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<https://doi.org/10.1057/s41599-023-02525-w>

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The effect of fluctuations in bilateral relations on trade: evidence from China and ASEAN countries

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China and ASEAN have strong ties and have become each other's largest trading partners. This article uses the gravity model and a novel method of analysis, based on massive event data provided by the Global Database of Events, Language, and Tone, to empirically analyse the impact of fluctuations in bilateral relations between China and ASEAN on bilateral trade from January 2001 to December 2020. An analysis of 1,204,126 event records concluded that the improvement of bilateral relations was beneficial for trade between China and ASEAN countries. China's export trade was more easily influenced by bilateral relations than its import trade. Compared to the one-way behavioural attitude of ASEAN countries towards China, China's one-way reaction to ASEAN countries had a greater impact on bilateral trade. China's trade dependence level with most ASEAN countries maintains a trend of steady growth, and trade relations show a positive trend. Therefore, China and ASEAN should maintain stable political ties, enhance mutual understanding, strengthen economic and political connectivity, take adequate measures to promote mutual trust, continue optimizing cooperation models, and promote high-quality and high-level sustainable development across the region.

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Introduction

During its four decades of reform and opening up, China's economy and politics have developed systematically and rapidly (Lu et al., 2019). Currently, China is the world's second-largest economy, and the Association of Southeast Asian Nations (ASEAN), which is located at the maritime crossroads of global trade, is an important participant in China's Belt and Road Initiative (Nye, 2020; Yu, 2017). Given ASEAN's limited political and economic influence over major powers, its regional status depends mainly on the bilateral support of its regional partners (Egberink and Van der Putten, 2010a). China and ASEAN countries are connected by land and sea, with a land border of more than 4000 km. These nations have strong cultural ties, and the interconnections among them involve a wide range of stakeholders at home and abroad (Shen, 2023).

Furthermore, China and ASEAN countries have developing economies, and since the partnership between them was established in 1991, there has been great potential for cooperation. The establishment of the China–ASEAN Free Trade Area (CAFTA) in 2010 increased the scale of bilateral trade. In 2020, the bilateral trade volume of China and ASEAN grew amidst the global impact of COVID-19, and they became each other's largest trading partners (Wang et al., 2022). In the two decades from 2001 to 2020, the trade volume between China and ASEAN countries generally exhibited an upward trend. However, there were 2 years of decline during this time period, in 2009 and 2016. In addition, China's export data to ASEAN countries since 2011 have been slightly higher than import data. Figure 1 shows the bilateral trade volume between China and ASEAN countries between 2001 and 2020.

Despite the current unstable growth in the global economy, the ongoing reverberations of the COVID-19 pandemic, and the rise of trade protectionism and populism, China and ASEAN countries remain essential engines of global economic growth, and their financial and trade ties are growing closer (Enderwick and Buckley, 2020). Asian powers are redefining their strategic positions and their approaches to each other. The most important factor behind this realignment is the rapid rise of China as a major international player (Egberink and Van der Putten, 2010b).

In particular, China's rapid economic rise is driving a shift in relative strategic and political power. Although China still lags

behind certain developed countries, such as the United States, on some measures, development is been a significant long-term trend for China (White, 2013: p. 3). China's economic growth can be converted into political and diplomatic influence. Along with the growing economic and trade relations between China and ASEAN countries, political relations have been widely discussed in academia, politics, and business. Bilateral relations have become an essential consideration for scholars, policymakers, and international trade decision-makers as they seek to achieve sustainable development. It has been shown that interstate relations profoundly impact global trade and economic transactions, in addition to being related to national and personal security (Fan and Lu, 2021; Nitsch, 2007; Yang et al., 2016). Although ASEAN's influence is limited in terms of geographic scope and impact on practical security issues, Southeast Asia has the potential to become an important object of great power competition, making the subregion highly relevant in Asian geopolitics (Egberink and Van der Putten, 2010a).

