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Research Article

Container Freight Rates and International Trade Causality Nexus: Evidence from Panel VAR Approach for Shanghai and ASEAN-6 Countries

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Container shipping drives the development of international trade, yet previous studies have not fully appreciated the possible bidirectional causal relationship between container freight rates and international trade. In the context of the "twenty-first Century Maritime Silk Road," we use data on export container freight rates and import/export data from Shanghai to ASEAN-6 countries (Singapore, Vietnam, Thailand, Philippines, Malaysia, and Indonesia) from February 2017 to January 2020 and apply a panel VAR to explore the relationship between maritime transport costs and international trade in the container shipping market. We use the freight rate data are from the Southeast Asia Freight Index, which is used for the first time in an empirical study. The quality and reliability of the freight rate data allow this paper to better identify causal relationships. The results of the panel Granger causality test and the orthogonal impulse response function suggest a bidirectional causal relationship between freight rates and export trade; to further explain, an increase in export trade lowers export freight rates, but an increase in export freight rates hinders export trade, and a growth in import trade unidirectionally raises export freight rates. We believe that international trade may impact freight rates through economies of scale and trade imbalances.

1. Introduction

Since the creation of the WTO, tariff and nontariff barriers have been significantly reduced, and transport costs have become the main factors affecting trade [1–3]. Over 80% of international trade is carried by the sea [4], and high and more volatile maritime transport costs seriously hinder international trade for some countries [5, 6]. Korinek and Sourdin [6] pointed out that a 10% increase in maritime transport costs reduces trade by 6–8% in OECD countries. Conversely, maritime transport costs are also affected by international trade. Maritime transport costs are expressed in the carrier's position as freight rates [7, 8], which depend on the interplay between transport demand and shipping capacity [9]. Among them, transport demand is a derivative of international trade, so freight rates are also affected by international trade [10, 11].

Maritime transport shortens the distance between people and goods in time and space, and thus makes the contact between different countries and regions more and more frequent, and the development of maritime transport is of great significance to the friendly relations between countries and regions. However, with the increasing importance of maritime transport costs to international trade, reducing maritime transport costs to promote international trade has become an issue of concern to transportation and trade policymakers. Therefore, as the country with the world's largest port cargo throughput, the "twenty-first Century Maritime Silk Road" strategy proposed by China has attracted global attention. It aims to enhance trade facilitation and logistics development by using Chinese ports to connect East Asia, Southeast Asia, and Africa [7, 12, 13].

Shanghai Port is vital as the largest integrated port in China in the context of the "twenty-first Century Maritime

Silk Road." Its container throughput has been ranking first globally for nearly a decade, trading spans Asia, America, Europe, and Africa, is internationally renowned, as well as leading the entire export index in China [7, 14, 15]. Therefore, the Shanghai Export Containerized Freight Index (SCFI), which represents Shanghai export freight rates, often reflects the movement of spot rates for Chinese exports [16]. Studying the correlation between export freight rates and international trade in Shanghai can provide policymakers with timely information to help improve and promote the "twenty-first Century Maritime Silk Road" implementation [7]. For this purpose, this study investigates the correlation between freight rates and international trade on Southeast Asian routes departing from Shanghai.

The reason for our research focusing on the Southeast Asian routes from Shanghai is those ASEAN countries, as a bridge to other regions, are an important testing ground for the "twenty-first Century Maritime Silk Road" strategy, and also Shanghai's most significant trade and investment partners. Specifically, we use export container freight rates and import/export data from Shanghai to ASEAN-6 countries (Singapore, Vietnam, Thailand, Philippines, Malaysia, and Indonesia) for the period from February 2017 to January 2020 and take advantage of the dimensionality of the panel data to control for unobserved heterogeneity effects and perform causal analysis.

2. Literature Review

The relationship between maritime transport costs and international trade has received increasing attention from researchers in recent years. Studies on the relationship between maritime transport costs and international trade can be categorized into two genres.

The first genre of these studies focuses on assessing the impact of maritime transport costs on trade. Most of these studies consider transport costs as an exogenous variable and use a gravity model for empirical analysis [7, 17, 18, 19]; Inmacula. The results showed the negative impact of rising maritime transport costs on exports.

