dependence in our series, according to the results of this analysis, we preferred to use Bootstrap IPS (Smith et al., 2004) and Bootstrap Hadri tests, which are robust unit root tests in case of cross-sectional dependence.

Bootstrap IPS (Smith et al., 2004) test is an improved version of the IPS test (Im et al., 2003) and Bootstrap Hadri test is improved version of the Hadri test (Hadri, 2000). On the one hand, the Bootstrap IPS (Smith et al., 2004) test is a unit root test, and its null hypothesis is that the series contains a unit root. On the other hand, the Bootstrap Hadri test is the stationarity test, and the null hypothesis is that the series is stationary. We applied the Bootstrap IPS test as the primary test and the Bootstrap Hadri test as the supporting test.

We chose the LSCI variable to represent transport networks for two reasons. First, due to the market structure, container ships regularly follow certain routes. This specification provides a regular and dynamic indicator for the countries visited by the ships. For bulk cargoes, route distribution and cargo volumes are generally irregular, as tramp shipping is generally used. Second, a more comprehensive situation arises as the final products are transported in container transportation and there is a demand for these products from every country. However, the traffic of bulk cargoes is concentrated only in certain production centers. For these reasons, we thought that the effects of economic convergence in countries could be seen more clearly in container transportation network.

Our dataset consists of Liner Shipping Connectivity Index (LSCI) scores of 22 EU countries. The LSCI developed by UNCTAD has six components that form the index which are "(i) the number of scheduled ship calls per week in the country; (ii) deployed TEU capacity offered at the country; (iii) the number of regular liner shipping services from and to the country; (iv) the number of liner shipping companies that provide services from and to the country; (v) the average size in TEU of the ships deployed by the scheduled service with the largest average vessel size; and (vi) the number of other countries that are connected to the country through direct liner shipping services". The index was determined as 100 for China in 2006 and the calculations of other countries are made based on China (UNCTAD, 2020a). The fact that the index has been published since 2006 causes our data to remain short, but it is hoped that this situation may not be a major obstacle in terms of analysis.

Table 1. Descriptive statistics of panel dataset

Country	Mean	Median	Max	Min.	Std. Dev.	Skew.	Kurt.	Obs.
Belgium	81.18	79.85	89.50	72.49	4.62	0.02	1.92	61
Bulgaria	7.48	6.94	16.56	5.27	2.34	2.76	10.95	61
Croatia	21.89	19.84	34.26	7.96	7.87	0.12	1.78	61
Cyprus	17.03	17.33	20.20	12.28	1.61	-0.90	4.22	61
Denmark	37.36	42.74	47.76	21.72	9.30	-0.48	1.54	61
Estonia	8.26	8.22	12.41	6.00	1.52	0.74	3.07	61
Finland	14.71	14.70	18.75	12.75	1.31	0.86	3.73	61
France	66.55	67.66	79.29	56.83	6.93	0.08	1.60	61
Germany	81.85	82.45	85.53	76.07	2.39	-0.43	2.05	61
Greece	41.93	41.19	60.31	25.00	10.96	0.38	2.03	61
Ireland	11.45	11.52	14.12	7.68	1.59	-0.56	3.16	61
Italy	63.36	62.89	77.14	54.19	5.22	0.62	3.45	61
Latvia	7.87	7.57	10.81	5.72	1.23	1.07	3.49	61
Lithuania	12.69	11.68	30.78	5.61	4.70	1.44	5.70	61
Malta	41.22	42.82	56.57	26.59	7.57	-0.26	1.94	61
Netherlands	82.19	81.25	92.16	71.35	5.08	0.29	2.50	61
Poland	35.17	43.61	56.67	8.88	16.49	-0.55	1.79	61
Portugal	43.01	44.38	59.91	26.42	8.17	-0.33	3.26	61
Romania	22.79	22.79	27.65	15.99	3.30	-0.30	1.74	61
Slovenia	23.74	21.47	35.47	12.50	7.28	0.25	1.67	61
Spain	77.78	75.43	89.97	65.45	6.81	0.28	1.71	61
Sweden	40.38	41.86	51.77	26.85	8.52	-0.34	1.49	61
All	38.18	30.68	92.16	5.27	26.63	0.49	1.85	1342

