Rakha and El-Aasar
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The impact of the belt and road initiative on the Suez Canal cargo trade

Anas Rakha[1*] and Khadiga El-Aasar[1]

*Correspondence:
anas_rakha2016@feps.edu.eg

[1] Faculty of Economics and Political Science, Cairo University, Giza, Egypt

Abstract

The Suez Canal (SC) serves as the shortest maritime transport route from east to west. In the absence of the SC, global trade and transportation costs would increase substantially, impeding the expansion potential of the global economy. The Belt and Road Initiative (BRI) is a key component of China's future international trading network, with significant implications for global seaborne trade. The BRI's two primary pillars are the Maritime Silk Road (MSR) and the Silk Road Economic Belt, both of which have significant infrastructural investments. The MSR connects China to various regions in Asia, Africa, and Europe via the SC, thereby serving as a significant maritime trade route on a global scale, particularly between Europe and China. This is due to the SC's distinctive positioning on the MSR. Consequently, studying the significance of BRI for the SC cargo trade is crucial. This study uses annual data from 1990 to 2022 to examine this dynamic relationship. To account for the interaction effect of the variables, we use the vector autoregressive model and the impulse response function. Model results show that China's seaborne trade will increase SC trade by 23%, and China's BRI investment projects are anticipated to have a 5% significant impact on SC cargo trade and will continue to grow in the medium and long run. According to these findings, the SC has to continue to adopt more flexible pricing and marketing strategies to encourage and attract more customers. As a result, the SC could become a global logistics center and transform from a trade gateway to a global hub if it develops more value-added activities in its adjacent areas and attracts substantial Chinese investments.

Keywords: Suez Canal, Belt and road initiative, China's seaborne trade, China's BRI investment projects, Maritime silk road, VAR model, Impulse response function

JEL Classification: F13, F15

Introduction

Global waterways serve as vital maritime nodes, enabling the shipping of over 80% of cargo related to international trade (Sirimanne et al. 2023). Their efforts have resulted in a significant reduction in logistical expenses while also ensuring efficient transit durations. Throughout history, numerous instances of maritime infrastructure have undeniably played a pivotal role in facilitating international trade. The SC has successfully decreased shipping times and transportation costs associated with trade between Asia and Europe, as Notteboom et al. (2020) demonstrated.

The containership "Ever Given" grounded incident at the end of March 2021 offers compelling evidence that the SC is a vital element of international maritime trade (Lee and Wong 2021). When compared to alternative routes, the SC provides the shortest connection between East and West. The implementation of the Canal route provides several benefits, including enhanced time management, decreased travel distance, reduced fuel consumption, and overall financial savings.

The SC continues to provide support to the maritime industry by promoting ongoing development. Numerous expansion initiatives have been implemented on the SC, such as double-tracking and deepening. The inauguration of the newly constructed SC, which had been undertaken for a duration of one year, occurred on August 6, 2015. The waterway under consideration was designed to traverse the existing canal in parallel for an extensive span of 72 km. The overarching objective of the project is to increase the navigable length of the canal from 80.5 km to 111.2 km, thereby enabling bidirectional vessel movement. According to Shibasaki et al. (2016), the daily crossing capacity doubled from 49 to 93 vessels, and the transit duration was reduced from 18 to 11 h as a result of the SC expansion. This facilitates the transit of 93% of the global dry bulk cargo fleet, comprising 100% of container vessels, 63% of tankers, and 100% of other ship types (Laih et al. 2022).

Since President Xi Jinping unveiled the BRI in 2013, numerous positive developments have occurred. The Belt and Road Initiative (BRI), which connects Asia, Europe, and Africa, has initiated more than three thousand cooperation projects and raised approximately one trillion dollars over the last decade. According to Lu et al. (2024), trade and foreign direct investment (FDI) in the countries participating in the BRI are projected to be 30% and 70% less than their potential, respectively.

China started the BRI to boost transcontinental connectivity, trade, and economic growth. China's economic restructuring relies on the BRI's energy supply, international collaboration, and international trade network. China's investments along the new MSR are a strategic move to increase its influence over the Sea Lanes of Communications and the interconnected global value chains of maritime transportation. Currently, the BRI is actively engaged in mitigating the risks associated with overdependence on established transportation pathways. This is being done by creating alternative routes that can bypass any bottlenecks. (Haralambides and Merk 2020).

The BRI was instigated by China with the principal aims of promoting economic development, enhancing global trade, and facilitating transcontinental cooperation and connectivity. China was connected to Gulf countries, East and North Africa, Europe, and Southeast Asia via the Maritime Silk Road, which passed through the SC. In contrast, the "Belt" via land, which originated in China and passed through Central and South Asia en route to Europe, is comprised of six land-based economic corridors, as depicted in Fig. 1.

According to the BRI literature that is currently available, no research has yet been done to examine the link between the BRI and the SC. The existing literature has paid limited attention to the ramifications of the SC within the framework of the BRI. This research study hopes to address this existing knowledge gap by introducing the concept of the SC within the framework of the BRI. This research makes a substantial contribution to an area of literature in four ways. To commence, the analysis relies on a new

Fig. 1 The scope of the belt and road initiative including the Suez Canal. Source: Authors

variable referred to as China's BRI investment projects, with tangible BRI investment projects being represented by China's outward FDI. Moreover, this article presents a novel approach to quantifying the BRI through an examination of China's maritime trade and investments in the context of the BRI in order to ascertain their impact on the SC cargo trade. Furthermore, it integrates the new SC project, ongoing SC development projects, double parts, and the new SC undertaking, presenting them as an unprecedented variable in the new SC development projects. Moreover, in order to address the lack of literature on the correlation between the BRI and global trade via the SC, a VAR model and an IRF are implemented.

The rest of the paper is organized as follows. Sect. "Literature review" is a review of the relevant literature, while Sect. "The nexus between the Suez Canal cargo trade and belt and road initiative" presents the BRI and SC. Sect. "Data and methodology" addresses research methods with the data. Sect. "Empirical results" discusses and interprets the empirical results. Sect. "Conclusion" provides the conclusion and directions for further research.