This article explores the impact of fluctuations in China's bilateral relations with ASEAN on trade flows by constructing an empirical model based on high-frequency monthly panel data between China and 10 ASEAN countries from January 2001 to December 2020. This approach is novel because the Global Database of Events, Language, and Tone (GDELT) was used to measure the fluctuations of bilateral relations through the extraction of GDELT event data and analysis of this massive database. A monthly average of Goldstein scores was calculated to measure the fluctuation. This article seeks to provide new insights and actionable information for strategy formulation related to promoting regional cooperation between China and ASEAN.

Literature review and research hypotheses

The relationship between international trade and political relations. International political relations have long been closely linked to international trade. Research on the correlation between international trade and political activity dates back to the 1940s. In *National Power and the Structure of Foreign Trade*, economist Albert O. Hirschman (1980) examined the foreign trade of Nazi



Fig. 1 Bilateral trade volume between China and ASEAN countries between 2001 and 2020. Source: UN Comtrade database.

Germany on the eve of World War II and found that German trade flows during that period shifted for political reasons, from wealthy countries to relatively weak and poor neighbours such as Hungary and Romania. The underlying reason for this paradoxical phenomenon was that Nazi Germany used the change in its trade structure to force some countries to support its political ideas (Reuveny and Kang, 1996).

Theoretically, there are both realist and liberal theories regarding the interaction between international politics and international trade (Reuveny, 2000). Since the 1970s, scholars have been examining the nature of this relationship (Reuveny and Kang, 1996). The growth of bilateral trade can lead to either conflict or cooperation, and changes in political conflict in turn can lead to an increase or decrease in the volume of bilateral trade (Su et al., 2020).

On one hand, studies based on the realist theory of international relations argue that international political relations determine the level of trade. According to this theory, good political relations promote trade cooperation between the two countries involved, while hostile political ties inhibit trade between them. Pollins (1989a) famously argued that 'trade follows the flag,' meaning that countries prefer to trade with allies or friendly partners. Furthermore, he contended that a country adjusts its economic decisions based on security and political relations and that when political relations deteriorate, trade between two countries decreases (Pollins, 1989a). In addition, Gowa and Mansfield (1993) found that alliances between trading partner countries have a positive impact on bilateral trade. Nitsch and Schumacher (2004) and Glick and Taylor (2010) showed that terrorist events, wars, and military conflicts have a damaging effect on trade, while Che et al. (2015) argued that nationalism and historical legacies are also detrimental to bilateral trade and economic exchanges.

On the other hand, studies based on the liberal theory of international relations have argued that international trade relations smooth the volatility of international political relations. The existence of trade relations leads to greater interdependence between countries and significantly reduces the likelihood of political friction between them (Gartzke, 2007). Polachek (1978, 1980) regarded the state as a rational person, arguing that welfare is affected by consumption as well as by the level of conflict and that conflict with a trading partner will make the price of its exports fall and the cost of its imports rise. If maximizing social welfare involves choosing the right level of conflict for a given level of consumption, then rational politicians will avoid confrontations with trading partner countries (Polachek, 1978, 1980). Scholars with views similar to those of Polachek include Arad and Hirsch (1981), who found that the two countries' attitudes toward peace depend on the impact of different bilateral trade on the welfare of producers and consumers in both countries. Two warring neighbours decided to reconcile, their governments promised to allow their citizens to participate in trade and other economic transactions (Arad and Hirsch, 1981). Furthermore, international trade can trigger bilateral political conflicts in situations where international trade is perceived as competition for limited resources because of the finite nature of resources. When states engage in conflict, situations such as trade wars and colonial expansion are inevitable, thus inhibiting international cooperation and even increasing the level of conflict (Reuveny and Kang, 1996).