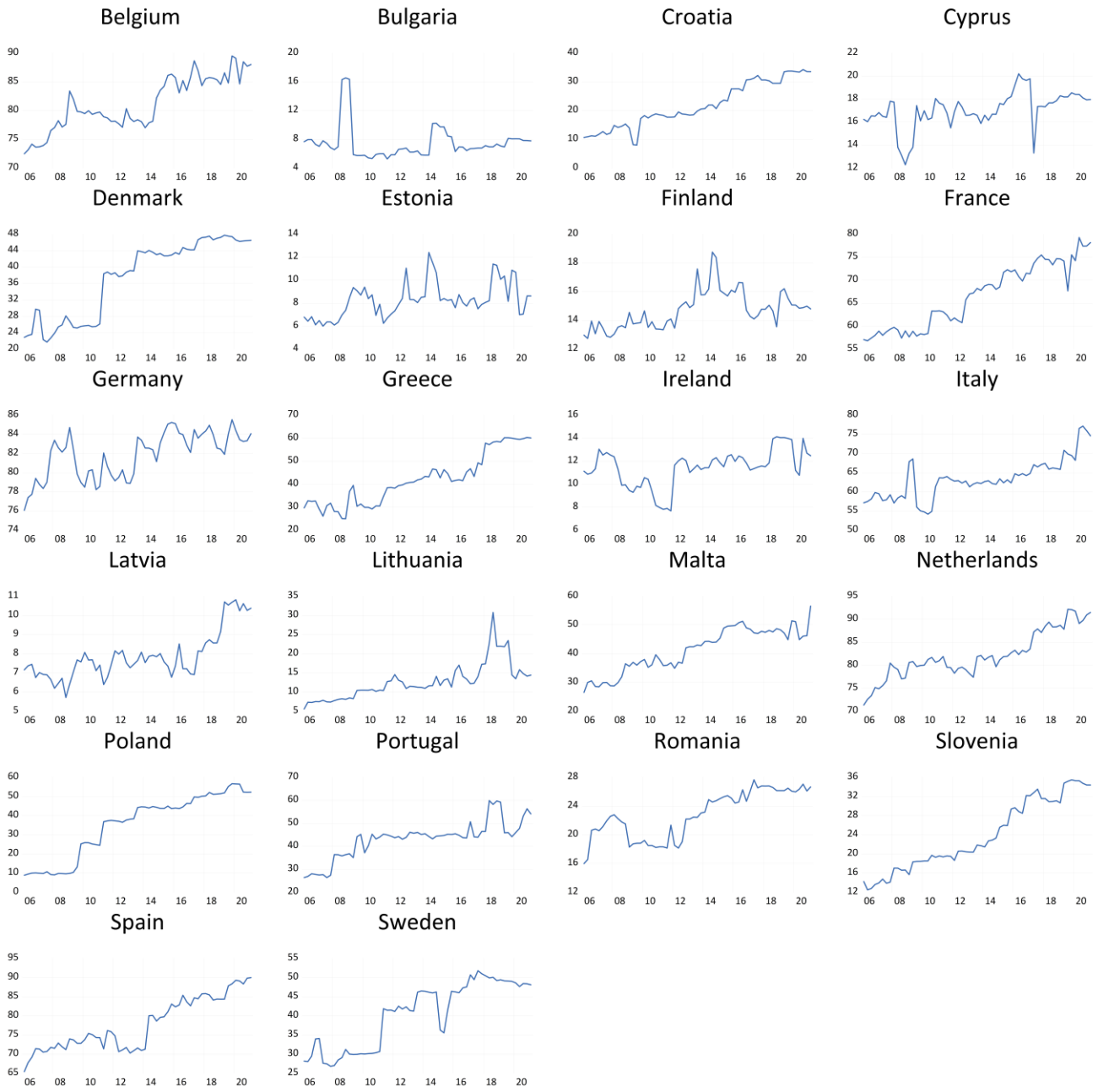

Figure 1. Graphical display of variables

Liner Shipping Connectivity Index values are obtained from UNCTAD (2020b). The dataset covers the period between the first quarter of 2006 and the first quarter of 2021. The included EU countries are Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, and Sweden. Since their LSCI values do not exist, Austria, Czechia, Hungary, Luxembourg, and Slovakia cannot be included in the sample. Therefore, the EU panel sample includes LSCI of 22 countries and consists of 1342 (22×61) observations. Descriptive statistics for each country included in the sample are presented in Table 1. When the mean values are examined, the countries with the highest LSCI values are the Netherlands (82.19), Germany (81.85), Belgium (81.18) and Spain (77.78), respectively. The countries with the lowest values are Bulgaria (7.48), Latvia (7.87), Estonia (8.26) and Ireland (11.45), respectively. The standard deviation values provide information about the size of the deviations in the LSCI values in the relevant countries. Considering the factors that make up the content of the LSCI variable, it can be said that there are great changes in the number of ships calling in the country, the number of companies providing regular line service and the average ship size calling into the country. These deviations may be caused by business strategies, political factors, and trends in global trade. While some

countries have positive changes, some countries have experienced negative changes. The graphs of the index values of the countries are presented in Figure 1.

In the next section, cross-sectional dependency and homogeneity tests were applied for a unit root selection to EU countries using the LSCI index. Then, appropriate unit root tests were selected and applied.

RESULTS

To select the most appropriate panel unit root test for the data set, the series should be examined in terms of cross-sectional dependence and homogeneity. LM test (Breusch & Pagan, 1980), CD and CDLM test (Pesaran, 2004) and LM adjusted test (Pesaran et al., 2008) were applied to the series by using GAUSS 19 to evaluate cross-sectional dependence and the results are presented in Table 2 for the EU countries. 