Literature review

There is a scarcity of literature dedicated to the examination of the cargo trade in the SC. Feyrer (2021), using a gravity model to analyze data collected between 1967 and 1975, found that the SC's closure negatively impacted both trade and revenue. Mostafa (2004) analyzed SC traffic from the SC's reopening in 1975 to 1998, created traffic projections using univariate ARIMA and neural network models, and found the trend of marine traffic patterns. Gao and Lu (2019) investigated how expensive it was to transfer the Chinese fleet by closing off nine major world waterways.

Using an aggregated logit model, Shibasaki et al. (2016 and 2017) described the variety of global route options available to shipping companies, focusing on market share for

each route, including the SC. Market share shifts from the SC route to the NSR and rail transport were the primary subjects of Zhu et al. (2018). Zeng et al. (2020) investigated competition for transporting cargo between Asia and Europe, focusing on the NSR, the SC route, and the railway route. Notteboom (2012) contrasted the SC route with the Cape route.

Wan et al. (2023) analyzed the effects of the SC closure on maritime transportation on a global scale and employed comprehensive maritime network data obtained from 2018 AIS ship trajectory data in order to emphasize the SC's essential role in international shipping. Furthermore, they underscored the vital role of supply chain management in the prevention of catastrophes.

Early BRI research focused on geopolitics, according to Ferrari and Tei (2020). Scholarly study on trade and shipping has increased to predict future effects on trade volumes, flows, shipping costs, and operational effectiveness. The BRI has been the subject of over 800 scientific studies in the past decade. Shipping economics, international trade, logistics, and supply chains are covered in these works. These works include literature reviews such as Lee et al. (2018, 2020, 2022), Wang et al. (2020; 2021), Jiang et al. (2023), and Saeed et al. (2023).

Haralambides and Merk (2020) analyzed the BRI's main goals, while Du and Zhang (2018), Nugent and Lu (2021), and Peng et al. (2021) assessed the BRI from a Chinese perspective, finding that execution of the BRI has a substantial impact on international shipping and that maritime trade plays an essential strategic role in the BRI. Because of the short duration since the BRI started, numerous launched projects are improbable to have yielded substantial benefits (Saeed et al. 2021). The BRI is expected to restructure maritime networks and change global seaborne trade, including the relocation of major waterways and ports (Lee et al. 2018). Completed BRI projects will increase regional and global trade by linking previously secluded and isolated developing regions like the Indian subcontinent (Alam and Baig 2019), Southeast Asia (Mueller 2019), and Africa (Luke and Mageto 2023; Chen et al. 2020; Lee 2016). By combining the two types of shipping transport, Yang et al. (2020) recreate the Asian-European shipping network. As reported by Hoffmann et al. (2020), several BRI countries anticipate that enhanced maritime infrastructure will increase international trade, decrease transaction costs, and facilitate greater national participation in the global supply chain. After 2013, China's outward FDI to Asia was positively impacted by the BRI countries' GDP and container port throughput levels (Ardianto et al. 2023). It is expected that the investment project of China's BRI will exert a substantial influence on SC trade over an extended period of time (Rakha and El-Aasar 2024). Depending on the country, BRI-related investments and infrastructure improvements are expected to enhance trade flows by 2.7% to 9.7% (De Soyres et al. 2019) and by 4.1% (Baniya and Rocha 2020) when reforms in trade complement the upgrading of transportation networks.

The connection between the BRI and the SC lacks scholarly attention. Ibrahim et al. (2019) examined the effects of China's BRI and SC, investigated the economic effects of the BRI as well as its energy movements and chokepoints, and used quantitative analysis to predict the hydrocarbon influx in the SC Zone. Furthermore, he contemplated the establishment of integrated trade corridors along the BRI, an extensive network of alternative routes connecting Europe and Asia. Additionally, he identified barriers to SC

through BRI analysis. Moreover, he concluded that the BRI facilitated Egyptian-Chinese Egypt 2030 cooperation.

Scholars concurred that the BRI has an effect on maritime trade, although a few VAR model evaluations have been published. Jiang et al. (2018) assessed shipping costs and MSR exports across all five shipping lanes using the VAR model. Wangping and Xiaolu (2018) created a VAR model to study how FDI, trade, and exports affect China and Japan. Paderon and Ang (2020) used a VAR model to analyze China's BRI's economic impacts on the Philippines. Lee et al. (2022) used panel VAR and data from 2000 to 2017 to find out how changes in China's real and monetary sectors hurt the economies of the 50 countries along the Belt and Road. They also looked at how these changes in China's real GDP, trade openness, and monetary metrics spread over time. Yu and Sun (2019) applied the vector-error correction model and impulse response functions to evaluate the openness of BRI service trade. From 2000 to 2016, service trade, openness, human capital, and product import and export were in a state of equilibrium. Zhang et al. (2022) used the VAR model to analyze how export trade from Central Asia to China affects land cover changes and ecosystem services before and after the BRI. This motivates us to probe the link between the SC and the BRI using the VAR model.

The nexus between the Suez Canal cargo trade and belt and road initiative

Since 1956, Egypt and China have promoted economic collaboration, specifically in the field of energy. Egypt is a BRI Africa-West Asia supporter. In order to advance the BRI, refine bilateral policies, and execute innovative economic strategies, Egypt and China are collaborating in the twenty-first century to strengthen their relations. By virtue of its MSR membership, Egypt is a valuable BRI partner. The BRI and the Egypt 2030 Plan operate in concert. The SC Corridor, which China and Egypt have agreed to develop into the future administrative capital, holds the potential for economic opportunities and renewable energy. The development of Chinese industrial parks overseas is highlighted in the Tianjin Economic-Technological Development (TEDA) Suez Economic and Trade Cooperation Zone, which is the China-Egypt Industrial Park (Bi et al. 2023).

The SC, situated in Egypt, is an essential element of infrastructure for international maritime transport. The SC is a man-made waterway that stretches for 194 km between the Mediterranean and the Red Seas. Trade between Europe and Asia, in particular, has greatly benefited from it since its opening in 1869. Table 1 shows that the SC can shorten

Table 1 Cape of Good Hope vs. Suez Canal BRI distance savings. Source: Authors' calculation using data collected at https://sea-distances.org/

Origin	Destination	Distance (Nautical Miles)			Time (Days)			
		Suez	Cape	Saving	Suez	Cape	Saving	Saving (%)
Shanghai	Piraeus	7,844	14,253	6,409	23	43	20	47
Shanghai	Constanza	8,233	14,768	6,535	24	44	20	45
Shanghai	Trieste	8,545	14,420	5,875	25	42	17	40
Shanghai	Rotterdam	10,525	13,843	3,318	31	41	10	24
Shanghai	Hamburg	10,778	14,096	3,318	32	42	10	24
Shanghai	ST Petersburg	11,767	15,085	3,318	35	45	10	22

the distance savings by ranging from 22 to 47 percent compared to the Cape of Good Hope for BRI countries.