Theoretically, changes in the distance of bilateral political relations can affect trade by influencing the uncertainty of the external environment. The political and institutional environment is an important factor affecting trade (Morrow et al., 1998), and good political relations between the two countries or the signing of a free trade agreement (FTA) is conducive to the

expansion of trade (Fan and Lu, 2021) because the shortening of the distance in bilateral political relations reduces economic uncertainty. Relevant research shows that regional trade agreements are based on political relations. Economic cooperation between countries, such as regional trade agreements, provides a good economic environment for bilateral trade (Gowa and Mansfield, 1993). In their study of the China-ASEAN Free Trade Area, Yang and Chen (2008) argued that its establishment has benefited the economic development of both sides. Yang and Martinez-Zarzoso (2014) examined the impact of free trade agreements and noted that they have produced significant trade creation effects. Moreover, as a significant economic entity, Asia-Pacific Economic Cooperation (APEC) has the potential to elevate the degree of trade liberalization and reduce the barriers to trade entry. Consequently, APEC has played a crucial role in fostering the expansion of overall trade among its member nations (Cheng et al., 2019).

Research by Chinese scholars on bilateral trade issues has focused on the economic and political interactions between China and Japan or China and the US. Xu and Chen (2014) empirically examined the impact of political tensions between China and Japan on bilateral trade from 2002 to 2012. During this decade, there were roughly three states: weak correlation, statistically significant, and not statistically significant (Xu and Chen, 2014). Zhou and Wang (2019) took the events that caused political conflict between China and Japan as an entry point and noted that different events would impact bilateral trade in various ways, political conflict brought a negative impact on trade. Based on empirical data from the US and China, Su et al. (2020) concluded that bilateral political relations have both positive and negative effects on economic relations.

The region in which China and ASEAN are located is increasingly becoming the most dynamic region in the global economy (Anwar, 2020). China has remained the largest trading partner of ASEAN for 11 consecutive years (Ghifari, 2020), making this relationship extremely close. Based on the literature on the relationship between international trade and political relations, it is important to consider the impact of fluctuations in bilateral relations between China and ASEAN countries on trade flows. The first hypothesis is thus as follows:

Hypothesis 1. The improvement of bilateral relations will help to promote trade between two countries or entities.

Scholarly research since the 1990s on the impact of fluctuations in international relations on trade can be roughly divided into three directions. First, the relationship between trade and politics involving colonies and suzerain states has been a common entry point for research due to such states' close trade links and relatively unique political relations. Various studies have examined the colonial period, such as that of Yeats (1990), who analysed the impact of politics on the prices of traded goods. As a result of lower transaction costs between colonial powers and a series of trade promotion policies pursued by sovereign forces for their economic benefit, the volume of trade between colonial powers belonging to the same imperial system was twice the volume of trade between nonimperial countries (Mitchener and Weidenmier, 2008). These articles on the relationship between colonies and suzerain states have demonstrated the influence of apparent nonmarket forces. Nevertheless, they have yet to provide a precise quantitative analysis of the impact of political factors.

Taking a historical perspective, some scholars have focused on the impact of military conflicts between countries on economic and trade exchanges. The impact of military conflicts or wars, as a particular, extreme political event, on trade has been assessed in different ways. Oneal et al. (2003), Martin et al. (2008), and Glick and Taylor (2010) have shown that military conflicts and wars have a negative impact on trade. However, this conclusion has

also been challenged by others who believe that these studies overlooked the role of expectations. Morrow (1999) argued that economic participants anticipate the possibility of future wars and military conflicts and thus constantly adjust their trading partners and flows so that such hostilities will have little impact on trade in the current period. On the other hand, Li and Sacko (2002) claimed that unanticipated conflicts can have a negative effect on bilateral relations. In a progressive line of research, Glick and Taylor (2010) empirically examined the trade costs of war between 1870 and 1997, finding that war significantly reduces bilateral trade, but not for long. In addition, they found that the damaging trade effects of war are not limited to belligerents but also impact neutral countries. Of course, military conflicts and wars are an extreme category of political events and cannot be readily compared with peaceful political relations. The consequences of the warmth or coldness of political relations for bilateral economic and trade exchanges cannot yet be determined conclusively through the two abovementioned research directions or in the relevant literature.

