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Examining the Cointegration Relationship Between the Container Trade in the Mediterranean and the Level of Labor Force Participation: A Panel Data Study

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Abstract

Today, container transportation and intermodal connections by sea contribute significantly to the economic activities and trade volume of the nation and region where the transportation is conducted. This study evaluates the volume of containers handled between 2000 and 2020 in the ports of Türkiye, Greece, Italy, and Spain in the Mediterranean Basin, as well as the labor force, and determines whether the two variables are co-integrated. The Organization for Economic Co-operation and Development provided information on the volume of containers handled in TEUs, and the World Bank provided information on the labor force. Two variables were tested for cross-sectional dependency, homogeneity, second-generation panel unit root, panel cointegration, and causality. Although a long-term relationship between the two variables could not be determined as a result of the analysis, it was determined that the two variables were Granger causes of each other and had a bidirectional causality relationship. In this context, it is evident that both data substantially impact one another. The results indicate that the maritime sector responds to changes in a country's economy and trade volume through a short-term decrease or increase in capacity.

Keywords: Maritime transportation, Container trade, Labor force participation, Cointegration

1. Introduction

Maritime transport is a mode of transport that, when combined with other modes of transport, allows for large amounts of cargo to be transported over long distances at a low cost. Because waterways carry a large portion of global trade, maritime transport is the backbone of the global economy and trade. Furthermore, it plays a significant role in global logistics activities and is directly affected by economic growth and global trade developments.

Container transportation, which plays an important role in maritime, has grown in popularity as global trade has improved. Container transportation and related logistics services, in addition to being a part of the supply chain, contribute to the socioeconomic development of countries and serve as an indicator in the evaluation of economic size. By regional and international container routes, the Mediterranean is an important region, and ports compete for a larger share of container shipping. The purpose of this research is to determine whether there is cointegration between the volume of containers handled in the ports of Türkiye, Greece, Italy, and Spain, which compete with each other in the Mediterranean container trade, and the level of the labor force in these countries, and to make a result-oriented situation assessment.

When the economic effects of container transportation are considered, it is believed that there is a directly proportional relationship between the change in the volume of containers handled in a country's ports and its labor force. Although there have been many studies on the relationship between container transportation and trade volume, economic activities, and country sizes, there has only been one study on the relationship between the change in the volume of

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containers handled at ports and the labor force. Bottasso et al. [1] discovered a positive relationship between regional employment and port volume using panel data analysis in their study. Furthermore, we have not encountered a study in which Türkiye was also evaluated in the literature. Therefore, panel data analysis is used in this context to assess the impact of the volume of containers handled in the ports of Türkiye, Greece, Italy, and Spain on the labor force in these countries.

Container transportation is one of the factors reshaping the port and maritime industries [2,3]. The integration of logistics modes and positive trade developments increase the volume of container transportation, which provides global intermodal transportation. As a result, the supply chain's functionality of ports, which are key points of global container transportation, improves. The increased use of containers in international trade has allowed ports to improve their infrastructure and superstructure for container handling [4,5]. As a result, container terminal volume and capacity have increased, particularly in ports with integrated systems, and storage and distribution services have improved. Container transportation and port operations are now regarded as important indicators in assessing international trade and a country's economic size, as well as being a component of the transportation system [6,7].

The Mediterranean Sea and its countries play an important role in maritime trade. The Mediterranean Sea is a maritime area served by regional and international routes in world container transportation. Furthermore, the region's container transportation volume is constantly increasing, contributing to socioeconomic development [8]. In particular, ports in the Eastern and Central Mediterranean compete for a larger share of container transportation. In this context, Türkiye emphasizes its practices to lower logistics costs, shorten transit transportation times, increase the rate of undamaged delivery, and increase speed and reliability [9]. Based on the competition in the region, a study will be conducted to reveal and emphasize the importance of the Mediterranean in global container transportation. The goal of this study is to see if there is a cointegration between the two variables based on the volume of containers handled in the ports of Türkiye, Greece, Italy, and Spain, which compete in the Mediterranean container trade, and the labor force in these countries between 2000 and 2020. The study begins by assessing the effects of container transportation on trade and the economy. Second, the relationship between the volume of containers handled and the labor force in the countries studied is examined. Finally, a situation assessment for the subject of the study is performed, and recommendations are presented.