"EVER GIVEN," a massive container ship, ran aground in the SC on March 23, 2021, blocking traffic in both directions. As a result, the canal's closure had a significant impact on the $400 million in value of goods transported every hour. The closure lowered yearly worldwide trade growth by 0.2% to 0.4%, and $9.6 billion in goods pass through the canal daily. Since the SC carries over $1 trillion worth of goods annually (Fan et al. 2022), its grounding has highlighted the importance of the SC for global supply networks and seaborne trade.

Every year, the SC can transport approximately more than one billion tons of food, medicine, fuel, and other human necessities. In 2022, approximately 23,851 vessels totaling 1.2 billion tons passed through the SC in both directions (SCA 2023). As shown in Table 2, container vessels accounted for the largest share of cargo tonnage (474 million tons, or 40.3% of the total). Throughout 2023, an estimated 26,000 vessels traversed the SC. 40% of all tonnage in transit was conveyed by containerships, followed by 23% and 19%, respectively, by oil tankers and bulk carriers.

China, the second-largest economy globally, carried out the majority of its operations internally prior to the 1970s. The exceptional rise of China during the 1980s was accelerated by a substantial increase in investment, imports, and exports. As a result of stagnant domestic overcapacity and insufficient external demand, China's GDP growth has declined. The administration implemented measures to strengthen and reform the economy in the wake of the opening and reform. As shown in Fig. 2, domestic demand, and consumption in particular, substantially increased GDP. Important investment projects along the BRI have been moving forward regularly. Global interest in energy trading and transportation projects is increasing, particularly in East and West Asia and Sub-Saharan Africa, as shown in Table 3.

China's sustained high growth rates have been substantially influenced by foreign trade ever since the country's membership in the World Trade Organization (WTO) in 2001. This can be attributed, in part, to the increased utilization of FDI by the country, the expansion of their foreign market share, and the heightened competitiveness

Table 2 Suez Canal transit statistics by vessel type in 2022. Source: Authors' calculations using data collected by the SCA (2023) & Clarksons Research, Shipping Intelligence Network Timeseries

Vessel Type	Number of Vessels		Cargo tons	
	No.	Share (%)	Amount (1000 ton)	Share (%)
Containers	5,721	24.0	474,013	40.3
Tankers	7,508	31.5	363,527	30.9
Dry Bulk	6,499	27.2	317,238	26.9
General cargo	2,132	8.9	11,363	1.0
Car carriers	1,031	4.3	7,624	0.6
RO/RO	224	0.9	2,548	0.2
Cruise	82	0.3	4	0.0
Others	654	2.7	1,114	0.1
Total	23,851	100.0	1,177,430	100.0
Global Total	105,393	22.6	11,882,069	9.9

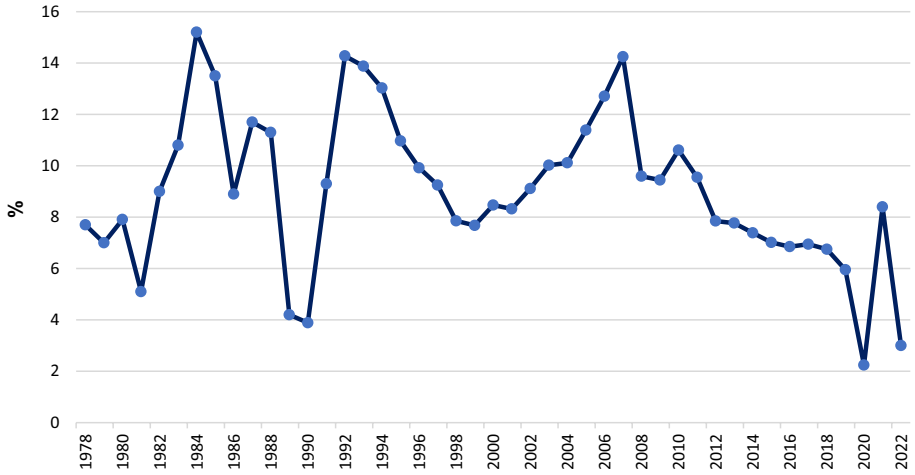

Fig. 2 China's GDP growth rate. Source: Authors using IMF database

Table 3 China's BRI Investment by Region and Sector ($m) from 2013 to 2022

Group	Energy	Transport	Metals	Real estate	Logistics	Other	Total	Share (%)
East Asia	73,030	57,840	21,260	23,330	13,820	47,550	236,830	26
West Asia	97,000	38,470	9,500	11,210	1,560	25,280	183,020	20
Sub-Saharan Africa	50,380	56,790	23,970	19,240	2,800	20,870	174,050	19
Arab Middle East and North Africa	73,140	19,180	2,030	23,460	1,560	23,860	143,230	16
Europe	19,860	32,160	2,530	1,310	2,570	32,740	91,170	10
South America	35,430	10,380	23,240	1,460	230	4,900	75,640	8
North America	1,010	5,080	300	450	0	1,830	8,670	1
Total	349,850	219,900	82,830	80,460	22,540	157,030	912,610	100
Share (%)	38	24	9	9	2	17	100	

Source: Authors' calculations using the China Global Investment Tracker, American Enterprise Institute and Heritage Foundation, retrieved September 1, 2023, at https://www.aei.org/chinglobal-investment-tracker/

of their exports. Over the period from 2000 to 2022, China's maritime exports grew at an average annual rate of 6%. In 2022, approximately 50% of China's total seaborne exports consisted of containers. Steel constituted 11% of this total, chemicals 9%, mineral minors 9%, fertilizers 6%, reefer cargo 4%, petroleum products 2%, and general cargo 2%, as shown in Fig. 3.