Finally, the impact of different types of political events or political relations on trade has also been a subject of debate. Several studies have shown that the deterioration of political relations can have a negative impact on trade. Pollins (1989b) examined the influence of political climate on trade based on indicators of the degree of bilateral cooperation or confrontation and found that countries prefer to establish closer trade ties with partners with which they have friendly political relations. Fuchs and Klann (2013) explored the economic consequences of the countries that received the Dalai Lama's visit. This event significantly reduced the exporting of goods to China from the countries visited, and this phenomenon was particularly pronounced between 2002 and 2008. However, Keshk et al. (2004) rejected this view, finding no significant correlation between political relations and trade (Keshk et al., 2004).

Many scholars have argued that fluctuations in bilateral political relations may impact bilateral trade. However, no consensus has been reached. In an era of globalization in which politics and economics are increasingly intertwined, strained relations between countries are often characterized as 'fighting but not broken,' and direct military conflicts or wars between major powers are only sporadic, with incremental changes in bilateral political relations becoming the norm. As a result, previous studies do not provide a good picture of contemporary developments. In addition, most existing literature focuses on historical colonial and suzerain countries and pays less attention to emerging countries. Since the international financial crisis, research on China has grown, with much of the literature focusing on the economic impact of the political situation between China and Japan or other major economies. China's growing global influence has had a profound impact on the political and economic decisions of its partner countries. Existing research suggests a stable, long-term relationship among trade, political relations, and GDP (Whitten et al., 2020).

As relations between China and ASEAN countries continue to advance, China's reliance on trade with countries and regions along the route of the Maritime Silk Road has gradually deepened. In view of the continuous development of trade between countries, in addition to focusing on overall bilateral trade, this article will also discuss the specific impact of fluctuations in international relations on China's exports and imports. Thus, the second hypothesis is as follows:

Hypothesis 2. The improvement of bilateral relations will promote China's exports and imports.

Approaches to measuring bilateral relations. As mentioned above, scholars have enriched the theoretical and empirical

foundation of the impact of political relations on international trade from different perspectives, but a consensus has not been reached. Currently, there are three main approaches to measuring countries' bilateral relations. The first is a correlation indicator based on United Nations General Assembly voting data (Bailey et al., 2017) and news events reflecting international exchanges. In recent years, some scholars have used the voting results of the General Assembly to represent the political stance of various countries. They believe that the similarity in the political stances of various countries can be used as a measure of bilateral political relations.

Second, the bilateral relations of countries can be measured based on relevant dimensions of political relations, such as high-level visits and bilateral investment agreements (Fan and Lu, 2021; Nitsch, 2007; Yang et al., 2016). Nitsch (2007) found that official visits by leaders usually lead to an increase in exports of ~8–10%. Fan and Lu (2021) reported that the higher the level of the summit leader is, the greater the boost to trade, and that reciprocal summit visits between China and developing countries have a greater trade-boosting effect than one-way visits.

Moreover, some researchers have constructed comprehensive indicators reflecting the state of political relations between countries based on event data analysis methods, such as the Sino-Foreign Relations Database proposed by Yan Xuetong's team at Tsinghua University (Yan and Zhou, 2004). Du et al. (2017) used this database to study the impact of changes in political relations between China and its major trading partners on bilateral trade. The results of the empirical analysis based on monthly trade data showed that the impact was small and lasted for only approximately two months.

These approaches to measuring countries' bilateral relations have shortcomings, such as the limited coverage of countries and the low frequency of data, which cannot reflect the short-term characteristics of fluctuations in bilateral relations. As the various news events that occur during an interaction between countries are an important way of presenting political relations, event data analysis offers certain advantages. In recent years, academics have come to favour big data on news events as represented by the GDELT database. Davis et al. (2019) found that import trade is significantly affected by bilateral political relations and that state-owned enterprises may be an important channel for political relations to restrict imports. Li et al. (2021) constructed continuous political relationship indicators based on news event data in the GDELT database, and their empirical results using firm-level trade data showed that China's import trade from partner countries was significantly affected by changes in bilateral political relations.

