RESEARCH ARTICLE/ ARAŞTIRMA MAKALESİ

ISSN: 2147-8414

Freight Transportation and the COVID-19 Outbreak: Fresh Insights from the US Economy

Yük Taşımacılığı ve COVID-19 Salgını: ABD Ekonomisinden Güncel İçgörüler

Esranur YILMAZ [1]
Mehmet Aldonat BEYZATLAR[2]

ABSTRACT

This study performs empirical analyzes to reveal the causal relationship between freight transportation and COVID-19 measures for the United States with monthly time-series data for the period January 2020 and April 2021. The Toda-Yamamoto approach is used in this study to reveal the causality relationship between four freight transportation and two COVID-19 variables. The empirical results indicate a unidirectional causality running from both COVID-19 cases and deaths to freight transportation services index, air freight revenues, rail freight traffic, and Cass freight index. The findings of this study clearly show that cases and deaths of COVID-19 cause freight transportation activities as determining factors. These results also emphasize that the contagion deserves much more attention from public and private transportation professionals, who are responsible for the governance and the regulation of the transportation market.

Keywords: Freight transportation, COVID-19, Toda-Yamamoto, United States

ÖZ

Bu çalışmada, Ocak 2020 ve Nisan 2021 dönemi için aylık zaman serisi verileriyle Amerika Birleşik Devletleri için yük taşımacılığı ile COVID-19 ölçümleri arasındaki nedensellik ilişkisini ortaya çıkarmak için analizler ampirik analizler yapılmıştır. Bu çalışma kapsamında, dört yük taşımacılığı ile iki COVID-19 değişkeni arasındaki nedensellik ilişkilerini ortaya çıkarmak için Toda-Yamamoto yaklaşımı kullanılmıştır. Ampirik sonuçlar, hem COVID-19 vakalarından hem de ölümlerden yük taşımacılığı hizmetleri endeksine, hava taşımacılığı gelirlerine, demiryolu yük trafiğine ve Cass yük endeksine doğru tek yönlü bir nedensellik olduğunu göstermektedir. Bu çalışmanın bulguları, COVID-19 vakalarının ve ölümlerinin, yük taşımacılığı faaliyetlerine belirleyici faktör olarak neden olduğunu açıkça göstermektedir. Bu sonuçlar aynı zamanda, salgınların, ulaşım piyasasının yönetiminden ve düzenlenmesinden sorumlu olan kamu ve özel ulaşım profesyonellerinden çok daha fazla ilgiyi hak ettiğini vurgulamaktadır.

Anahtar Kelimeler: Yük taşımacılığı, COVID-19, Toda-Yamamoto, Amerika Birleşik Devletleri

Cite (Atıf): *Beyzatlar, M.A. & Yılmaz, E. (2021). Freight Transportation and the COVID-19 Outbreak: Fresh Insights from the US Economy. Toros University FEASS Journal of Social Sciences, 8(Special Issue): 1-8.*

Received Date (Makale Geliş Tarihi): 30.06.2021 Accepted Date (Makale Kabul Tarihi): 02.09.2021

[1]Graduate Student, Dokuz Eylul University Graduate School of Social Sciences, Tınaztepe Campus 35390 Buca, Izmir, Turkey, esranur.y@ogr.deu.edu.tr, ORCID: 0000-0002-4570-4525

[2]Assistant Professor, Dokuz Eylul University Faculty of Business, Tınaztepe Campus 35390 Buca, Izmir, Turkey, mehmet.beyzatlar@deu.edu.tr, ORCID: 0000-0002-8434-8447

1. INTRODUCTION

World economies have struggled with the effects of an unexpected health crisis, which is called coronavirus disease 2019 (COVID-19, hereafter), that emerged at the end of 2019. The virus was first detected in December 2019 in China and later spread from one country to another and became a pandemic. On 11 March 2020, the World Health Organization (WHO) officially declared the COVID-19 outbreak as a pandemic due to the global spread and severity of the disease (Açıkgöz and Günay, 2020). The first confirmed case in the United States (US was reported on January 19, and the first recorded death related to COVID-19 in the US was on March 2 (Boettke, 2021). Moreover, the virus transmitting to other healthy people mostly in hospitals, houses, offices, supermarkets, public transportation as well as many people have been infected by the virus and unfortunately lost their lives, the lifestyle of people and economic activities and have reshaped depending on the conditions of the pandemic in countries. It has caused great public health and economic challenges to countries around the world (Osotimehin, 2020).