According to the data illustrated in Fig. 4, there was an average annual growth rate of 11% in Chinese seaborne imports between the years 2000 and 2022. Iron ore comprised an approximate 40% of China's total seaborne imports in 2022, followed by crude oil (17%) and coal (9%). Cereals, containers, and LNG, respectively, comprised the remaining 5%, 4%, and 3%.

China has made huge investments in energy, transportation networks, metals, and central logistics along the economic corridors of the BRI since its inception in 2013. The recently integrated feature enhances the reliability and accessibility of worldwide maritime routes, specifically those that connect Europe and China through the SC. The BRI and the SC not only help in the prompt transportation of goods to their

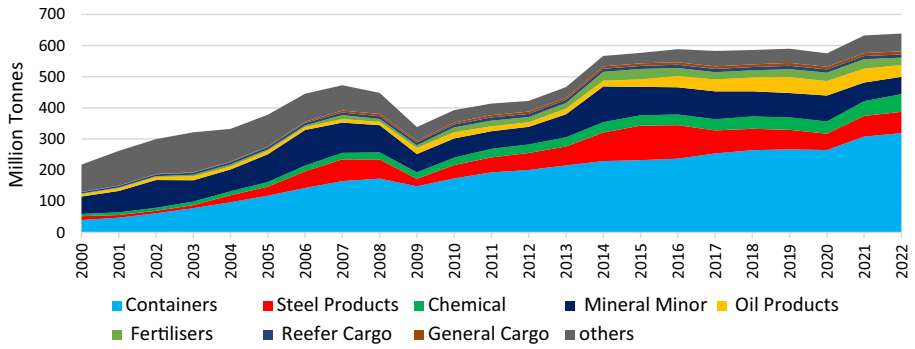

Fig. 3 China's seaborne global exports by cargo type. Source: Authors' calculations using Clarksons Research, Shipping Intelligence Network Timeseries, July 2023

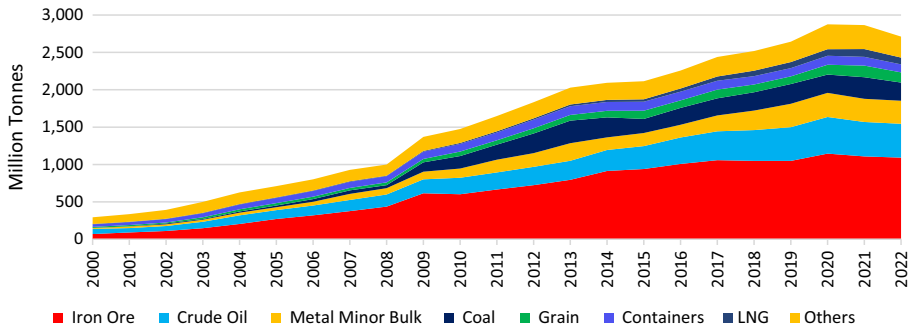

Fig. 4 China's seaborne global imports by cargo type. Source: Authors' calculations using Clarksons Research, Shipping Intelligence Network Timeseries, July 2023

designated destinations but also play a role in mitigating the environmental impact of the maritime industry by reducing shipping time.

Data and methodology

Data description

This article chooses the SC cargo trade annual data given by the Suez Canal Authority (SCA) from 1990 to 2022, for a total of 33 periods of available data points for empirical analysis, to delve into the connection between BRI and the SC cargo trade. Other variables included Chinese seaborne trade, China's BRI investment projects, and SC's new development projects.

Regarding the shipping data, we utilize Chinese seaborne trade as an indicator for total Chinese seaborne imports and exports. China is a significant catalyst for worldwide seaborne demand, as evidenced by the record-breaking growth of imports to 2778 mt and exports to 638 mt in 2023, as demonstrated in Fig. 5. Furthermore, China's SC trade constituted 30 percent of the world's SC cargo trade in 2022.

The outward FDI of China is used as an indicator of the nation's active participation in tangible investment endeavors associated with China's BRI investment projects. Chinese investments in the global real estate, energy, transportation, commodities, and technology sectors comprise this category. As shown in Fig. 6, China's BRI investment projects have increased significantly since the initiative's inception in 2013.

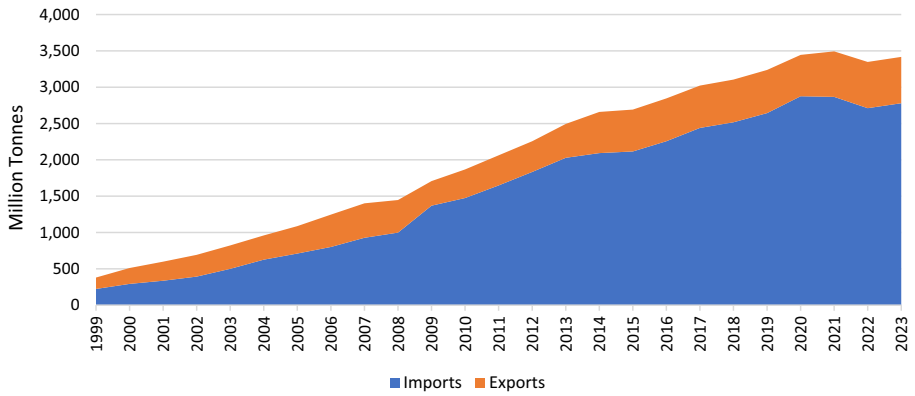

Fig. 5 Chinese seaborne trade. Source: Authors' calculations using Clarksons Research, Shipping Intelligence Network Timeseries, retrieved January 1, 2024

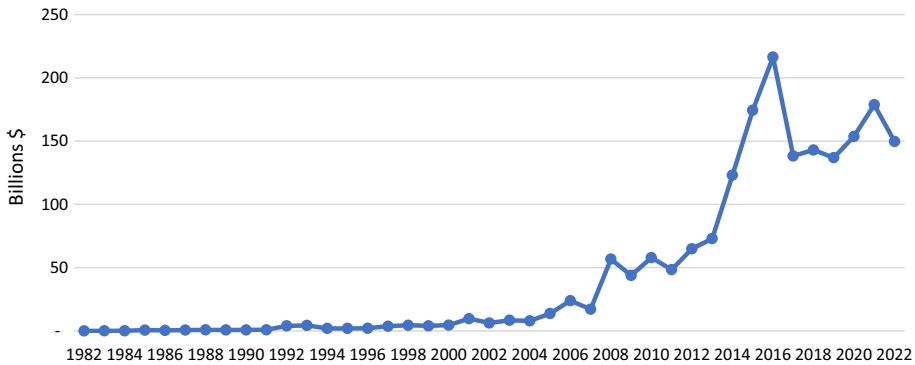

Fig. 6 Chinese outward FDI. Source: Authors' calculations using the World Bank database, retrieved January 1, 2024