2. Literature Review

The development of container transportation has resulted in a shift in maritime freight transportation. General and special cargoes are thus delivered more quickly, safely, and securely to their destinations [10]. Furthermore, intermodal freight movements between ships, trains, and trucks increase carrying capacity [4].

Container transportation comprises three basic components: cargo, carrier, and port. Adding a new container terminal to the schedule of a container carrier is a factor that accelerates commercial development in the destination area [11]. Port service capacity grows with cargo and ship traffic [12]. Increased performance in container ports improves production efficiency, including labor and capital [13]. On the other hand, the decrease in cargo volume during crisis periods reduces port transaction volumes and, thus, the countries' growth rates [14].

Several studies have been conducted on the relationship between container transportation and countries' trade volume, size, and economic activity. According to Luo and Grigalunas [15], the importance of a well-planned container port on intermodal transportation costs and its economic impact on the markets served is significant. According to Hall [16], large ports serve producers and consumers in a broad hinterland, which impacts the employment structure in ports and port-related sectors. Using panel data analysis, Bottasso et al. [1] discovered a positive relationship between regional employment and port transaction volume in their study. Takım and Ersungur [17] emphasized the significance of container volume handled at ports in Türkiye's foreign trade. Ünver [18] used unbalanced panel data analysis to reveal the effect of maritime transport connectivity on the export level of economies. In their study on the foreign trade volume by transportation type in Türkiye, Emirkadı and Balcı [19] mentioned the importance of container transportation. According to Hlali and Hammami's [20] research, container port development provides economic development for all modes of transportation. According to Özer et al. [21], maritime container transportation has a positive and statistically significant effect on short- and long-term economic growth. Using the panel vector autoregressive approach, Michael et al. [6] demonstrated that container trade is an important determinant of GDP growth. Dördüncü's [22] study used the Toda-Yamamoto causality analysis to test the interaction between the amount of export and container transportation and discovered that changes in exports affected the volume of containers handled and the number of TEUs. Using a panel data regression model, Fartila-Adam et al. [23] discovered that maritime transport, air pollutants caused by maritime transport, and investment in port infrastructure are positively related

to economic growth. Tunalı and Akarçay [24] used panel cointegration analysis to examine the relationship between the GDP growth of container transportation and port infrastructure investments and concluded that container transportation and port infrastructure investments had a positive effect on economic growth (Table 1).

When the economic effects of container transportation are considered, it is believed that there is a positive relationship between the change in the volume of containers handled at a country's ports and its labor force. However, only one study on the relationship between the change in the volume of containers handled at ports and the labor force was found in the literature review. However, we have not found a study in which Türkiye was evaluated. In this regard, panel data analysis is used to assess the impact of the volume of containers handled in the ports of Türkiye, Greece, Italy, and Spain on the workforce in these countries.

3. Methodology

Panel data analysis was used in this study to determine whether there is a cointegration between the volume of containers handled in the Mediterranean Basin container trade in Türkiye, Greece, Italy, and Spain between 2000 and 2020.

The study of cross-sectional units over time is referred to as panel data analysis [25]. A cross-sectional data set in this framework consists of observations on a specific number of variables at a specific time [26]. Panel data is used to gather information about multiple units in a time series [27]. Panel datasets are comprised of individuals and time series; in this context, issues like stationarity vs. non-stationarity and causality vs. non-causality of time series econometrics arise [28]. The superior aspects of the analysis enable the control and measurement of distinct properties of the same units. More comprehensive studies can be conducted because it combines cross-sectional and time series data [25,29,30].

To achieve the study's goal, data on the volume of containers handled in TEUs between 2000 and 2020 were obtained from the Organization for Economic Co-operation and Development (OECD) [31], and data on the associated labor force were obtained from World Bank (WB) [32] websites. For the study, the following hypotheses were developed.

H1: There is a cointegration relationship between the volume of containers transported by sea and the total labor force employed.

H2: The volume of containers transported by sea and the total labor force are the Granger causes of each other.