6 lags were selected for the analysis since the sample was quarterly. LM, CD and LM adjusted tests can be used in the case of T>N and according to the applied cross-sectional dependency test results, null of no cross-sectional dependence hypothesis is rejected by all tests. The table also includes homogeneity test results conducted by Delta Tilde and Delta Tilde adjusted tests. The results show that the null of homogeneity is rejected for the EU countries. According to these results, it has been revealed that the use of second-generation unit root and stationarity tests is more appropriate for the EU sample.

Table 2. Cross sectional dependence and homogeneity test results

Test	Stat	Prob
LM (Breusch & Pagan, 1980)	418.649	0.000*
CDlm (Pesaran, 2004)	8.730	0.000*
CD (Pesaran, 2004)	-2.943	0.002*
LMadj (PUY, 2008)	7.204	0.000*
Delta Tilde	4.909	0.000*
Delta Tilde Adjusted	5.039	0.000*

Note: * indicates that H_0 is rejected

Considering the heterogeneity and cross-sectional dependency in the structure of the data set, it has been determined that the application of second-generation unit root tests is necessary. We applied the Bootstrap IPS test as the primary test and the Bootstrap Hadri test as the supporting test. In the application of the tests, quadratic spectral was selected as variance estimator, maximum lags were selected as 6, block size was selected as 50 and number of bootstrap simulations was selected as 1000. In this direction, tests were applied by using GAUSS 19, and the results are presented in Table 3. The null hypothesis of the Bootstrap Hadri stationarity test is that the series is stationary. According to the results obtained, the null hypothesis could not be rejected in trend & intercept. This result shows that the variable is stationary. On the other hand, the null hypothesis of the Bootstrap IPS unit root test is that the series contains a unit root. According to the results obtained, the null hypothesis is rejected at the 10% confidence level in the intercept and at the 1% confidence level in the trend & intercept. The results obtained from both tests show that the series is stationary and does not contain unit root.

According to the analysis results, the LSCI variable converges for EU countries. The deviations in the long run steady state index values of the countries are temporary and the values tend to return to their average in the long run.