As the virus spread internationally, many countries have taken action to limit the spread, through social isolation policies, such as shutting educational institutions, limiting work, and restricting the mobility of people (Maliszewska et al., 2020). The increasing number of cases and deaths has obliged governments to take some important precautions and apply policies in many areas to control the outspread of the virus. At the end of February and early in March 2020, the number of COVID-19 cases has exponentially increased in Asia, Europe, and the USA and it has been caused by taking decisions border closures and quarantines by policymakers (Ivanov, 2020). As a result of social distancing, travel demand has dropped due to an increased amount of working from home, e-learning, and a reduced number of public activities and events (De Vos, 2020). Besides, regulations have closely affected the transportation sector both positively and negatively, depending on economic and social restrictions. Especially, freight transportation activities are directly related to the process of the pandemic because functioning supply chains are a major success factor for economic prosperity enabled by freight transportation in today's increasingly globalized world (Loske, 2020). According to the European Commission Report, before the virus outbreak, while it was estimated that passenger transport would have grown by 42% between 2010 and 2050, freight transport was expected to grow by 60% during the same period (EC, 2019). COVID-19 spread to the world and became a pandemic, the transportation sector has been affected directly within the demand-supply and indirectly via economic effects. On the other hand, medical equipment is transported to countries with road, maritime, rail, and air shipments. US airlines have played a key role in providing cargo services to address the shortfall of medical supplies during the COVID-19 pandemic (Bartle et al., 2021). Besides, it has increased the importance in terms of transporting vaccines because it is provided to the time and optimum temperature while vaccines are distributing across the globe by transportation modes.

Considering the effects of the pandemic on the transportation industry, this study tries to reveal the causal relations between freight transportation and COVID-19 measures in the US. The study aims to answer the following research question in general: What is the causal relationship between the US freight transportation and COVID-19 statistics over the period from January 2020to April 2021? Especially, this paper empirically aims to analyze the impact of COVID-19 on freight transportation activities in the US economy, using the Toda and Yamamoto (1995) approach of Granger-causality. The study concentrated on the US as the sample country because: (i) the US has been one of the most affected

countries by the COVID-19 pandemic, (ii) data availability of high frequency (monthly) and various freight transportation measures, and (iii) to monitor the indirect effects of economic policies for preventing the negative impacts of pandemic via freight transportation measures. By using causality analysis within the US freight transportation and COVID-19 measures as economic indicators, can show the reflections of the fluctuations in the number of confirmed cases and deaths of the COVID-19 to the US freight transportation measures.

The remainder of this paper is structured as follows. In section 2, a brief review of the literature is provided. Section 3 introduces the data and empirical methodology. Empirical findings are represented in Section 4. Finally, Section 5 concludes the paper.

1. LITERATURE REVIEW

The literature accumulation is increasing in COVID-19 studies, which are revealing the impact of the pandemic on economic activities, include various approaches to the transportation industry. While some studies are emphasized on negative impacts of COVID-19 on freight transportation, findings of the other studies are examined that there is a positive impact of the pandemic. Bombelli (2020), Cui et al. (2021), Ho et al. (2021), and Loske (2021) analyzed how freight transportation is affected by the economic results of the COVID-19, depending on the confirmed cases and deaths. For example, Ho et al. (2021) found that COVID-19 has a positive impact on the road freight transport turnover with the multi-region demand model, using monthly panel data of 13 Chinese provinces over the period from December 2019 to August 2020. Loske (2021) examined that the increasing freight volume for dry products in retail logistics does not depend on the duration of the COVID-19 pandemic but on the strength quantified through the total number of new infections per day, including 208 countries around the world between December 31, 2019, and April 30, 2020, as daily.

Besides, each form of freight transportation is affected differently from the COVID-19 statistics in terms of the supply-demand chain in the economy. Bouali et al. (2020), Danışman and Akkartal (2020), Gray and Torshizi (2021), Li (2020), and Vida et al., (2021) examined the relations between freight transportation modes and the COVID-19 pandemic to reveal the situation of the intercountry economic activities. Bouali et al. (2020) analyzed that volume of air freight decreased because of the closure or limited working of factories and only continuing to the transportation of medical equipment and food supplies in some countries. Nwokedi et al. (2021) determined by using Yarmanyaro's formula that while Twenty-Foot-Equivalent-Units (TEU) transportation costs have a significant increase, container trade flow from the seaports damages and decline in trade relations with the restrictions and conditions of the COVID-19 pandemic.

This study aims to contribute to the literature by exposing the effects of the COVID-19 pandemic on various freight transportation measures for the US economy. The monthly data used in our analysis and the methodology, which is the Toda-Yamamoto approach of the Granger-causality test, can be found in the next section. The empirical analysis will cover the causality over the period between January 2020 and May 2021. Thus, the results of the study will give information about the cause or effect roles of freight transportation and how changes occur during the process of the COVID-19 pandemic.