In this article, analysis of GDELT data is used to measure the fluctuation of bilateral relations. Since behavioural givers and receivers are already differentiated in this database, the resulting time series of Goldstein scores are directional. It is possible to analyse the one-way behaviour of China towards ASEAN countries and of ASEAN countries towards China in reaction to the impact of bilateral relations on trade flows between the two countries. Indirectly, the impact of unilateral political attitudes of a particular country on trade cooperation between two countries or entities in the process of international engagement can be explored to further enrich existing research. Therefore, we derive the following hypothesis:

Hypothesis 3. One-way behavioural fluctuations in relations between China and ASEAN countries may impact trade flows between the two countries differently.

Although ASEAN has been established for over five decades, there is still a gap in research on how bilateral relations between China and ASEAN countries are related to their economies and how bilateral relations affect trade flows with a sample of China's

trading partners. Therefore, using the GDELT, the world's largest free and open news database, to enable quantitative analysis of the impact of bilateral relations on trade between China and ASEAN countries should improve the precision of results.

Data and methods

Data description. The core explanatory variable in this article is the fluctuation of bilateral relations, which is determined from the GDELT database. This database, created in 2013, contains all news media data from January 1, 1979, to the present. It monitors various forms of media events worldwide in real-time in over 100 languages and extracts relevant information such as time, place, people, and event type. As a terabyte-sized database, it has now been updated to version 2.0, with real-time updates every 15 min. It is the most extensive and large-scale social event news media database in the world, containing 20 major categories and over 300 subcategories of news event types. GDELT's event database uses Conflict and Mediation Event Observations (CAMEO) to code events (Gerner et al., 2002). Therefore, the event database mainly contains political cooperation and conflict events, which are classified according to the nature of the event and assigned a value on the Goldstein Scale (GS) ranging from -10 to 10 to characterize the degree of cooperation or conflict between two participating subjects, where -10 indicates the strongest conflict and 10 indicates the most active cooperation.

Each event recorded in this database contains information on the participating countries or regions and has two actors. Of these, Actor 1 is the active party in the event and Actor 2 is the passive party. Since the analysis in this article involves interactive events, the Goldstein score of interactive events between China and ASEAN countries is directional. Since the interaction events are included in the analysis, they are divided into those with China as the active party and ASEAN countries as the passive party (denoted as 'China → ASEAN countries') and those with the action going in the reverse direction ('ASEAN countries → China').

Since this database assigns a Goldstein score to each event to measure the degree of conflict or cooperation, the average Goldstein score of all events of interaction between China and ASEAN countries is used as a proxy variable for fluctuations in bilateral relations. A positive value indicates that a bilateral relationship is improving and shows a trend of cooperation, while a negative value indicates that the bilateral relationship is deteriorating and that a conflict may ensue. Whereas a higher value indicates that the bilateral relationship is developing better, a lower value indicates that the bilateral relationship is antagonistic, so it is possible to measure the direction and degree of change in the bilateral relationship. In addition, because each event contains information about the participating countries or regions, the Goldstein score of 'China → ASEAN countries' is a measure of China's reaction to the behaviour of ASEAN countries, while the Goldstein score of 'ASEAN countries → China' is a measure of ASEAN countries' reaction to China's behaviour. Therefore, it is also possible to discuss quantitatively the fluctuations in the one-way behavioural attitudes of countries. BigQuery and Python were used in this article to determine the time, Actor 1, Actor 2, NumArticles (the number of articles mentioning each event), and the Goldstein Scale for the events covered by GDELT and then to compute variables. Overall, 1,204,126 event records were included in the analysis.

Since political relations can fluctuate rapidly, the use of low-frequency data such as annual or quarterly data may lead to a wrong estimation of the impact of fluctuations in international relations on trade (Du et al., 2017). Therefore, high-frequency monthly data are selected for the analysis, and the Goldstein

scores of all interaction events between China and ASEAN countries are averaged for each month between 2001 and 2020 to obtain a directed time series with monthly frequency and thus characterize quantitatively the fluctuations in bilateral relations. In addition, since various events may be mentioned with different frequencies, there is a problem of ignoring the impact of events if only the average Goldstein score of events that occur each month is calculated. Therefore, this article uses NumArticles (the number of articles mentioning each event) as an indicator to calculate the weight of the event and then obtains the average of monthly Goldstein scores containing the weights with the following formula:

