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## Method Article

# The impact of COVID-19 on freight transport: Evidence from China



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## A B S T R A C T

Using a monthly panel data of 13 Chinese provinces (cities) over the period from December 2019 to August 2020, this research investigates the impact of COVID-19 on the freight transport. We find that COVID-19 has a positive impact on the road freight transport turnover. This effect is pronounced under the higher numbers of COVID-19 confirmed cases and the lower level of gasoline production, and vice versa. In brief,

- This study finds that COVID-19 has a positive impact on the road freight transport turnover.
- This effect is pronounced under the higher numbers of COVID-19 confirmed cases and the lower level of gasoline production, and vice versa.

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## Introduction

The outbreak of coronavirus disease (COVID-19) in early 2020 is one of the worst disasters in human history. According to the World Health Organization (WHO), there were 34,804,348 for COVID-19 cumulative confirmed cases worldwide and more than 1,030,738 for death cases.<sup>1</sup> The rising uncertainty of the COVID-19 pandemic has emerged to mount a serious challenge to China in terms of the public's consumption behavior and economic activity. Therefore, understanding the effect of COVID-19 on road or water freight transport turnover is crucial.

The issue of the COVID-19 outbreak and its impacts have been the focus of extensive research among many scholars. One strand of studies examines the impact of COVID-19 on different industries, such as Mishra and Rampal [18], Okoi and Bwawa [21] for medical industry, Fezzi and Fanghella [9] for electricity industry, Sigala [25] and Lee and Chen [12] for tourism industry, Wang et al. [28] for insurance industry, and Liu et al. [14] for energy industry, Vidya and Prabheesh [27] for trade industry, and Yu et al. [30] for labor industry. Another strand of contemporary literature focuses on the detrimental impact on global supply chain due to the spread of the COVID-19 around the world.

Many studies have studied the impacts of the COVID-19 on the relationship between supply and demand based on economics models or theories [3]. On the supply side, due to all factories to be forcibly closed, various industries have experienced supply chain problems that continue to this day. For example, Gu et al. [10] find that the manufacturing industry has been negatively affected by COVID-19 due to the shortage of raw materials. On the demand side, markets for emergency medical equipment, personal protective equipment and healthy food have surged in the wake of the COVID-19 outbreak. Therefore, people are hoarding supplies for fear of shortages as the epidemic continues to spread around the world [17]. The outbreak has brought uncertainty and economic hardship, but it has also created new opportunities and changed the business environment – during the outbreak, communities relied on delivery workers for critical necessities such as food, medical care and cleaning supplies. The epidemic has changed people's consumption behavior, increasing the demands for delivery services and online shopping, which has increased the use of mobile payment [13,15]. This relates to the increased volume of road freight transport during the epidemic and the high demand for supplies.

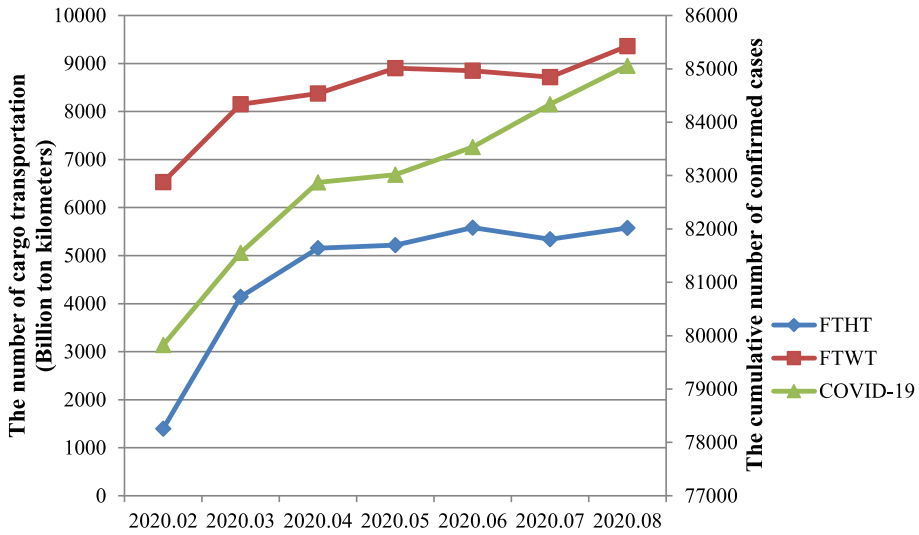
Several papers consider COVID-19 is detrimental to transportation industry [10,11,16,24]. Those papers mentioned are exclusively focusing on a negative impact on freight volumes in transportation industry due to the increase in inventories of different industrial firms in the economy during the COVID-19s shock. In contrast, few papers focus solely on China's freight transport from macro level. Our findings are different, that is, COVID-19 has a positive impact on road freight transport. The pandemic creates new consumption demand and the popularity on China's mobile payment enhances this consumption behaviors [13], thus increases road freight transport [3]. In addition, this effect is pronounced under the lower level of gasoline production. COVID-19 negatively affects oil prices [2,23], which in turn lead to lower level of gasoline production.