2. DATA AND METHODOLOGY

The data used in the study are those covering freight transportation and COVID-19 measures in the US are as follows: Air Revenue Ton Miles of Freight and Mail (ARFM), Cass Freight Index (CASS), Freight Transportation Services Index (FTSI), Rail Freight Intermodal Traffic (RFIT), Number of Confirmed Cases in the US (CVCA), and Number of Deaths in the US (CVDE). FTSI consists of inland and air

freight activities such as for-hire trucking and pipeline movements. CASS includes the freight expenditures and shipment volumes. Data of all four freight transportation variables were obtained from the Federal Reserve Bank St. Louis Economic Research database. Data of all two COVID-19 measures were extracted from World Health Organization (WHO). The descriptive statistics of all variables can be seen in Table 1.

Table 1. Descriptive Statistics

Variables*	Source	Mean	Median	Minimum	Maximum
ARFM	Federal Reserve Bank St. Louis Economic Research database	15,179	15,202	15,066	15,289
CASS		1,024	1,026	0,808	1,239
FTSI		4,885	4,889	4,833	4,919
RFIT		13,946	13,943	13,795	14,063
CVCA	World Health Organization database	12,886	14,306	2,398	15,661
CVDE		10,334	10,400	7,782	11,486

*ARFM is Air Revenue Ton Miles of Freight and Mail; CASS is Cass Freight Index; FTSI is Freight Transportation Services Index; RFIT is Rail Freight Intermodal Traffic; CVCA is Number of Confirmed Cases in the US; CVDE is Number of Deaths in the US. All variables are in natural log form.

The Toda-Yamamoto approach, which is proposed by Toda and Yamamoto (1995), is used to investigate the existence of a causality between freight transportation and COVID-19 measures in the US. This methodology, which follows a modified Wald test for the causality testing procedure, is important because it enables us to avoid the problems associated with the ordinary Granger-causality test by ignoring any possible non-stationarity and/or co-integration between series.

This approach fits a vector autoregression (VAR, hereafter) model to the levels of the variables, thereby minimizing the risks associated with possible incorrect identification of the order of integration of the series. The main idea of this approach includes the estimation of an augmented VAR (k+dmax) model where k is the optimal lag length in the original VAR system, and dmax is the maximum order of integration of the variables in the VAR system.

To apply the Toda-Yamamoto approach to the Granger non-causality test, the freight–covid model is used as the following VAR system:

$$\text{freight}_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i}\text{freight}_{t-i} + \sum_{j=k+1}^{dmax} \alpha_{2j}\text{freight}_{t-j} + \sum_{i=1}^{k} \beta_{1i}\text{covid}_{t-i} + \sum_{j=k+1}^{dmax} \beta_{2j}\text{covid}_{t-j} + \varepsilon_{1t} \quad (1)$$

$$\text{covid}_t = \theta_0 + \sum_{i=1}^{k} \theta_{1i}\text{covid}_{t-i} + \sum_{j=k+1}^{dmax} \theta_{2j}\text{covid}_{t-j} + \sum_{i=1}^{k} \delta_{1i}\text{freight}_{t-i} + \sum_{j=k+1}^{dmax} \delta_{2j}\text{freight}_{t-j} + \upsilon_t \quad (2)$$

3. EMPIRICAL FINDINGS

The causality relationship between freight transportation indicators and COVID-19 statistics in the US will be estimated by the following equations (1) and (2). Before these estimations, the unit root testing procedure is applied as a pre-estimation process. These tests will provide both freight transportation and COVID-19 variables are stationary or not. To test the stationarity of the variables with the unit root test, it is taken attention for this study to the Augmented Dickey-Fuller (ADF) and Dickey-Fuller Test with GLS Detrending (DF-GLS) unit root testing procedures, proposed by Dickey and Fuller (1979) and Elliot et al. (1996), respectively. As represented in Table 2, all variables are found stationary as integrated of order one, I(1).

Table 2. Unit Root Test Results

Tests		CVCA	CVDE	ARFM	CASS	FTSI	RFTI
ADF	Level	-1.152	-2.051	-1.672	-2.113	-2.189	-2.776
	1st dif.	-9.171***	-5.968***	-4.263**	-8.461***	-3.073***	-3.412**
DF-GLS	Level	-0.942	-2.781	-2.568	-1.137	-2.293	-3.214
	1stdif.	-3.616**	-4.855***	-4.754***	-3.266**	-3.391***	-4.147***

Note: ADF: Augmented Dickey-Fuller; DF-GLS: Dickey-Fuller GLS. ***, **, and * denotes the rejection of the null hypothesis at 1%, 5%, and 10% significance levels, respectively.