Table 4 Development of the Navigation in the Suez Canal. Source: Authors' calculations using data collected by the Suez Canal Authority, retrieved January 1, 2024 at:https://www.suezcanal.gov.eg/English/About/SuezCanal/Pages/CanalCharacteristics.aspx

Description	1869	1956	1962	1981	1994	1996	2001	2010	2015 +
Overall Length (Km)	164	175	175	189.8	189.8	189.8	191.8	193.3	193.3
Doubled Parts (Km)	0	27.7	27.7	77	77	77	79	80.5	111.2
Depth (M)	8	14	15.5	19.5	20.5	21	22.5	24	24
Cross Sectional Area (M2)	304	1200	1800	3600	4000	4300	4800	5200	5400
Max. Draft (Feet)	22	35	38	53	56	58	62	66	66
Max. tonnage (1000 Tons)	5	30	60	150	170	185	210	240	240

In regards to the SC's new development projects, we use the length of double-part sections and the SC's additional development projects. The new canal, which runs parallel to the ancient SC, commenced operations on August 5, 2014. Sections of the SC were widened and deepened (Elsherbiny 2019). As shown in Table 4, the development of the SC benefits shipping. Table 5 lists variables, indicators, and data sources. Table 6 shows variable descriptive statistics before logarithmic adjustment.

Table 5 Variables considered, their indicators, and sources

Variable	Description	Unit	Symbol	Source
SC cargo trade	It is an annual indicator of the volume of global seaborne trade passing through the Suez Canal	m. t tonnes	SC	SCA
Chinese seaborne trade	It measures the volume of China's goods loaded and unloaded annually in the china's seaports	m. tonnes	CT	Clarksons Research
China's BRI investment projects	China's outward FDI is used as a proxy for the actual BRI projects that China is investing in. Chinese investments in the world's energy, transportation, metals, technology, and real estate markets are included	m. US$	BRI	The World Bank
SC new development projects	It measures the length of a double section. It includes Suez Canal double parts, the new Suez Canal, and other development projects	kilometers	NDP	SCA

Table 6 Variable descriptive statistics. Source: Authors' analysis

Variable	SC	CT	BRI	NDP
Mean	576.8	1,511.2	35,343.4	86.1
Median	565.2	1,246.9	10,979.1	79.0
Maximum	1,088.9	3,498.4	126,840.0	113.3
Minimum	271.9	135.6	531.2	77.0
Std. Dev	267.4	1,172.7	42,864.2	14.7
Skewness	0.3	0.4	1.1	1.3
Kurtosis	1.8	1.6	2.6	2.8
Jarque–Bera	2.5	3.4	6.4	9.6
Probability	0.00	0.00	0.0	0.01

Table 7 ADF test results

Variable	ADF Test Statistic	*p* value	Variable	ADF Test Statistic	*p* value
SC	1.1275	0.9969	D(SC)	− 5.2603	0.0002*
CT	− 2.7413	0.0082*			
BRI	− 1.2792	0.6269	D(BRI)	− 5.7294	0.0000*
NDP	− 0.4384	0.8905	D(NDP)	− 5.6100	0.0001*

*Estimated significance is at the 1% level. Automatic lag length selection uses the Schwarz Information Criterion (SIC)

D: the first difference level

Unit root test

The stationarity of each variable in a VAR model must be checked. The Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1979, 1981) is the most often used unit root test for time series. Table 7 shows the outcomes of a unit root test for the ADF with the most important variables. With the exception of China's seaborne trade, which is not stationary at the first difference level, Table 7 demonstrates that all other variables are stationary. In causality analysis, level series can be employed to estimate regressions without the need for an additional cointegration test (Said and Dickey 1984).

The VAR model

Sims's (1980) development of the VAR model is widely employed in the study of causal relationships between variables. It uses a linear combination of the lags of a group of endogenous variables to characterize their change over time. To be more specific, the progression of each endogenous variable depends on the lagging components of not just the other endogenous variables but also the controlled variables. We use a VAR (p) model to examine the factors that influence SC cargo trade by evaluating the relationship between their p-lag variables. This model includes China's seaborne trade, BRI investment, and SC's new development projects as multivariables.

The set of equations below is estimated using the VAR (p) model. The generic VAR model can be written as follows if the lag order is p and Xt is an endogenous variable with dimensions (4×1):

$$X_t = C + B_1 X_{t-1} + B_2 X_{t-2} + \cdots + B_p X_{t-p} + A_e Z_t + \epsilon_t \quad (1)$$

where C is a constant vector with dimensions of 4×1, X_t is a column vector of controlled variables with dimensions of 4×1, p represents the order of lags, each B_1, B_2,..., B_p denotes a coefficient matrix with dimensions of 4×4, each of X_{t-1}, X_{t-2},..., X_{t-p} entails a vector of lag endogenous variables with dimensions of 4×1, A_e is the matrix of Z_t coefficients, and ϵ_t is the vector of random error terms in the system with dimensions of 4×1.

After transforming all variables into natural logarithm form and accounting for controlled variables, the VAR model presented in this paper is expressed as follows:

$$\mathrm{D(LSC)}_t = C + B_1 \mathrm{D(LSC)}_{t-1} + B_2 \mathrm{LCT}_t + B_3 \mathrm{D(LBRI)}_t + B_p \mathrm{D(LNDP)}_t + \epsilon_t \quad (2)$$

As can be seen in Table 8, the lag length of VAR p is selected using the minimal Akaike Information Criterion (AIC), with a maximum lag of 1.

The stability of the VAR model is maximized since all inverse roots of the characteristic polynomial of AR are less than 1. Furthermore, as can be seen in Fig. 7, it provides a useful model for illustrating the interaction between various components.

Table 9 shows that if SC trade increases by 1% compared to the previous year, it will increase by 69% this year. Rising navigational safety standards, the reliability of SC operations, and the ongoing increase in global demand for goods and commodities are all factors in this evolution. China's seaborne trade is predicted to increase SC trade by 23%, while China's BRI investment projects are likely to have a major positive influence of 5% on SC trade. Every 1% increase in the number of construction projects in the SC will result in a 3% increase in cargo trade.