The Stata and EViews software packages were used to test the hypotheses. EViews is a statistical package program for Windows that is primarily used for econometric testing and analysis. It statistically analyzes the relationships between variables and allows for analyses with cross-sectional data, time series data, and panel data to make predictions and future predictions [33]. The Stata program facilitates and accelerates statistical analysis when working with large and complex quantitative data sets with varying file structures. It is used to cluster statistically significant data obtained after panel data analysis [34]. Similarly, Stata is a software package that includes statistical and econometric testing and analysis, as well as data science, visualization, and extensible reporting. While EViews and Stata are capable of general statistical analysis, their primary applications

Table 1. *Some research on the relationship between container transportation and trade volume, economic activities, and sizes of countries*

Author	Year	Data	Method
Bottasso et al. [1]	2013	Statistical Data	GMM-System Estimator
Yıldırım et al. [48]	2013	Statistical Data	Standard and Multiple Break Unit Root
Alper and Oransay [39]	2015	Statistical Data	Panel Causality Analysis
Ünver [18]	2016	Statistical Data	Unbalanced Panel Data Analysis
Kar et al. [44]	2018	Statistical Data	Panel Cointegration Analysis
Turgut and Uçan [43]	2019	Statistical Data	Panel Data Analysis
Çelik and Ünsür [30]	2020	Statistical Data	Panel Causality Analysis
Demir and Görür [27]	2020	Statistical Data	Panel Cointegration Analysis
Okşak and Sarıtaş [25]	2020	Statistical Data	Panel Data Analysis
Özer et al. [21]	2021	Statistical Data	Autoregressive Distributed Lag
Dördüncü [22]	2021	Statistical Data	Toda-Yamamoto Causality Analysis
Fartila-Adam et al. [23]	2021	Statistical Data	Panel Data Regression Analysis
Michael et al. [6]	2021	Statistical Data	Panel Vector Autoregressive
Tunalı and Akarçay [24]	2022	Statistical Data	Panel Cointegration Analysis

are regression and econometric analysis. EViews and Stata, both of which support Excel and SPSS program types, can test panel data, time series, and cross-sectional analysis. The hypotheses were tested using the Westerlund panel cointegration test [35] and the Dumitrescu and Hurlin [36] causality test. The Granger test is one of the most commonly used causality tests in the literature. According to Clive Granger's analysis in his 1969 study titled "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," if the variable y is predicted better when the variable x is used than when it is not used, the variable x causes y [37]. The Westerlund test was used because it accounts for structural breaks and cross-sectional dependence. Because it is an adapted version of the Granger-causality test for heterogeneous panel data analysis, the Dumitrescu and Hurlin [36] test was chosen [38]. This method considers the panel's cross-sectional dependence and heterogeneity; it can also be used when the time dimension is larger or smaller than the cross-sectional dimension, producing effective results in unbalanced panel data sets [39].

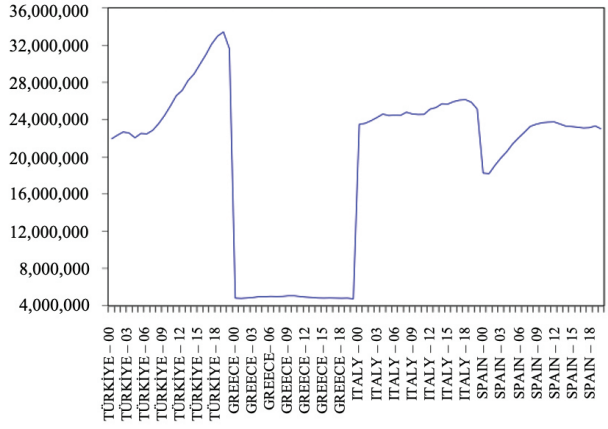
Figure 1 depicts the level graphs of the series concerning the total labor force by country and the volume of containers handled in TEUs of the countries in the analysis.