The second genre of these studies focuses on the impact of international trade on maritime transport costs. Some of this literature states that a decline in international trade when fleet capacity is constant represents a decline in demand for transport services and can lead to lower freight rates [11, 10]. Luo et al. [11] analyzed time-series data of the world container shipping market from 1980 to 2008 and found that the decline in world trade volume would contribute to the decline in world container freight rates. However, when the studies focus on specific routes and regions, they point out that international trade affects freight rates mainly through economies of scale [2, 20–22]. In other words, economies of scale are prevalent in the maritime industry, and an increase in the volume of trade leads to economies of scale and thus lower freight rates. For example, the use of higher capacity vessels results in lower costs per container to use the access channel at the port [2]. Thus, to better improve economies of scale, carriers deploy higher capacity vessels on routes with greater transport demand, resulting in lower freight rates per container [20]. In addition to the economies of scale mentioned above, trade imbalance is another important factor in international trade affecting maritime transport costs, especially for the container shipping market. Trade imbalance means that carriers need to reposition empty containers [8], and the larger the trade imbalance is, the more significant the cost of empty container repositioning [23]. Most current studies use export and import trade to construct new variables to measure trade imbalances and study their impact on freight rates [2, 20, 21, 24]. However, it is questionable whether such variables can accurately measure trade imbalances [25]. In addition, of course, the different ways of constructing variables across the literature may also lead to the inability to reach an empirical consensus on determining the impact of trade imbalances on freight rates. However, it is worth affirming that maritime practitioners generally agree that trade imbalances significantly impact freight rates [22]. The possible mechanisms of influence between international trade and maritime transport costs covered by the above literature are summarized in Figure 1.

In addition, some studies have argued that the relationship between maritime transport costs and international trade is not unidirectional. Inmaculada Martínez–Zarzoso and Suárez–Burguet [3] pointed out that an increase in exports can reduce transport costs through economies of scale, and conversely, higher transport costs can discourage exports. But they did not consider the impact of import trade on freight rates by changing trade imbalances. Brancaccio et al. [5] analyzed data on dry bulk transport markets and found that increased exports from net exporting countries increase trade imbalances and ultimately lift freight rates, and vice versa. Jiang et al. [7] explored the interrelationship between Shanghai export container freight rates and Shanghai export trade through a VAR model in the context of the "twenty-first Century Maritime Silk Road." They analyzed freight rates and export value from January 2010 to June 2014 for Europe, the Persian Gulf, Southeast Asia, Taiwan, and Hong Kong routes. Likewise, they failed to consider import trade and the disruptions caused by macroeconomics, global shipping market movements, and other unobservable factors. Moreover, in contrast to classic trade theory, which considers trade costs exogenous, current trade theory research has increasingly focused on the endogeneity of trade costs [5, 26, 27]. However, empirical evidence on the endogeneity of trade costs is currently not abundant.

To fill this gap, this paper establishes a panel VAR model for the first time to study the dynamic linkage and feedback effects between container freight rates and import and export trade. The advantage of panel VAR is that export container freight, export trade, and import trade can simultaneously be considered endogenous variables and allow controlling for unobserved heterogeneous effects. Second, this paper is the first empirical study using the Southeast Asia Freight Index (SEAFI), issued by the Shanghai Shipping Exchange (SSE). It is an index reflecting the spot rate changes of export containers on the services from Shanghai to Southeast Asia base ports. The emergence of SEAFI completes the Shanghai Export Container Freight Index

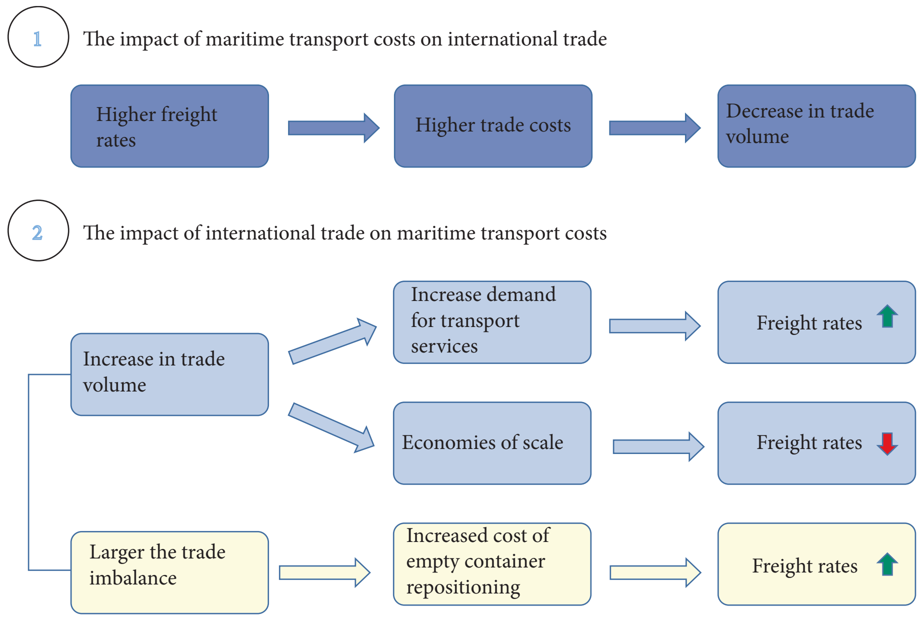

Figure 1: The possible mechanisms of influence between international trade and maritime transport costs.