To understand the relationship between COVID-19 and total transport turnover, this research provides the trend chart, according to the National Bureau of Statistics of China and the Chinese Health Commission. Fig. 1 compares the trends of the COVID-19 with those of total freight transport turnover in China by road or water freight over the period from February to August by 2020. We observe that a synchronous growth—the cumulative number of COVID-19 confirmed cases accompanies with the trends on road or water freight transport turnover. Based on the above literature and trend analysis, we therefore hypothesize that:

**Hypothesis:** COVID-19 is likely to have a positive impact on the road or water freight transport.

The main contribution is that our research analyzes the overall impact of the epidemic on China's freight transport from a macro-level perspective, which adds to the pandemic literature. Through subsample analysis, the empirical results help fill in the gaps in the COVID-19 transport literature supporting new consumption behavior during the COVID-19 outbreak. The next section introduces

<sup>1</sup> Information comes from WHO's website updated by 2020/10/4 (<https://covid19.who.int/table>).



**Fig. 1.** Trends on the Covid-19 and China's freight traffic volumes.

Notes: Turnover of road freight transport (FTHT) and Turnover of water freight transport (FTWT) are used to measure China's road and water freight transportation volumes, respectively.

our model and data. Section 3 discusses the empirical results. Lastly, the final section presents the conclusions of this study.

## Model

This article follows the multi-region demand model [22], which considers service demand as an exogenous input for modeling the freight demand. To examine the impact of COVID-19 on China's freight transport, we consider the panel regressions with fixed effect models. The baseline model is shown as follows.

$$Y_{it} = \alpha_i + \beta X_{it} + \lambda Z_{it-1} + \eta K_{it-1} + \varepsilon_{it} \quad (1)$$

where  $i$  denotes the province and  $t$  denote month.  $Y_{it}$  is the dependent variables to measure China's freight transport in the province  $i$  at month  $t$ .  $X_{it}$  is the core independent variables to measure the spread of COVID-19 of province  $i$  in month  $t$ .  $Z_{it}$ , and  $K_{it}$  are control variables, including the consumer price index, and energy outputs of gasoline and diesel, respectively.  $\alpha_i$  is individual effect of province  $i$ ,  $\varepsilon_{it}$  is the error term.

Due to the availability and accessibility of monthly data, we finally collect panel data sets over the period from December 2019 to August 2020 and in China's 13 provinces or cities, including Shanghai, Sichuan, Shandong, Shanxi, Guangdong, Jiangxi, Hebei, Hubei, Hunan, Fujian, Guizhou, Liaoning, and Shanxi. All data are obtained from the official websites of the provincial statistical bureaus and the provincial transportation departments.

We calculate the logarithm of the growth rate of road freight transport turnover (lnFTHTrate) and the logarithm of the growth rate of water freight transport turnover (lnFTWTrate) as proxied by dependent variables to measure China's freight transport. Following Wang et al. [29], we also calculate the logarithm of the cumulative number of COVID-19 confirmed cases in each province (lnCOVID) and the cumulative number of COVID-19 confirmed cases divided by the number of permanent residents in each province (PCCOVID) as the core independent variables for measuring COVID-19. Table 1 summarizes the definitions of variables in the model. In Table 1, the average logarithm of road freight turnover and water freight turnover are 0.019 and 0.066, respectively. This indicates that China's average freight volumes continue to grow. The average logarithm of the cumulative number

**Table 1**  
Descriptive statistics for different variables.

	Variable	Definition	Mean	Max	Min	S.D.	Skewness	N
Dependent variables	<i>lnFTHRate</i>	the growth rate of the turnover of road freight transport	0.019	1.133	-0.138	0.140	6.440	84
	<i>lnFTWRate</i>	the growth rate of the turnover of waterway freight transport	0.066	2.856	-0.683	0.430	5.141	74
Independent variables	<i>lnCOVID</i>	cumulative number of confirmed cases at the end of each month, by province	6.283	11.13	3.296	1.599	1.614	105
	<i>PCCOVID</i>	cumulative number of confirmed cases/provincial population (10,000 per unit)	0.861	11.50	0.005	2.849	3.463	105
Control variables	<i>CPI</i>	monthly consumer price index	103.8	106.9	101.6	1.303	0.258	104
	<i>lnGP</i>	monthly production of gas, measured in 10,000 tons	52.93	192.6	0	52.49	1.342	78
	<i>lnDP</i>	monthly production of diesel, measured in 10,000 tons	68.58	290.2	0	77.25	1.549	78

Notes: Our data comes from the official websites of the provincial transportation departments and the Health Commission. All data are calculated in logarithm, except for CPI and the average diagnoses reported in total numbers of provincial population (*PCCOVID*).