Table 8 Selection Criteria for the VAR Lag Order

Lag	LogL	LR	FPE	AIC	SC	HQ
0	56.47903	NA	2.22E-08	− 3.43194	− 3.1984	− 3.35723
1	178.4357	195.1306*	3.56e-11*	− 9.895712*	− 8.494515*	− 9.447457*
2	196.5193	22.90592	6.58E-11	− 9.43462	− 6.86576	− 8.61282

*Indicates lag order selected by the criterion

LR Sequential modified LR test statistic (each test at the 5% level). *FPE* Final prediction error. *AIC* Akaike information criterion. *SC* Schwarz information criterion. *HQ* Hannan-Quinn information criterion

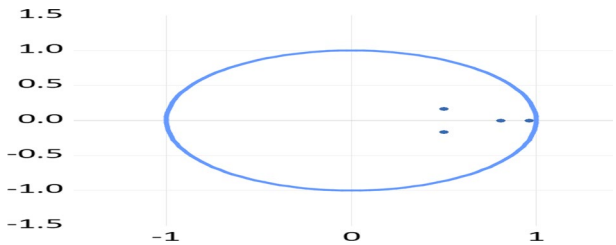

Fig. 7 The inverse roots of the AR characteristic polynomial

Table 9 The VAR model results

Variable	D(LSC)	LCT	D(LBRI)	D(LNDP)
D(LSC) $_{(-1)}$	0.69	0. 30	0.04	0.55
	(0.00)	(0.07)	(0.00)	(0.07)
LCT $_{(-1)}$	0.23	0.90	0.41	0.31
	(0.00)	(0.00)	(0.01)	(0.01)
D(LBRI) $_{(-1)}$	0.05	0.25	0.66	0.10
	(0.01)	(0.06)	(0.03)	(0.03)
D(LNDP) $_{(-1)}$	0.03	0.03	0.02	0.77
	(0.01)	(0.05)	(0.09)	(0.00)
C	0.05	0.27	− 0.33	0.39
	(0.03)	(0.21)	(0.81)	(0.04)

The *P* values are enclosed by parenthesis. (− 1) in the parentheses represents the lag length

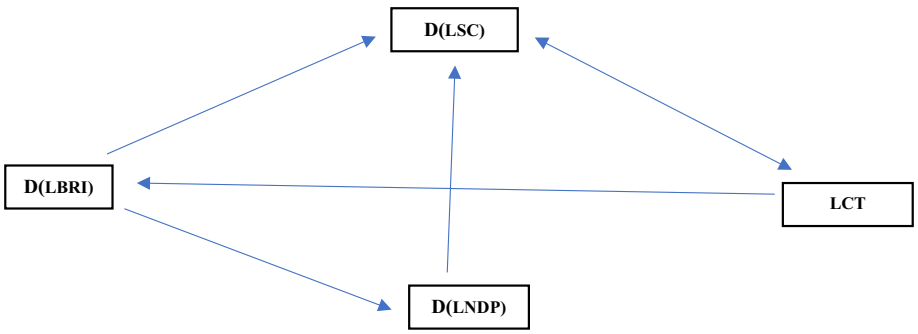

Fig. 8 Short-run causal relations between SC cargo trade, China's seaborne trade, China's BRI, and SC development projects. *Note* Statistically significant at the 10% level

Granger causality test

In this paper, we utilize the Granger causality test according to the VAR findings to check for a Granger causal relation between the variables of SC trade and BRI. It determines if one-time series' prior values may predict another's future values. Statistically significant future value prediction can demonstrate a Granger causal link between two or more time series. Granger causation cannot be proven without statistically significant data. Granger causality rejection probability is given by each variable's p-value. If the p-value is insignificant, the alternative hypothesis is accepted and the null hypothesis is rejected. Figure 8 shows a robust connection between China's seaborne trade, China's BRI investment, and SC's new development

projects. Therefore, the short-run dynamics suggest a unidirectional causal relationship running from (LBRI) and (LNDP) to (LSC) and a bidirectional causal relationship between (LCT) and (LSC).

Impulse response function

The impact of China's seaborne trade on SC cargo trade

Figure 9 shows the impulse response function of China's seaborne trade shocks on SC cargo trade. The vertical axis depicts shock impact, whereas the horizontal axis shows annual frequency. The findings show that China's seaborne trade positively affects SC cargo traffic in the short, medium, and long run, with a progressive increase until period 10 and a peak in the tenth year.

The findings highlight the significance of the SC for shipping trade in China, and the growth of maritime trade in China serves as an incentive for the demand for the SC. Consequently, it is essential that the development of the SC align with predictions of improvements in maritime trade in China.

The impact of China's BRI investment on SC cargo trade

China's BRI investment shock has a stable effect on SC cargo trade over a one-year period. This effect begins to decline in the second and third years and turns positive in the fourth year, with a positive and stable effect in the long run. See Fig. 10.

The findings highlight the significance of the BRI investment projects for SC, as they are expected to have a medium-run positive impact. This is due to the fact that these investments should be implemented over a construction period to fulfill the expected profitability.

The impact of SC new development projects on SC cargo trade

For an illustration of how the SC New Development Project shock affected the SC cargo trade, see Fig. 11. The data suggests that there is a positive and consistent influence on