DISCUSSION AND CONCLUSION

The relationship between the transportation sector and the economy can be explained by the supply-led growth and demand-led growth models. According to the supply-led growth model, improving transportation infrastructures and increasing investments to these structures increase commercial activities and support economic development in the relevant regions. There are always potentials for supply and demand for various goods in any part of the world. However, in addition to marketing activities, transportation opportunities and costs are important obstacles for these goods to reach the relevant places. By providing the necessary investment and infrastructure opportunities, these obstacles can be removed, and commercial activities can be realized. In this context, the developments in the LSCI variable also affect the transportation costs negatively (Fugazza & Hoffmann, 2017) and contribute positively to exports (Şeker, 2019). According to the demand-led growth model, there is a demand for certain goods first and as a result of this demand, transportation infrastructure and investments are needed. This situation leads to an increase in investments in the transportation sector and facilitating commercial activities. Whatever the direction, supply or demand led, there is a very close relationship between transportation possibilities and economic activities. Situations such as increasing commercial activities and facilitating the mobility of capital and production factors cause the gap between economically poor countries and rich ones to decrease over time. In this way, the distribution of income and welfare is balanced, and the countries converge to each other. This convergence can be seen more clearly in regions with high integration, such as the European Union. In addition, economic integration is implemented as a policy in such regions. As a result, there is economic convergence in the European Union countries, both politically and empirically. In economic terms, this convergence is likely to show its effects in the transportation sector, which is the most

Table 3. Results of stationarity and unit root tests

Tests		Intercept	Trend and Intercept
Bootstrap Hadri	Panel – Z	14.578	4.254***
	Bootstrap CV. 10%	4.114	2.337
	Bootstrap CV. 5%	6.080	3.126
	Bootstrap CV. 1%	10.844	4.738
Bootstrap IPS	t-bar statistic	-1.761*	-2.827***
	p-value for t-bar	0.097	0.000

Note: *** indicates acceptance at 99% for Bootstrap Hadri and rejection at 1% for Bootstrap IPS; * indicates rejection at 10% for Bootstrap IPS.

important factor supporting commercial activities. Because as the welfare level of economically poor countries increases, their demand for goods will also increase, which will require the development of the transportation networks that the country needs. Thus, a convergence in transport networks is likely to be observed.

We chose container shipping to measure the convergence of transport networks. The first reason for this selection is that mostly final and high value-added goods are transported with this mode of transport. As the transport of raw materials will be around certain production centers, convergence may be somewhat more difficult to observe. Because final products are demanded by all people, while raw materials are demanded only by industrial production centers. The second reason is related to data availability. Since raw material transportation is mostly conducted on irregular lines and under perfectly competitive market conditions, there is no regular indicator of transport network of every country. However, since container transportation is generally monopolistic and oligopolistic, there are regular voyages to countries. In addition, the demand for cargoes also requires regular transport activities because there are many cargo owners on a single ship. Therefore, considering the LSCI variable, we analyzed whether the liner shipping connectivity in EU countries converged.

As a result of the analysis in which we measured stochastic convergence using panel unit root tests, we determined that the panel data set did not contain a unit root, was stationary, and thus the series converged. Additionally, according to the results of the cross-sectional dependence test, we found that there is a dependency in the dataset and that the shocks (changes) in the LSCI value of a country also affect other countries. Considering the integrated structure of the European Union, it is clear that this result is quite normal. The convergence of LSCI values may also be related to the increasing welfare levels of the countries. As the welfare levels of economically converging countries increase, their demand for goods also increases. Since the transport sector also has a derived demand structure, convergence in the economy also affects transport networks. This situation causes convergence in terms of connectivity in the transportation sector. The gap between countries with weak transport network and countries with strong transport network is decreasing over time. This situation emerges because of both EU policies and the globalizing world. Additionally, increased efficiency and technological development in the fleets for various reasons over time have led to a decrease in absolute transportation costs. This reduction has encouraged trade and increased the number of stakeholders interested in commercial activities, which has consequently resulted in a convergence in transportation networks. In conclusion, our findings show that the process of economic integration not only contributes to the economic income of poor countries but also leads to improvements in their transport networks. Here, strategic partnerships to be established between countries by considering the strong sides of them contribute to collective development.

As a result, the fact that the subject of examining the transportation sector in terms of convergence in the literature does not attract the attention of enough researchers has formed our motivation. By choosing an economically, politically and geographically integrated region such as the EU, we identified the similar impact of economic convergence on transport. We made an original contribution by finding that, in addition to the convergences in GDP, unemployment, and trade determined in the literature, there is also convergence in the liner shipping transport. In future studies, the issue of convergence in transportation can be examined in terms of different regions. For countries with similar characteristics in various profiles, the subject can be discussed again.

Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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