After the process of analyzing the unit root test, the Toda-Yamamoto causality test is applied for revealing any causal relationship between the variables in the study. According to the test results, all variables are found significant and stationary at a one percent significance level and the null hypothesis of being non-stationary is rejected. Table 3 clearly shows the causality test results and significant relations between freight transportation indicators and COVID-19 statistics for the US. Test results emphasize that there is unidirectional causality from CVCA to ARFM; to CASS; to FTSI; to RFIT. When we look at the effects of the number of deaths, it is also found a unidirectional causal relation from CVDE to ARFM; to CASS; to FTSI; to RFIT in this study.

Table 3. Toda-Yamamoto Causality Test Results

	Chi-sq.	Direction		Chi-sq.	Direction
CVCA→ARFM	16.096***	unidirectional	CVDE→ARFM	9.424***	unidirectional
CVCA←ARFM	3.536		CVDE←ARFM	1.462	
CVCA→CASS	5.934***	unidirectional	CVDE→CASS	9.232***	unidirectional
CVCA←CASS	0.022		CVDE←CASS	2.427	
CVCA→FTSI	10.972***	unidirectional	CVDE→FTSI	5.272***	unidirectional
CVCA←FTSI	3.632		CVDE←FTSI	1.304	
CVCA→RFIT	6.904***	unidirectional	CVDE→RFIT	7.375***	unidirectional
CVCA←RFIT	1.539		CVDE←RFIT	3.942	

Note: ***, **, and * denotes the rejection of null hypothesis at 1%, 5%, and 10% significance levels, respectively.

In the light of all results of the causality, it is inferred that a significant causal relationship between freight transportation and COVID-19 measures for the US economy. It explains to us that freight transportation is mostly affected by pandemic conditions. Besides, it is a part of the important elements in the economic activities while it is decided the COVID-19 pandemic for economic sustainability.

4. CONCLUSIONS

Transportation of goods and passengers is vital for economies and this relationship at the causal level was researched by some empirical studies (Beyzatlar et al., 2014; Beyzatlar and Yetkiner, 2017; Yetkiner and Beyzatlar, 2020). This paper investigates the causal relations between various freight transportation indicators and COVID-19 statistics for the US. COVID-19 pandemic affects economies through various sectors, and transportation is an important one that has a causality relationship with economic activities. Changing the number of cases and deaths causes the reshaping the economic activities. Restrictions, closure of borders, and new policies are implemented to prevent the negative effects of the pandemic. These decisions have mostly affected the transportation industry. Especially, freight transportation has a significant position in terms of sustaining the movements of goods and services across the world. The volume of freight transportation has changed because of the conditions of the pandemic. From this point of view, this study is constructed for analyzing the impacts of the pandemic on freight transportation activities and showing the direction of the causal relationship between the variables over the period January 2020 and April 2020, using the Toda-Yamamoto causality test.

The empirical results of the study emphasize clearly that there are significant causal relations between freight transportation and COVID-19 statistics for the US economy. Analyzing COVID-19 statistics, in terms of the number of cases and deaths, it is shown that a unidirectional causality relationship is found from COVID-19 cases to freight transportation indicators (CVCA to FTSI, RFIT, ARFM, and RFIT). COVID-19 deaths also cause all freight transportation indicators, and it is also determined a unidirectional causality for all indicators (CVDE to FTSI, RFIT, ARFM, and RFIT). The whole empirical results prove that the COVID-19 pandemic is a determining factor for the freight transportation activities in terms of providing goods and services to the market in the US. That means

any changes in the number of cases and deaths affect the economic process of freight transportation in the same direction. In the light of these findings, the study has important policy implications. Regulations about the pandemic should give importance by taking attention to freight transportation because it has an important ring of the supply chain for the economy, and it connects to other sectors. The demand and supply sides of the economy are affected by decisions to be made and policies to be implemented during the pandemic. Therefore, it should be necessary the convenient conditions for continuing the freight transportation activities smoothly in the market.

One of the grey areas of this study lies in not considering variants and the determinants of transportation measures for the US. The contagion spreads through people, not goods. However, it is aimed to evaluate how much the economy is affected by only the movement of freight, and therefore we did not consider passenger mobility. Due to the COVID-19 outbreak, restrictions are placed in many countries. These short periods or the whole pandemic period could be considered in terms of how it affects the interaction between other variables as an externality. Lastly, data availability was an important limitation of our study.

Present study outcomes are significant in covering the causal linkage between freight transportation and COVID-19 measures in the US. Future studies may want to consider the impact of COVID-19 measures on various determinants of transportation, such as movement of passengers, infrastructure, investment, prices, and indexes may be taken up. Future alternative studies might also use different time and cross-sectional dimensions as a longitudinal investigation. Moreover, data availability is a challenging task of transportation economics especially in accessing high-frequency data to be compatible with not only COVID-19 data but also many other measures.

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