$$\begin{aligned} \text{Average daily Goldstein score} &= \text{Goldstein score for event 1} \times \frac{\text{NumArticles of event 1}}{\text{NumArticles of all events}} \\ &+ \dots + \text{Goldstein score for event } N \times \frac{\text{NumArticles of event } N}{\text{NumArticles of all events}} \end{aligned} \quad (1)$$

$$\begin{aligned} \text{Average monthly Goldstein score} &= \frac{\sum \text{Average daily Goldstein score}}{\text{Days with Goldstein score for the month}} \end{aligned} \quad (2)$$

According to the calculation, the mean Goldstein scores of all interaction events between China and Cambodia, Laos, and Singapore from 2001 to 2020 ranked as the top three among the ten ASEAN countries. These scores were all over 2, at 2.41, 2.33, and 2.02, respectively, indicating that China's bilateral relations with these countries show an overall and relatively fast positive development over the 20-year period. Moreover, the Goldstein scores of China's interactions with Brunei and the Philippines ranked low, at approximately 0.5, indicating that China's bilateral relations with these two countries have developed relatively slowly. In addition, the standard deviation of the Goldstein scores of China's interactions with Singapore and Malaysia was comparatively small, at no more than 1, indicating that the frequency and magnitude of changes in China's bilateral relations with these two countries were small. In contrast, the frequency and magnitude of changes in China's bilateral relations with Brunei and Laos were slightly larger. These data show a significant, positive development in China's one-way behaviour attitude towards Cambodia, Laos, and Indonesia, whereas the one-way attitude towards Malaysia and Singapore fluctuated with less frequency and magnitude. Laos, Cambodia, and Singapore showed a significant development of one-way behavioural attitudes towards China in a positive direction, while Malaysia's one-way attitudes towards China fluctuated less in both frequency and magnitude. The figures for changes in Goldstein scores between China and ASEAN countries from 2001 to 2020 are shown in Appendix 1.

Methods. The gravity model of trade originated from Newton's Law of Gravitation and was first applied to the field of international trade by Tinbergen (1962) and Pöyhönen (1963), who noted that the scale of bilateral trade flows between two countries is directly proportional to their respective economic aggregates and inversely proportional to the distance between them. The bilateral distance constitutes the resistance factor for trade between two countries. The gravity model has become an important analytical method for researching trade flows and impact factors. In this article, econometric methods are utilized to estimate the impact of fluctuations in bilateral relationships on bilateral trade. The econometric model is based on the international trade gravity model, which is a statistical tool for analysing trade flows (Fuchs and Klann, 2013).

Subsequent scholars have made continuous improvements to the basic gravity model according to their different research objectives. Linnemann (1966) accounted for the influence of the population of two countries on bilateral trade and introduced the national population variables of each country into the model. He pioneered the use of the gravity model to examine the impact of a preferential trade agreement signed by two countries on trade. The gravity model has also been applied to the investigation of free trade areas. In addition, Garman et al. (1998) and Wall (1999) considered the impact of institutional factors such as economic integration measures and trade protection systems on bilateral trade. Sohn (2001) introduced an APEC variable (which refers to whether a trading partner is a member of an international type of economic organization) to measure the impact of institutional arrangements on bilateral trade. Furthermore, the determination of trade costs between two countries is affected by various factors. Initially, trade costs were primarily assessed based on bilateral geographic distance (Anderson, 1979). However, subsequent studies have accounted for additional factors such as shared borders (Anderson and Van Wincoop, 2003) and the presence of active FTAs (Baier and Bergstrand, 2009) when calculating trade costs.