**Table 2**  
Empirical result.

Variable	Panel A: Results based on <i>lnFTHRate</i>				Panel B: Results based on <i>lnFTWRate</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>lnCOVID</i>	0.082* (1.99)	0.078* (1.91)			0.272* (2.00)	0.256* (1.87)		
<i>lnPCCOVID</i>			1.364* (1.88)	1.311* (1.82)			3.636 (1.49)	3.383 (1.38)
<i>CPI</i>	0.060*** (3.56)	0.060*** (3.57)	0.059*** (3.49)	0.058*** (3.51)	0.198*** (3.34)	0.193*** (3.26)	0.183*** (3.07)	0.179*** (3.01)
<i>lnDP</i>	-0.000053 (-0.05)		-0.0001 (-0.10)		0.002 (0.50)		0.001 (0.39)	
<i>lnGP</i>		-0.001 (-0.66)		-0.001 (-0.72)		-0.001 (-0.26)		-0.002 (-0.37)
R square	0.2237	0.2310	0.2170	0.2255	0.2198	0.2164	0.1880	0.1877
N	61	61	61	61	55	55	55	55

Notes: This table reports the results from the regressions by using the fixed effects model. Robust standard errors are calculated by the t-statistics. \*\*\*, \*\*, and \* represent statistical significance at the 1%, 5%, and 10% levels, respectively. Please see the variable definitions in Table 1.

of confirmed diagnoses is 6.283, and the average diagnoses reported in total numbers of provincial population is 0.861%.

As for the control variables, we follow Aderamo [1], Apergis and Apergis [2], and Paladugula et al. [22]. CPI is used to measure commodity prices [6,7]. The logarithm of gasoline production (*lnGP*) and diesel production (*lnDP*) are used to measure energy production. Rising prices may lead to panic buying, and an increase for the number of freight transport [16]. We expect CPI has a positive relationship with freight transport. For gasoline or diesel production, there is a positive correlation with the expected volume of freight transport [22]. As shown in Table 1, the average logarithm of gasoline or diesel production are 52.93 and 68.58, respectively, and the average CPI is 103.8.

**Results**

Panels A and B of Table 2 reports the empirical results of the panel fixed effect model. By using different dependent, independent, and control variables, we find that the coefficients of *lnCOVID* on both *lnFTHRate* and *lnFTWRate* are positive and statistically significant at the 10% level. For the

**Table 3**  
Sub-sample empirical result.

Sub:COVID-19	(1) <i>lnFTHTrate</i>		(2) <i>lnFTHTrate</i>		(3) <i>lnFTWTrate</i>		(4) <i>lnFTWTrate</i>	
	low	high	low	high	low	high	low	high
<i>lnCOVID</i>	0.006 (0.42)	0.107*** (5.65)	0.006 (0.44)	0.107*** (5.65)	0.040 (0.67)	0.179*** (2.92)	0.047 (0.78)	0.179*** (2.91)
<i>CPI</i>	-0.002 (-0.23)	0.094*** (3.66)	-0.002 (-0.23)	0.094*** (3.66)	0.030 (0.85)	0.223*** (2.68)	0.031 (0.88)	0.223*** (2.68)
<i>lnDP</i>	-0.00003 (-0.32)	-0.00002 (-0.07)			-0.0004 (-0.79)	0.00003 (0.03)		
<i>lnGP</i>			-0.00005 (-0.30)	-0.00005 (-0.12)			-0.001 (-0.99)	-0.00007 (-0.05)
R square	0.0034	0.4141	0.0044	0.4137	0.0255	0.4075	0.0268	0.4073
<i>N</i>	34	27	34	27	28	27	28	27
<b>Sub: gasoline production</b>	<b>low</b>	<b>high</b>	<b>low</b>	<b>high</b>	<b>low</b>	<b>high</b>	<b>low</b>	<b>high</b>
<i>lnCOVID</i>	0.076*** (4.26)	0.005 (1.29)	0.077*** (4.41)	0.005 (1.27)	0.120*** (2.69)	0.009 (0.92)	0.124*** (2.91)	0.009 (0.94)
<i>CPI</i>	0.070*** (3.58)	-0.002 (-0.48)	0.069*** (3.54)	-0.002 (-0.48)	0.182*** (2.79)	-0.008 (-0.80)	0.177*** (2.71)	-0.008 (-0.81)
<i>lnDP</i>	-0.001 (-0.28)	-0.00001 (-0.27)			-0.001 (-0.29)	-0.0001 (-0.82)		
<i>lnGP</i>			-0.001 (-0.57)	-0.00002 (-0.18)			-0.003 (-0.60)	-0.0003 (-1.25)
R square	0.1542	0.2837	0.1884	0.2830	0.2791	0.1308	0.2895	0.1197
<i>N</i>	43	18	43	18	38	17	38	17