4. Findings and Discussion

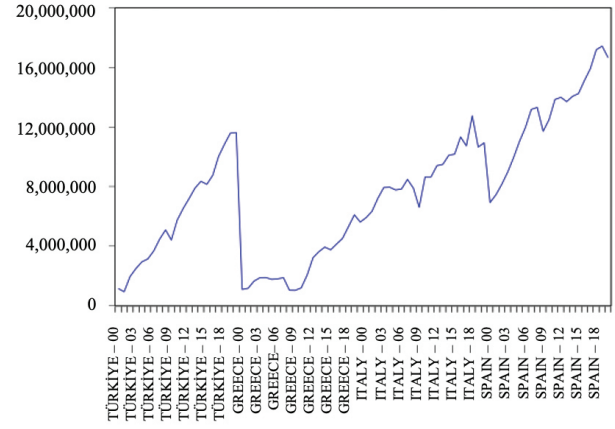
4.1. Cross-Sectional Dependency Test Results

In cross-sectional dependency analysis, various tests can be used. Before testing the cointegration relationship between the series in econometrics, the Breusch and Pagan [40] LM (lagrange multiplier) test, Pesaran [41] CD and CD-LM (cross sectional dependent-lagrange multiplier) tests and Pesaran et al. [42] deviating corrected horizontal cross-sectional tests are used to determine whether there is an dependence between the horizontal sections that comprise the panel. Breusch and Pagan [40] uses the LM test when the time dimension is greater than the cross-sectional dimension (T>N), and Pesaran [41] uses the CD test when both the time dimension and the cross-sectional dimension are greater than the time dimension (T>N, N>T). Unfortunately, these tests are biased when the group mean is zero, but the individual mean is not zero. Pesaran et al. [42] corrected this error by incorporating the variance and mean into the test statistic. As a result, it is known as the deviation-corrected LM test.

The Breusch and Pagan [40] test is used in this framework because the panel's time dimension is greater than its cross-sectional dimension [43]. Table 2 displays the



Regarding Total Number of Labor Force by Countries Series Level Chart



Level Graph of the Series Regarding the Amount of Containers Handled in TEUs by Country

Figure 1. *Time graph of variables*

Table 2. *Container volume-horizontal sectional dependency test results*

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	102.7159	6	0.0000
Pesaran scaled LM	27.91948		0.0000
Bias-corrected scaled LM	27.81948		0.0000
Pesaran CD	10.12359		0.0000

cross-sectional dependency test results for the volume of containers handled at the ports of Türkiye, Greece, Italy, and Spain, which are the subject of the study. As a result, the null hypothesis in the Breusch and Pagan [40] LM cross-sectional dependency test is "there is no cross-sectional dependency," and the null hypothesis is rejected at the 5% significance level when the probability value for all test statistics obtained for the volume of containers handled variable in TEUs of countries is examined. As a result, there is a cross-sectional dependency in the variable related to the volume of containers handled in the panel's units. In this framework, panel unit root test and panel cointegration tests, which are used in cases of cross-sectional dependence, were used for further study.

Another variable in Table 3, the null hypothesis of "there is no cross-sectional dependence" for the labor force in the total population, is also rejected at the 5% significance level. There is a cross-sectional dependency in this variable, as in the variable related to the volume of containers handled. Therefore, due to the cross-sectional dependency, second-generation panel unit root and panel cointegration tests were applied to the variable of "the labor force in the total population" in subsequent sections of the study.

4.2. Homogeneity Test Results

The homogeneity test determines whether any of the selected countries are affected at the same level by changes in the "volume of containers handled" and the other variable, "the labor force," as Türkiye, Greece, Italy, and Spain. The economic situation of the countries is critical in this case. If the economic conditions of the countries differ, the coefficients within the framework of the model are expected to be heterogeneous. The coefficients should be homogeneous if the countries' economic conditions are similar [43,44]. For the homogeneity test, the Hsiao multivariate Granger-causality test was used [45]. As a result, there may be direct, indirect, and two types of illusory correlations between the x and y variables [46]. The Hsiao test is based on three different hypotheses, H1, H2, and H3. According to these assumptions, the H1 hypothesis asserts that the coefficients are homogeneous, whereas the alternative hypothesis asserts that they are heterogeneous. The H2 hypothesis, on the other hand, is identical to the H1 hypothesis in that it defends homogeneity while claiming that its alternative is heterogeneous. However, unlike other hypotheses, the H3 hypothesis assumes that its alternative is partially heterogeneous [43].

Table 4 shows the homogeneity test hypotheses and results for the volume of containers handled in the study and the labor force in the total population.