Anderson and Van Wincoop (2003) provided the theoretical basis for the extension and use of the gravity model in international trade research. Inspired by the above literature and based on the actual situation of bilateral relations between China and ASEAN countries, in this article we use the gravity model to explore the impact of fluctuations in bilateral relations between China and ASEAN countries on trade. The model is set as follows:

$$\begin{aligned} \text{Intra}_{jt} = & \beta_0 + \beta_1 \text{pir}_{jt} + \beta_2 \text{lnmkt}_{jt} + \beta_3 \text{Indist}_j + \beta_4 \text{lnpop}_j \\ & + \beta_5 \text{bou}_j + \beta_6 \text{law}_j + \beta_7 \text{fta}_{jt} + \beta_8 \text{apec}_{jt} + \gamma_t + \varepsilon_{jt} \end{aligned} \tag{3}$$

$$\begin{aligned} \text{lnimp}_{jt} = & \beta_0 + \beta_1 \text{pir}_{jt} + \beta_2 \text{lnmkt}_{jt} + \beta_3 \text{Indist}_j + \beta_4 \text{lnpop}_j \\ & + \beta_5 \text{bou}_j + \beta_6 \text{law}_j + \beta_7 \text{fta}_{jt} + \beta_8 \text{apec}_{jt} + \gamma_t + \varepsilon_{jt} \end{aligned} \tag{4}$$

$$\begin{aligned} \text{lnexp}_{jt} = & \beta_0 + \beta_1 \text{pir}_{jt} + \beta_2 \text{lnmkt}_{jt} + \beta_3 \text{Indist}_j + \beta_4 \text{lnpop}_j \\ & + \beta_5 \text{bou}_j + \beta_6 \text{law}_j + \beta_7 \text{fta}_{jt} + \beta_8 \text{apec}_{jt} + \gamma_t + \varepsilon_{jt} \end{aligned} \tag{5}$$

where j denotes the target partner (i.e., the ASEAN countries), t denotes time in months, and Intra_{jt} is the explained variable, or the amount of trade between China and ASEAN countries j in a month t . Considering the possible heteroscedasticity of the data, the trade volume is logarithmically processed (see Eq. (3)). For further analysis, the explained variables are replaced by China's imports (lnimp_{jt}) from and exports (lnexp_{jt}) to country j . Additionally, to avoid possible heteroscedasticity, the import and export data are logarithmically processed. To explore the specific impact of fluctuations in international relations on China's import and export trade, we use Eqs. (4) and (5).

The core explanatory variable pir_{jt} represents the fluctuation of bilateral relations between China and country j in month t , which is represented by the average of the Goldstein scores of all interactions between China and country j in month t measured above. In addition, cpir_{jt} and apir_{jt} , which are the monthly means of Goldstein scores for the events 'China $\rightarrow j$ ' and ' $j \rightarrow$ China,' are introduced as new core variables and brought into Eqs. (3) through (5), respectively. Six model-setting formulas can be obtained to explore the impact of China's one-way behaviour

towards country j and of country j towards China on the trade between the two countries and on China's imports and exports.

The control variable lnmkt_{jt} is the market size, expressed as the logarithm of the average GDP of China and country j . Due to the lack of monthly GDP data for China and ASEAN countries, EVIEWS software was used to convert low-frequency quarterly or annual data into high-frequency monthly data. The control variables Indist_j and lnpop_j are the logarithm of the geographically weighted distance between China and country j and the logarithm of the total population of the two countries, respectively. Other control variables, and apec_{jt} (all of which are dummy variables), denote whether China shares a border with country j , whether they have the same legal system whether they are in the same free trade zone, and whether they are members of an international economic organization, respectively. In addition, γ_t indicates the time-fixed effect to control the impact of the time trend; ε_{jt} is a stochastic error term. The data in this article were obtained from the GDEL website (<https://www.gdelproject.org/>), the International Monetary Fund (IMF) database, the World Bank Statistical database, the CEIC Data Global Database, the UN Comtrade database, and the Centre d'Études Prospectives et d'Informations Internationales (CEPII) database.

In this article, the panel data of China and ten ASEAN countries from January 2001 to December 2020 were chosen as the examination object, and the descriptive statistics of the main variables obtained by using the STATA software are shown in Table 1.