(SCFI) for Southeast Asia routes. The freight rates published by SEAFI include only direct traffic and are not influenced by transshipment. Each route corresponds to only one country, making it convenient for us to use macroeconomic variables as control variables. SEAFI's freight rate data are collected from 35 world-renowned liner companies, cargo owners, and forwarders, which can fully reflect the market situation in Southeast Asia. In other words, SEAFI is more current and representative than other methods of obtaining freight rate data. Therefore, the quality and reliability of freight rate data make advantages superior to other research in identifying the causal relationship between freight rates and international trade.

3. Data and Methods

3.1. Source of Freight Rate Data. The reliability of the freight rate data is the key to determining the credibility of our empirical results. Most early studies used CIF/FOB ratio data to proxy transport costs. However, due to the differences in how data are collected between countries, the reliability of these data has been widely questioned [3, 20, 28]. Another primary source of freight rate data is databases based on import-charge data from customs declarations, such as the International Transport Database (BTI) created by ECLAC and the Maritime Transport Cost Database created by OECD [3, 6, 17, 18, 22, 24]. Nevertheless, these databases are limited to Latin America and the OECD countries and do not contain data for the last decade. Recently, UNCTAD, the World Bank, and International Maritime Organization (IMO) have developed a Global Transport Costs dataset for International Trade, covering the world, but it currently only has cross-sectional data for 2016 [29].

Due to the lack of publicly available data, some scholars obtained freight rate data by interviewing exporters and shipping lines [19, 20, 25, 30]. Nonetheless, it is not easy to fully represent the movement of the entire seaborne markets using only data from specific shipping lines. Moreover, the freight rate data obtained using the above methods are annual data, which can hardly be used to analyze the short-term changes in freight rates.

Recently, freight rate indices have received increasing scholarly attention. The Baltic Dry Index (BDI), the China (Export) Containerized Freight Index (CCFI), and the Shanghai Export Containerized Freight Index (SCFI) are considered the dominant market indicators for maritime shipping [15, 31, 32]. For example, Jiang et al. [7] selected monthly freight rate data for five branch routes of SCFI (Europe route, Persian Gulf route, Southeast Asia route, Taiwan route, and Hong Kong route) and used a VAR model to examine the interaction between export container freight rate and Shanghai export trade for each of these five routes. However, due to the large number of countries on the route, freight rates are susceptible to the influence of transit ports, and it is challenging to use country-specific macro variables as control variables. Therefore, it is difficult to identify the relationship between freight rates and export trade. The Southeast Asia Freight Index (SEAFI) that we use circumvents these shortcomings.

The Southeast Asia Freight Index (SEAFI) compiled by the Shanghai Shipping Exchange (SSE) reflects the spot rate changes of export containers on the services from Shanghai to Southeast Asia base ports. SEAFI includes freight rates on the six individual shipping routes: Singapore, Vietnam, Thailand, the Philippines, Malaysia, and Indonesia.

SEAFI's published freight rates of individual shipping routes have the following advantages (For more information about SEAFI, as seen in SSE [33]):

(1) The freight rates of individual shipping routes are based on prices in the spot market under the CIF terms, excluding those for long-term agreements and

large customers and are being unaffected by special service requirements.

(2) The freight rates are only for direct service, not transshipment.

(3) The freight rates include basic ocean freight and seaborne surcharges (Seaborne surcharges related to seaborne operational costs as bunker, currency, and equipment reposition and risks as war, port congestion, etc., excluding terminal handling, space-booking, and document charges.)

(4) The freight rate data come from 18 well-known global liner companies and 17 shippers and freight forwarders, which can fully reflect the movement of the freight market.

3.2. Data. Considering the available data and the structural changes in the data due to COVID-19, this paper selects freight rate data from February 2017 to January 2020 for six branch routes of SEAFI (Singapore, Vietnam, Thailand, the Philippines, Malaysia, and Indonesia). Following Jiang et al. [7], we select monthly export and import data for Shanghai and ASEAN-6 countries and convert the weekly freight rate data into monthly freight rate data by simple average calculation.