Notes: This table reports the results from the regressions under the sub-samples according to the average values of COVID-19 and gasoline production (above the mean is high and below the mean is low). Robust standard errors are calculated by the t-statistics. \*\*\*, \*\*, and \* represent statistical significance at the 1%, 5%, and 10% levels, respectively. Regressions 1 and 2 mainly study the impact of COVID-19 on road freight. Regressions 3 and 4 mainly study the impact of COVID-19 on water freight. In the sub-sample analysis, cumulative number at the end of each month by province (*lnCOVID*) is chosen as core independent variable. Please see the variable definitions in [Table 1](#).

robustness check, the coefficients of *lnPCCOVID* on *lnFTHTrate* remain unchanged. The results show that the impact of COVID-19 on China's road freight transport turnover is positive, suggesting that road freight transport turnover increases with the number of confirmed cases of COVID-19. The possible explanations are as follows: First, concerning the trajectory of the COVID-19 outbreak, people may be more inclined to hoard supplies or have improper use of important materials and equipment [2,3,16,17]. Second, the COVID-19 outbreak not only threatens the food industry with market supply and demand imbalance, but also shocks the energy market and causes oil prices to fall sharply [14,19]. Third, the epidemic has changed consumers' consumption patterns [13], increased fear sentiment [5], and reduced investment [31]. With the popularity of mobile payment in China, the retail or food industry accelerates the distribution of online channels, thereby resulting in increased freight transport turnover [18].

To examine whether our results vary with the numbers of COVID-19 confirmed cases and the level of gasoline production, we further divide our sample into two sub-samples. In the sub-sample data for the high numbers of COVID-19 confirmed cases as shown in [Table 3](#), the result shows that the coefficients of *lnCOVID* on both *lnFTHTrate* and *lnFTWTrate* are statistically significant and positive at the 1% level. This result supports the findings of Baqaee & Farhi [3], which indicate that people are hoarding supplies for fear of shortages as the epidemic continues to spread around the world through road or water freight transport. Additionally, this result confirms the evidences of Devpura & Narayan [8], Loske [16] and Narayan [19,20], who indicate that governments implement personnel control policies, especially when the COVID-19 turns into severity, leading to the increasing freight or water transport. This is in line with our hypothesis.

In the sub-sample data for gasoline production, the result shows that the impact of the COVID-19 on the transportation is significantly positive under the lower production of gasoline, which also

is consistent with the hypothesis. This result is also consistent with those notions of Talebian et al. [26] and Brand et al. [4] who show that regions with low oil production tend to more reliance on efficient transport instead of the gasoline transportation, leading to an increase in freight transport.

## Conclusions

This article uses a fixed-effects model and data from China's provincial level over the period from December 2019 to August 2020. We find that the spread of the COVID-19 has a positive impact on China's road freight transport turnover. These results are robust after using different dependents and independents. In addition, we also use sub-sample data classified by the mean values of COVID-19 and gasoline production. Evidence shows that in the context of high level of COVID-19 confirmed cases and low level of gasoline production, the COVID-19 increases freight transport.

Our empirical results have several implications. First, COVID-19 causes people to increase their consumption behaviors through freight transport. If the COVID-19 did not get controlled, it causes occurrences of the expected loss of income and stockpiling behavior. That is, the increase in freight transport may be the result of stockpiling behavior. Some economists argue that market failure results from soaring prices due to the panic—people who are really in need of the product cannot afford to buy it, or need to pay more for it. Second, governments and relevant departments should try their best to expose market information, reduce irrational consumer behaviors caused by the COVID-19, and make the price mechanism re-operate in the market.

## Compliance with Ethical Standards

All authors declare that they have no conflict of interests. This article does not contain any experiments with human participants or animals performed by any of the authors.

## Declaration of Competing Interest

The authors declare that they have no conflict of interest. This article does not contain any experiments with human participants or animals performed by any of the authors.

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