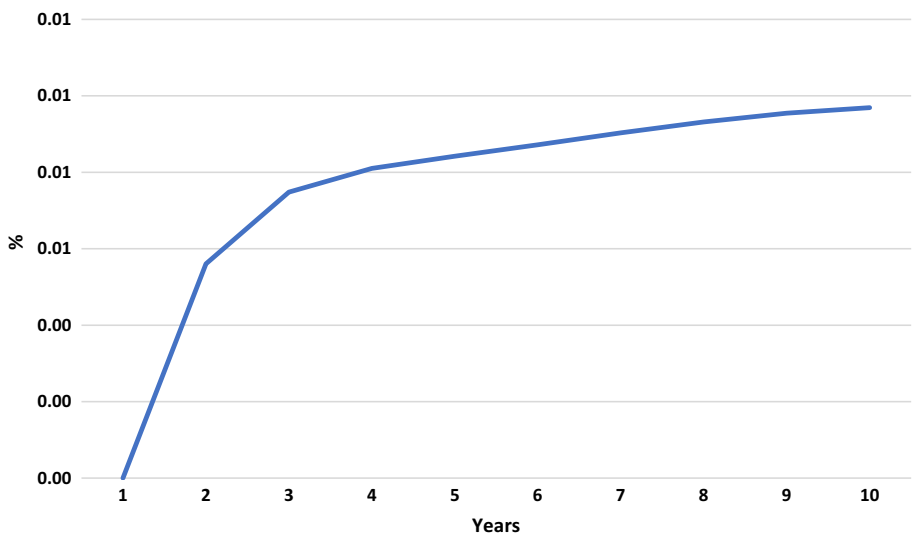

Fig. 9 Response of SC cargo trade to China's seaborne trade

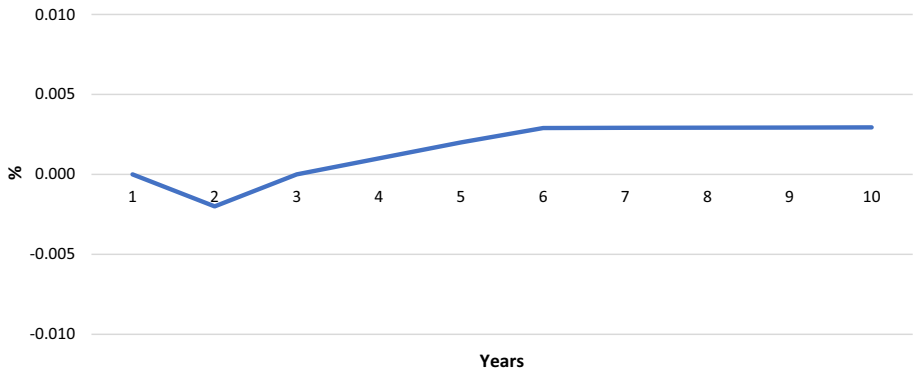

Fig. 10 Response of SC cargo trade to China's BRI investment

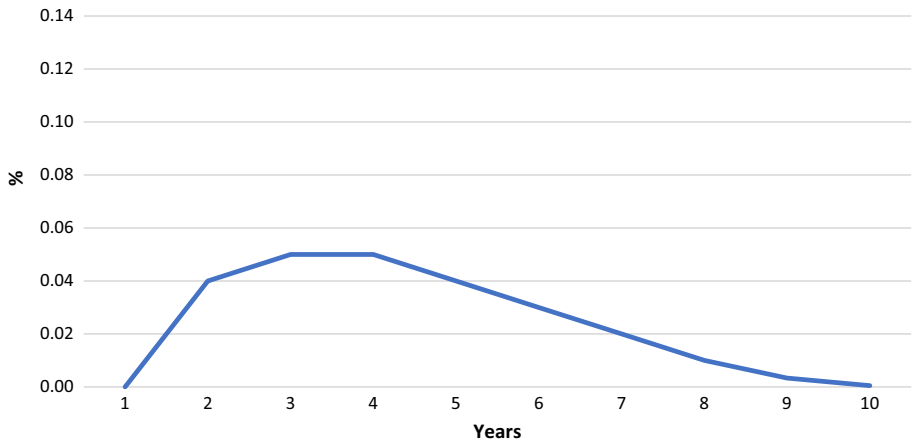

Fig. 11 Response of SC cargo trade to SC new development projects

SC cargo trade in the first and second years following the SC new development project shock, with the effect gradually increasing until period 3 and peaking in years 3 and 4. This beneficial effect lasted through the fourth year, then tapered off in the years that followed, although its positive aftereffects remained.

The continuous expansion efforts of the SC, which consider every development associated with the expanding international maritime fleet, exert a progressively greater influence on the trade transiting the canal. As a result, the SC is compelled to implement a four-year evaluation of its development strategies pertaining to the widening of the waterway.

Empirical results

In the short run, this study reveals a direct correlation between the BRI and SC cargo trade. The SC is expected to have a 5% positive impact on BRI investment projects over the medium to long term due to the SC's advantageous location along the MSR, which connects Asia, Africa, and Europe. Comparing China's share of global trade before and after the BRI, Fig. 12 reveals that China's share of global maritime trade increased to 25.5% by 2022. Chinese seaborne imports increased from 1.8 bt in 2012

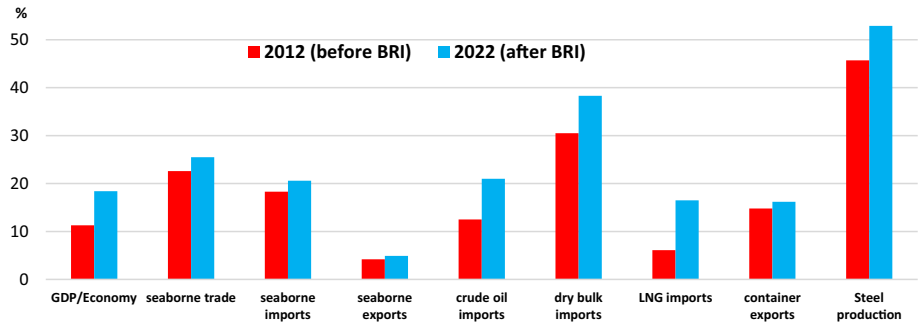

Fig. 12 China's share of global trade before and after the BRI. Source: Authors' calculations using Clarksons Research, Shipping Intelligence Network Timeseries, and IMF databases, July 2023

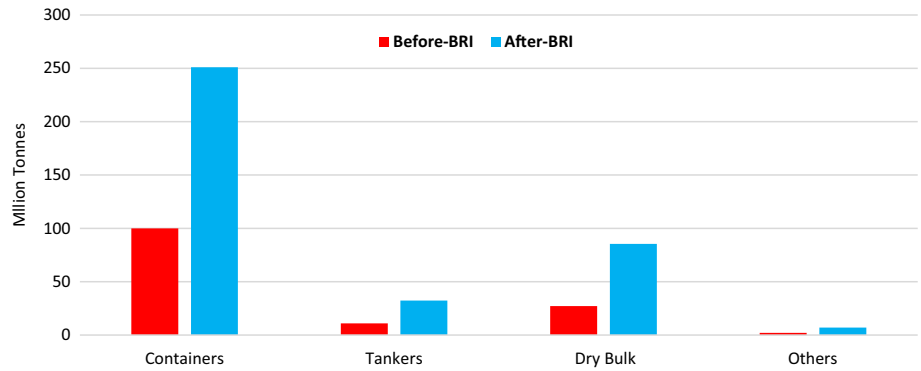

Fig. 13 China's seaborne trade via the Suez Canal by cargo type before (2012) and after the BRI (2022). Source: Authors' calculations using data collected by the SCA

to 2.5 bt, representing 21% of total global imports. From 480 mt in 2012 to 582 mt in the present, China's maritime exports have increased to approximately 5% of the global total.