We also use the macroeconomic variables of the route counterpart countries as control variables. As is widely known, the indices of industrial production (IIP) have a strong correlation with container freight rates [34, 35]. Therefore, we use the industrial production index of ASEAN-6 countries as the control variables. At the same time, the bilateral exchange rate is a key factor affecting bilateral trade and trade balance [34, 36]. For example, when the Chinese Yuan strengthened against the Vietnamese Dong, Chinese cargo lost much of its price competitiveness, and China's exports to Vietnam fell. Therefore, we use the monthly average of bilateral exchange rates between the ASEAN-6 countries and China as a control variable.

Panel VAR can take advantage of the dimensionality of panel data compared to traditional VAR, allowing for the inclusion of individual fixed effects and time effects in the model [37, 38]. Individual fixed effects allow us to control time-invariant factors affecting container rates and international trade, including geographically relevant factors such as distance and islands. In addition, variables such as the market structures on maritime routes, the shipping connectivity of bilateral countries, the location of ports in international liner-shipping networks, and the level of port infrastructure and port efficiency also affect freight rates [2, 8, 24, 25]. However, these variables that define the structure of the shipping routes are only available at the annual base level, and they remain stable in the short term [20]. Instead, we use monthly data, mainly considering short-term changes in freight rates and trade. Therefore, individual fixed effects can also control these variables well. In addition, time-fixed effects can control global time effects, which simultaneously affect all shipping routes and countries. These global time effects include crude oil prices, global macroeconomics, shipbuilding industry, shipping market cycles, and other factors [35, 39, 40]. Table 1, reports the definitions of the variables we used, the data sources, and descriptive statistics.

According to the data we collected, Shanghai's trade with Southeast Asia is a severe trade imbalance. This is because Shanghai's exports to Southeast Asia are much smaller than its imports. Therefore, when exports are constant, an increase in imports will aggravate the trade imbalance. Moreover, when imports are constant, an increase in exports will ease the trade imbalance.

3.3. Methodology. We use a panel VAR model in the generalized method of moments (GMM) framework proposed by Abrigo and Love [41] to investigate the causal direction between export container freight rates, export trade, and import trade.

The specific model is shown as follows:

$$Y_{it} = Y_{it-1}A + X_{it}B + u_i + d_t + e_{it}, \quad (1)$$

where Y_{it} is a vector of dependent variables, including export container freight rates, export trade, and import trade. X_{it} is a vector of exogenous control variables, including the industrial production index and the bilateral exchange rate with China for ASEAN-6 countries. Matrices A and B are parameters to be estimated. The lag order of the model is determined according to MAIC, MBIC, and MQIC information criteria [42]. As shown in Table 2, we chose the first-order lag as the preferred model since the first-order has the smallest criteria values.

$u_i$denotes individual fixed effects. Since the panel VAR contains a lagged term for the dependent variable, using the mean-differencing method, which is commonly used for panel data, to eliminate individual fixed effects would result in bias. Therefore, we use the forward mean difference method to eliminate individual fixed effects [43]. d_t denotes the time dummy variables. We eliminate the time-fixed effects by the intragroup difference of means method [44].

We apply the empirical methodology of panel Granger causality tests to examine the causal relationship between export container freight rates, export trade, and import trade. Granger causality tests provide the direction of causality by determining whether one variable can predict another variable. In the panel VAR model, Granger causality tests are carried out employing Wald tests which are implemented based on the GMM estimate of the A matrix and its covariance matrix.

Then, we investigate the dynamic relationship between the endogenous variables through orthogonalized impulse-response functions. The orthogonalized impulse-response functions allow us to separate the response of export container freight rates to shocks from export trade or import trade. In other words, it is possible to obtain the response of

Table 1: Reports the definitions of the variables we used, the data sources, and descriptive statistics.

Variables	Definitions	Sources	Unit	Mean	Std. Dev.
CFI	Export container freight rates from shanghai to ASEAN-6 countries	Shanghai shipping exchange (SSE)	100 USD/ TEU	1.53	1.12
EX	Shanghai's exports to ASEAN-6 countries	Shanghai custom	Billion dollars	3.39	1.40
IM	Shanghai's imports to ASEAN-6 countries	Shanghai custom	Billion dollars	5.49	2.73
IIP	Indices of industrial production	World bank	Billion dollars	14.09	12.12
ER	Monthly average of bilateral exchange rates	World bank	LCU per CNY	913.1	0.276

export container freight rates to shocks from export trade when holding import trade constant.

The following section presents our empirical results. The causal and dynamic relationships are derived from panel Granger causality tests and orthogonal impulse response plots.