Table 4 shows that Hsiao, based on homogeneity, was rejected at the 1% and 5% significance levels in all three hypotheses. The H1 and H2 hypotheses are rejected because the p-values are less than 0.05, and the alternative hypothesis, heterogeneity, is accepted. Furthermore, partial heterogeneity is accepted because the p-value for partial homogeneity, which is the H3 hypothesis, is less than 0.05. It is concluded in this context that the coefficients are heterogeneous.

4.3. Second Generation Panel Unit Root Test Results

When determining cross-sectional independence in panel data analysis, first-generation unit root tests can be used, but second-generation panel unit root tests produce more accurate results, as shown in Table 4, due to the cross-sectional dependence in this study's data. Furthermore, due to globalization, country import and export volumes have increased by all modes of transportation, particularly

Table 3. *Number of labor force in the total population-horizontal sectional dependency test results*

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	45.86068	6	0.0000
Pesaran scaled LM	11.50679		0.0000
Bias-corrected scaled LM	11.40679		0.0000
Pesaran CD	3.283967		0.0010

Table 4. *Homogeneity test results*

Hypotheses	F-Stat	p-value
H1	1899.984	1.22E-80
H2	38.98734	2.31E-15
H3	1539.772	5.83E-70
H1: p=1.22E-80 <0.05 Heterogeneous H2: p=2.31E-15 <0.05 Heterogeneous H3: 2.31E-15 <0.05 Partially heterogeneous		

by sea between countries and continents and by combined transportation. As a result, the reliance on the horizontal sections that comprise the panel must be considered. Therefore, the CADF (cross-sectional augmented Dickey-Fuller) test, a second-generation panel unit root test developed by Pesaran [47], was used. This test takes into account the series' cross-sectional dependence [48].

The unit root test shown in Table 5 was performed at a level and constant for each series, and the results showed that the variables were stationary. Next, the cointegration test was used to examine the long-term relationship after determining that the variables are stationary.

4.4. Westerlund Panel Cointegration Test Results

Because of the cross-sectional dependence, the Westerlund panel cointegration test was used to test the cointegration between the variables, and the results are shown in Table 6.

According to the Robuts p-values in Table 6, there is no long-term relationship between the variables related to the volume of containers and the level of individual labor force participation in the total population because the null hypothesis of "no cointegration relationship" could not be rejected at the 1%, 5%, and 10% significance levels for all group and panel statistics. Therefore, it was determined that no equilibrium relationship existed.

4.5. Panel Causality Test Results

Because there was no cointegration relationship between the variables, the Dumitrescu-Hurlin causality test was used to determine whether there was a short-term causality relationship between them. As shown in Table 7, the delta homogeneity test was used as a secondary homogeneity test for this purpose [42].

The delta homogeneity test's significance is rejected at the 5% level, and the units are heterogeneous. Therefore, the Dumitrescu and Hurlin [36] causality test, as shown in Table 8, can be used in this case.

According to the results in Table 8, the volume of containers is the Granger cause of the labor force, and the labor force is the Granger cause of the volume of containers. As a result, bidirectional causality exists. Therefore, the result can be expressed as "volume of containers ↔ level of labor

Table 5. *Pesaran CADF second-generation panel unit root test results for volume of containers variable*

	t-bar	cv10	cv5	cv1
Container volume - 1st difference	2.610	-2.210	-2.340	-2.600
Number of labor force - 1st difference	2.610	-2.210	-2.330	-2.570
Container volume-level	2.610	-2.210	-2.330	-2.570
Number of labor force-level	2.610	-2.210	-2.330	-2.570

Table 6. *Westerlund panel cointegration test results*

Statistic	Value	Z value	p-value	Robust p-value
Gt	-0.916	0.116	0.546	0.480
Ga	-1.911	0.832	0.797	0.630
Pt	-1.810	0.676	0.250	0.400
Pa	-1.885	0.593	0.277	0.360
Note: The Bootstrap loop is 400 pieces. Latency and leading are set as 1				

Table 7. *Delta homogeneity test*

Delta	p-value
9.474	0.000
Adj.10.233	0.000
H0: Slope coefficients are homogenous	

Table 8. *Results of the Dumitrescu and Hurlin [36] causality test*

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
CONTAINER VOLUME does not homogeneously cause Number of Labor Force	5.37493	2.20339	0.0276
NUMBER OF LABOR FORCE does not homogeneously cause Container Volume	5.37280	2.20184	0.0277
NOTE: The max lag length is taken as 2 according to the AIC information criterion			

force participation". In this context, it can be stated that historical data on the variable related to container volume has a significant effect on the variable of labor force number, and data on the variable of labor force significantly affects container volume.