Furthermore, the research findings explicitly show the profound connection between Chinese seaborne trade and SC cargo trade. Considering that SC cargo comprises the overwhelming majority of containers that transit from Asia to Europe, it is not surprising that Chinese seaborne trade constituted 30% of the worldwide SC cargo trade in 2022. Moreover, through the utilization of the SC, BRI nations may be able to achieve significant time savings ranging from 22 to 47% when traversing the Cape of Good Hope. The financial savings that result from the time saved are attributable to fuel, maintenance, and transportation costs. Before and after 10 years of the BRI, Chinese seaborne trade through the SC increased dramatically in terms of containers, tankers, dry bulk, and other ship categories, as shown in Fig. 13.

The BRI projects as a whole are expected to boost the seaborne trade of raw materials, especially dry bulk cargoes, in addition to enabling China to diversify its energy supply networks. To better place BRI countries in the international trading network and lay the groundwork for the future trade network, new ports and infrastructure networks are being built. They will aid in gaining access to new markets as well. More trade prospects can be expected from BRI projects. New shipping routes between

China and Europe are anticipated to be created as a result of these developments, which will have a major effect on global shipping and SC, and this accords with the results of the study of Haralambides and Merk (2020).

The SC plays a crucial role in international trade for both commercial and strategic reasons. About 9.9% of all maritime traffic, 22.6% of all fleets, and 15% of all grains passed via the canal in 2022. Moreover, the significance of the SC differs across different maritime sectors. It was estimated that the canal facilitated the transit of over 25% of container seaborne trade. Approximately one-third of containership capacity was used on services scheduled to use the Canal, and 45% of containership tonnage passed through the Canal in 2022. Typically, 14% of the total capacity of the car carrier fleet transits the canal each year. This is compared to 10% for LNG carriers, 9% for oil tankers, 7% for LPG carriers, and 4% for bulk carriers (SCA, 2023). These findings emphasize the significance of the worldwide maritime trade for the SC, and the need for the SC arises from the global maritime trade. These insights indicate that the important role of the SC in international trade stems from its dual benefits.

The ongoing expansion projects of the SCA, such as the new SC and developing the Southern Sector, which take into account all developments related to the growing global maritime fleet, have an increasing impact on the trade passing through the SC. This is because of the reduction in transit waiting time and the increase in navigational safety owing to ongoing development projects. Consequently, the SC is required to evaluate its development plans for the expansion of the waterway every four years and implementation every ten years before the negative impact begins. According to these findings, the SC needs to adopt flexible pricing and marketing strategies in order to attract more customers to transit the SC. As a result, the SC needs to continue with its waterway expansion strategies to accommodate the increase in both Chinese seaborne trade and BRI investment projects.

Although the BRI will have a positive effect on the SC due to an increase in Chinese trade and investments, it is also anticipated to have a little negative effect on the SC due to, for example, an increase in railway transport between China and Europe, an increase in intra-trade among China and Asian countries, and the expectation that new pipeline construction will increase China's land-based oil imports. New refineries built in BRI nations could increase crude imports and pipeline product exports.

Conclusion

In light of China's BRI, this study analyzed the SC with a particular focus on SC cargo trade, Chinese seaborne trade, China's BRI investment projects, and the SC's new development projects, using annual data from 1990 to 2022, and relying on time series data obtained from the SCA, the World Bank, and Clarksons Research. The model reflected recent developments in the SC cargo trade, such as Chinese seaborne trade, China's BRI investment projects, and the SC's new development projects, by using input data acquired from a variety of data sources. To shed light on the cause of the observed interaction effect among all variables, a VAR model is calculated alongside the impulse response.

The results indicated that BRI investment projects will have a medium- to long-term impact on SC beginning in the fourth year. Therefore, it is essential that SC development

coincide with anticipated shifts in global seaborne trade, especially Chinese seaborne trade. The SCA's ongoing expansion projects, which have a growing impact on trade passing through the SC, account for all changes related to the growth of the world's maritime fleet. Therefore, the SC needs to review its expansion plans for the waterway every four years and its implementation every ten years before the adverse effects become noticeable.

Further research is required to figure out the extent to which the SC is affected by different types of vessels, such as containers, dry bulk carriers, tankers, and LNG carriers. Additionally, it is important to understand how the SC impacts the India-Middle East-Europe Economic Corridor (IMEC), a newly launched initiative that aims to improve trade and connectivity between Europe, the Arabian Gulf, and India. Future study efforts could investigate environmentally sustainable developments, such as the SC economic corridor, the International Maritime Organization's (IMO) objective of decarbonizing international shipping routes in association with green shipping corridors (Song et al. 2023), and the sustainability potential of greening BRI.

In addition to the IMO, SC operators and cargo owners, the World Shipping Council, the International Chamber of Shipping, BIMCO, and insurance companies that are concerned with mitigating hazards in the shipping industry would benefit from knowing how China's BRI will affect the SC cargo trade. It would be helpful for any stakeholder to understand the global maritime shipping market dynamics if the influence of China's BRI could be evaluated globally on a ship type basis instead of just on the overall SC through coordination with trade statistics.

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Author contributions
All authors of this research paper have directly participated in the planning, execution, or analysis of this study; All authors of this paper have read and approved the final version here submitted.

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Availability of data and materials
The datasets generated during and/or analyzed during the current study are not publicly available because they are subject to third-party restrictions. Data cannot be shared openly because of the third party agreement but are available on request from authors.

Declarations

Competing interests
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article. The authors declare the following financial or non-financial interests which may be considered as potential conflicts of interest.

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