4. Empirical Analysis

4.1. PVAR Model Estimation Results. To ensure the validity of the estimated results of the panel VAR model, we applied the LLC and IPS unit root tests to determine the stationarity of all variables (Table 3).

Before we draw inferences from the estimation results, we checked the system stability of the entire panel VAR model. According to Hamilton [45]; Figure 2 shows that each eigenvalue is inside the unit circle, thus indicating that our model is stable.

Table 4presents the estimation results of our panel VAR model. Hansen's test of overidentifying restriction demonstrates the validity of the instrumental variables used in our study.

We performed a Granger causality test based on the Wald test. The results of the Granger causality test are shown in Table 5.

Combining the estimation results of the panel VAR and the results of the Granger causality test, we summarize the causal relationship between export container freight rates and import and export trade in Figure 3. The results show a bidirectional causal relationship between export container freight rates and export trade. An increase in export trade will reduce export container freight rates. At the same time, a decrease in export container freight rates promotes export trade. This is consistent with the findings of Inmaculada Martínez–Zarzoso and Suárez–Burguet [3]. In addition, there is a unidirectional causal relationship between import trade and export container freight rates. A decrease in import trade decreases export container freight rates, which is consistent with the results of Camisón–Haba and Clemente–Almendros [21].

Table 2: Lag order selection criteria.

Lag	MBIC	MAIC	MQIC
1	−414.163	−102.820	−229.336
2	−376.998	−91.600	−207.573
3	−338.392	−78.940	−184.370

Export container freight rates are a type of trade cost; hence, an increase in trade cost will hinder exports, which is consistent with international trade theory. Conversely, due to economies of scale, an increase in export trade helps reduce operating costs and export freight rates. Economies of scale in the shipping industry are considered the critical determinant of freight rates. At the ship level, the larger the size of the container ship is, the lower the cost of transporting a single container. For example, the cost per TEU for a 19,000 TEU ship is 40–46% less than that for an 8,500 TEU ship [46]. The larger the container ship is, the shorter the total voyage time, the more efficient the operation, and the lower the environmental impact [47]. Therefore, shipping companies will deploy larger ships on routes with higher trade volumes to take advantage of economies of scale at the ship level, resulting in lower average freight rates [2, 20]. In addition, another aspect of economies of scale is that the increase in trade volume on a route may attract more shipping companies to enter, thus increasing competition on the route and resulting in lower freight rates [2, 7, 21].

We add import trade variables to the analysis of Jiang et al. [7]; allowing us to consider the impact of trade imbalances on export freight rates. Trade imbalances imply that carriers are forced to haul empty containers back, a process known as repositioning empty containers. For shipping companies, repositioning empty containers only incur additional costs [48]. Due to high port handling costs, the cost of empty container repositioning has become a core cost for shipping companies [49]. In 2009, empty containers resulted in a total cost of $30.1 billion, accounting for 19% of the shipping industry's global revenue [50]. According to Table 1, we find that Shanghai's exports to the six Southeast Asian countries are much smaller than their imports, which means a severe trade imbalance between them. Therefore, the increase in export trade can also alleviate the trade imbalance, and the rise in import trade will aggravate the trade imbalance. Suppose the trade imbalance of the Shanghai-Southeast Asia route increases. In that case, the operating cost of shipping companies will also increase, and shipping companies will have to raise the freight rates to compensate for the loss.

Papers such as Clark et al. [2], Wilmsmeier et al. [22], Wilmsmeier and Martínez–Zarzoso [24], and De Oliveira [20] argue that when there is a trade imbalance, and carriers need to handle the relocation of empty containers on the leg of the trip with less traffic (exports). Therefore, carriers reduce export freight rates to attract those lower trade volumes and increase freight rates for the leg of the trip with

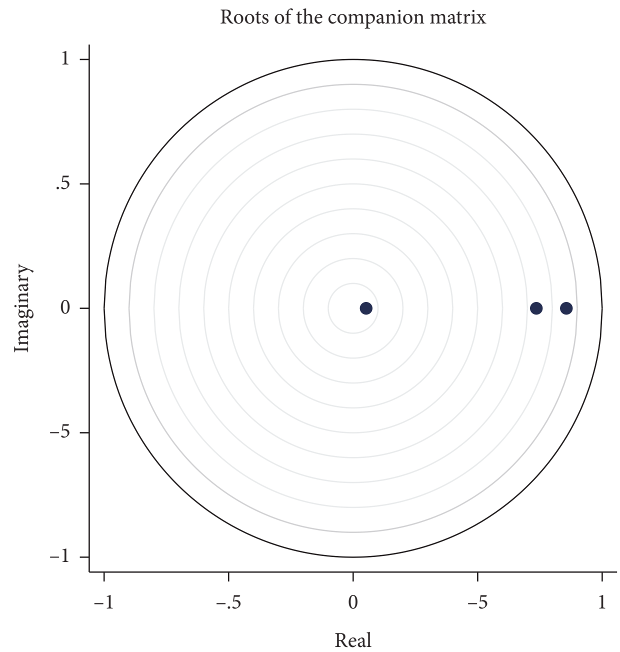

Figure 2: Stability Condition.