5. Conclusions

Maritime transport, which accounts for approximately 80% of global freight transport and is the preferred mode of transport compared to other modes, is growing in importance in national economies. An example of this is the negative impact on supply chains and the global economy caused by the Suez Canal blockage due to a recent container ship stranding. In this context, as bulk and dry cargo transportation has given way to container transportation, the Mediterranean Basin, which includes Türkiye, has grown in importance as one of the most competitive trade areas. Container trade has an impact on the Mediterranean Basin's economic balance because it has an impact on macroeconomic variables. This study attempted to determine whether there is a cointegration relationship between the "volume of containers handled" of Türkiye, Greece, Italy, and Spain, which have an active role in international container lines, and the "the labor force in total population," which is one of the macroeconomic variables, between 2000 and 2020. Based on the findings, the causality between the volume of containers handled in the maritime sector and the level of labor force participation was assessed.

The panel data analysis method was used in this study. Panel data analysis examines cross-sectional data from a specific period and time series. It contains distinguishing features of the same units and allows them to be controlled and measured. In addition, more comprehensive studies can be conducted because it combines cross-sectional and time series data. To achieve the study's goal, data on the volume of containers handled in TEUs between 2000 and 2020 were obtained from OECD [31] and labor force from WB [32] websites.

The Stata and EViews software packages were used to test the hypotheses. The hypotheses were tested using the Westerlund panel cointegration test and the Dumitrescu and Hurlin [36] causality test. The Westerlund test was used because it takes into account structural break and cross-sectional dependence. Because it is an adapted version of the Granger [37] causality test for heterogeneous panel data analysis, the Dumitrescu and Hurlin [36] test was also chosen. Because the cointegration relationship between the variables was not found, the Dumitrescu and Hurlin [36] causality test was used to determine whether there was a short-term causality relationship between the variables.

According to the Westerlund panel cointegration test results, there was no long-term equilibrium relationship between the volume of containers handled and the variables related to the level of individual labor force participation in the total population when the study's findings were examined. According to the Dumitrescu and Hurlin [36] causality test, the labor force variable is the Granger cause of the volume of containers variable, and the volume of containers variable is the Granger cause of the labor force variables. The obtained result is bidirectional causality, expressed as "volume of containers ↔ level of labor force participation." In this context, the variable related to container volume has a significant effect on the variable of labor force level, and the data of the variable of labor force level has a significant effect on container volume.

The study found that, while there is no long-term cointegration relationship between the volume of containers handled and labor force participation, there is a bidirectional Granger [37] causality relationship. According to the findings, all sectors respond to changes in a country's economy and trade volume as a contraction or increase in capacity in the short term. In this context, it is believed that there is a relationship between the volume of containers handled and labor force participation. A larger data set should be used to examine long-term impacts. Simultaneously, it is assumed that in the short term, the level of labor force participation in sectors such as textiles, electronic goods, and pharmaceuticals, whose cargoes are mostly transported by containers, has changed or the volume of containers has changed with the change in the level of labor force participation in these sectors. These findings overlap with those of Bottasso et al. [1], Michael et al. [6], Dördüncü [22], and Tunalı and Akarçay [24]. As a result, the study's findings are consistent. A larger data set should be used to examine long-term impacts. In this regard, all types of cargo transported by sea, as well as the product and service production areas where they are used, can be examined, and an evaluation for the related sectors can be made. This study examines the role of container transportation in trade and its effects on a country's labor force participation rate. In future studies, Türkiye's regional competitors can be compared by comparing maritime transport data based on countries and foreign trade data based on inflation, national income, unemployment, and sectors, using panel data analysis in the maritime sector. Türkiye's potential weaknesses can be assessed based on the comparison results, and policies to improve these aspects can be proposed.

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