Table 3: Panel Unit Root Test Results.

Variables	Levin-Li-chu test Level		Im-pesaran-shin test Level	
	C	C&T	C	C&T
CFI	-3.64^{***}	-2.13^{***}	-3.55^{***}	-2.31^{***}
EX	-3.73^{***}	-2.75^{***}	-4.71^{***}	-3.51^{***}
IM	-6.32^{***}	-7.29^{***}	-7.71^{***}	-6.78^{***}
IP	-8.96^{***}	-8.51^{***}	-8.73^{***}	-9.95^{***}
ER	-1.84^{**}	-2.74^{***}	-1.59^{*}	0.16

Table 4: Estimation results for the panel VAR models.

Variable	Regressand: CFI	Regressand: EX	Regressand: IM
CFI_(t-1)	-0.822^{***} (0.069)	-0.217^{**} (0.108)	0.151 (0.337)
EX_{t-1}	-0.085^{**} (0.034)	0.145 (0.093)	0.407 (0.250)
IM_{t-1}	0.047^{***} (0.011)	0.087^{***} (0.026)	0.675^{***} (0.084)
IP	0.069^{**} (0.033)	0.159^{**} (0.072)	−0.250 (0.169)
ER	0.0014^{**} (0.00064)	0.00078 (0.0013)	-0.0074^{*} (0.0044)
Time-fixed effects	Control		
Obs.	204		
Hansen's test (*P*-value)	0.155		

Note. ***, ** and * denote 1%, 5%, and 10% significance levels, respectively. Corresponding robust standard errors allowing for intragroup correlation are in parentheses.

more traffic (imports) to compensate for the losses. Thus, the trade imbalance leads to a large freight rate gap between the two directions. However, this claim is not contradictory to our empirical results.

Shanghai and Southeast Asian countries have long been in a trade imbalance where exports are more significant than imports, and therefore export freight rates have remained low for a long time. Among the routes, the Shanghai to Philippines route, where the most severe trade imbalance has long had negative freight rates (the freight rates here do not include all surcharges, and the actual cost to the consignor is a positive amount.). In this case, we believe that an increase in trade imbalances will raise freight rates for imports but will not lead to a decrease in export freight rates. This is because the low export freight rates have made it challenging to cover the costs of transporting the goods. Carriers prefer to ship back empty containers to save time and gain revenue by transporting more imported cargo. Therefore, the export freight rate needs to be increased before the carrier accepts the shipment. Although the increase in trade imbalance will result in the broader gap between import and export freight rates, on average, both import and export freight rates will become higher. For example, the China–US container route was affected by COVID-19. The overlap of China first resuming production and the recovery of U.S. consumer demand has led to a significant increase in U.S. demand for Chinese goods. The surge in imports from China and the growing trade imbalance between the U.S. and China led to a spike in U.S. import freight rates from China, but U.S. export freight rates to China did not decline. As a result, shipping companies rejected many U.S. agricultural exports during October and November 2020, opting to ship empty containers to China [51].

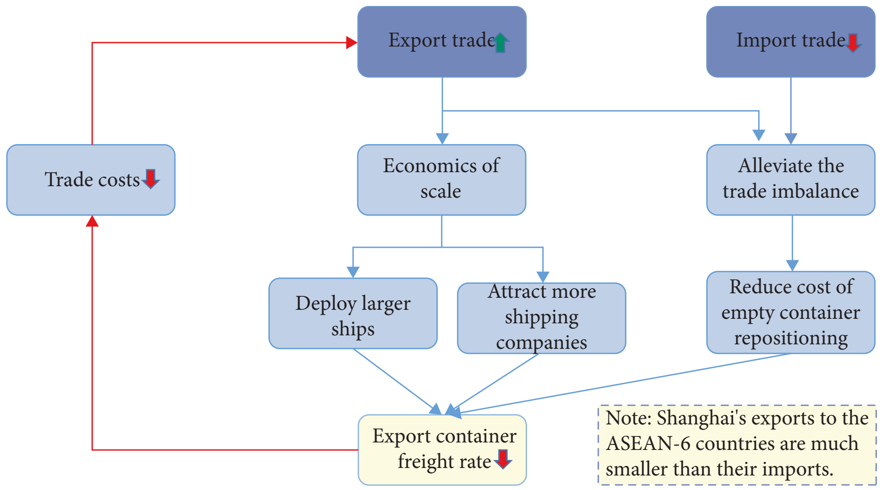

Figure 3: Causal relationships.

Table 5: Wald test of Granger causality.

		x^2	Df	prob>x^2
CFI				
	EX (t-1)	6.136	1	0.013
	IM (t-1)	18.363	1	0.000
	ALL (t-1)	35.036	2	0.000
EX				
	CFI (t-1)	4.003	1	0.045
	IM (t-1)	11.013	1	0.001
	ALL (t-1)	22.739	2	0.000
IM				
	CFI (t-1)	0.203	1	0.653
	EX (t-1)	2.652	1	0.103
	ALL (t-1)	2.698	2	0.259

Note. H0: The excluded variable does not Granger-cause the equation variable. H1: The excluded variable Granger causes the equation variable.

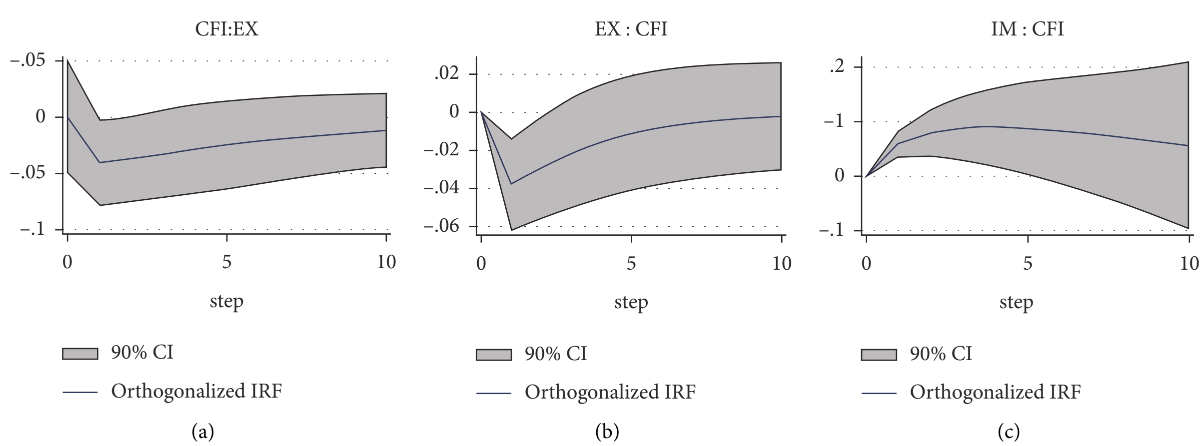

Figure 4: Impulse response graphs.

Shipping companies have indicated that they will not transport unless freight rates are increased.

4.2. Impulse Response Analysis. Impulse response graphs are presented in Figure 4. 90% confidence bounds are based on 300 bootstrap simulations.

Presents the estimation results of our panel VAR model. Hansen's test of overidentifying restriction demonstrates the validity of the instrumental variables used in our study.

In Figure 4(a), an one standard deviation unanticipated positive freight rate shock immediately hurts export trade. A significant impact is observed in the first period, after which it gradually decreases and converges to zero. Thus, we find that the

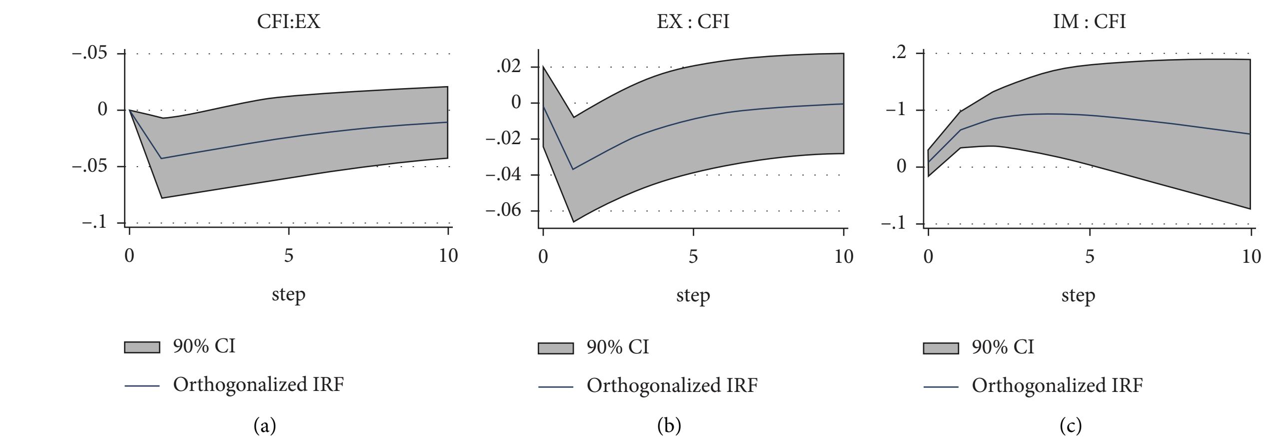

Figure 5: Impulse response graphs.

impeding effect of export container freight rates on export trade takes effect immediately but is not maintained for a long time.

In Figure 4(b), a positive shock to export trade decreases export container freight rates. This effect is maximized in the first period and is statistically significant up to the second period.

In Figure 4(c), a positive shock to import trade significantly contributes to increased export container freight rates for at least five months. This indicates that a larger trade imbalance due to increased import trade can impact export container freight rates for a more extended period. At the same time, the impact caused by import trade is twice as large as that of export trade and lasts longer.

Finally, we performed a robustness test. To identify shocks and keep other shocks zero, we need to give the variables a specific order [45]. The current order of the variables is [CFI, EX, IM]. For a robustness check, we reverse the order of the variables to [IM, EX, CFI]. See Figure 5, where the variable order has no substantial effect on the results.

5. Conclusion

To investigate the relationship between container freight rates and international trade, we analyze the relationship between export container freight rates and imports and exports from Shanghai to ASEAN-6 countries by applying a panel vector autoregression technique. Our study not only considers the relationship between export trade and freight rates but also considers the impact of import trade by changing trade imbalances. The panel vector autoregression technique has advantages in controlling macroeconomic factors and unobservable heterogeneity using individual fixed and time effects. It thus can identify the causal relationship between container freight rates and international trade more accurately.

The results show a bidirectional causal relationship between export container freight rates and export trade. An increase in export trade reduces export container freight rates by achieving economies of scale and improving trade imbalances. Conversely, an increase in export container freight rates implies increased trade costs and hinders export trade. However, the causal relationship between import trade and export container freight rates is unidirectional. The increase in import trade raises export container freight rates by exacerbating trade imbalances.

In addition, this paper also investigates the dynamic effects through orthogonal impulse response functions. We find that the impact of import trade on export container freight rates is larger and longer lasting than that of export trade, indicating the importance of import trade in changing trade imbalances. As well known, trade imbalances are widespread worldwide, with satellite data of ship movements showing that 42% of ships are traveling without cargo [5]. Therefore, trade in both directions needs to be considered when studying trade costs. Overall, our findings validate that trade costs are endogenous and provide empirical evidence for current trade theory research on the endogeneity of trade costs, in contrast to existing literature that interprets trade costs as exogenous based on classic trade theory.

According to the empirical results, we put forward the following suggestions. First, as the leader of serving the construction of the “twenty-first Century Maritime Silk Road,” Shanghai should continue to speed up the structure of the international shipping center and form a linkage with the construction of the Shanghai free trade zone to create a shipping development environment with international competitiveness. Second, Shanghai should also seize the opportunity to implement the “twenty-first Century Maritime Silk Road” to promote the integration of trade with ASEAN and other countries, expand trade exchanges, and further highlight the function of Shanghai as an international trade center. Especially after the signing of the RCEP, the economic and trade cooperation between ASEAN and Shanghai has been ushering in more significant development opportunities. The ASEAN region is increasingly becoming the core area for Shanghai to construct the “twenty-first Century Maritime Silk Road,” but the structural trade imbalance between Shanghai and ASEAN has hindered the further development of bilateral trade. Therefore, Shanghai should collaborate with the Yangtze River Delta region to participate in global competition and cooperation and create opportunities for industries with comparative advantages to enter the ASEAN market. This initiative utilizes the shipping capacity that was previously wasted due to trade imbalance and reduces the cost of shipping by reducing empty containers, which ultimately contributes to the development of the trade and shipping industry.

Due to the limitation of the data, this paper only examined the relationship between one direction container freight rates and international trade. However, their relationship may change due to the difference in directions, which would require further data collection and analysis. In addition, many macrodata in the monthly data are not applicable.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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