Empirical analysis

Regression analysis. Regression analysis was performed according to Eq. (3). Unit root tests were performed on the panel series used, and IPS tests and LLC tests showed that all variables rejected the null hypothesis. None had unit roots, indicating that the model used smooth panel data. Before the benchmark model regression was conducted, the poolability test was first used to test whether the pooled OLS could be used for estimation. The result of rejecting the null hypothesis indicates that the pooled OLS cannot be used for model estimation. Second, the robust Hausman test was used to test whether the fixed effects model or the random effects model should be used, and the result showed that the fixed effects model should be chosen as the panel regression model. The results of the tests are shown in Table 2.

Therefore, a fixed effects model was first used for the regression in this article, and the results are shown in Table 3.

In panel regression, the variables of the model may have cross-sectional dependence, so based on the benchmark regression, we

Variable	Obs	Mean	SD	Min	Max
Intrade	2400	20.52	2.042	13.71	23.83
Inimport	2400	19.36	2.683	4.828	22.95
Inexport	2400	19.90	2.013	13.32	23.29
pir	2400	1.636	1.474	-10	7.400
cpir	2400	1.853	1.555	-10	8.500
apir	2400	1.810	1.527	-10	8
lnmkt	2400	26.18	0.810	24.56	27.45
Indist	2400	8.156	0.235	7.754	8.560
lnpop	2400	21.06	0.0590	20.96	21.25
bou	2400	0.300	0.458	0	1
law	2400	0.600	0.490	0	1
fta	2400	0.550	0.498	0	1
apec	2400	0.700	0.458	0	1

This table presents the descriptive statistics for the main variables, obtained by STATA software.

Table 2 Determining the regression model.

Test	Test results using STATA software	Conclusion
Poolability test (<i>F</i> test)	Prob > <i>F</i> = 0.0000	The fixed effects model is superior to the pooled OLS model.
BP-LM test	Prob > Chibar2 = 0.0000	The random effects model is superior to the pooled OLS model.
Robust Hausman test	<i>P</i> value = 0.0000	The fixed effects model is superior to the random effects model.

These test results were obtained by STATA software.

Table 3 Benchmark regression results.

Variables	(1)	(2)	(3)
	Intrade	Inimport	Inexport
pir	0.1461*** (9.0467)	0.1464*** (6.1557)	0.1613*** (9.2100)
lnmkt	65.9128*** (41.9557)	95.9064*** (41.4700)	60.6121*** (35.5885)
Indistance	-6.4882*** (-27.2644)	-7.9957*** (-22.8241)	-6.2395*** (-24.1855)
Inpopulation	-0.6365 (-0.7261)	-7.2845*** (-5.6448)	1.7736* (1.8662)
boundary	-0.8269*** (-9.2532)	-0.4556*** (-3.4635)	-0.7596*** (-7.8405)
law	-2.0577*** (-22.8937)	-2.3959*** (-18.1077)	-1.9739*** (-20.2577)
fta	-1.8e + 02*** (-41.2653)	-2.6e + 02*** (-40.9437)	-1.7e + 02*** (-34.9797)
apec	0.3905*** (5.0076)	0.5511*** (4.8011)	0.1255 (1.4842)
_cons	-1.5e + 03*** (-45.6215)	-2.1e + 03*** (-42.8330)	-1.5e + 03*** (-39.9678)
Time-fixed effects	Yes	Yes	Yes
<i>N</i>	2400	2400	2400
Adj. <i>R</i> ²	0.763	0.702	0.713

This table reports the regression results using the fixed effects regression model, with *t*-statistics in parentheses.
p* < 0.10; *p* < 0.05; ****p* < 0.01.

Table 4 FGLS regression results.

Variables	(1)	(2)	(3)
	Intrade	Inimport	Inexport
pir	0.0174** (2.5058)	0.0074 (0.7500)	0.0185*** (2.7149)
lnmkt	52.9458*** (43.4346)	69.8191*** (37.8963)	53.2624*** (55.5141)
Indistance	-5.5485*** (-56.8797)	-6.6626*** (-47.6085)	-5.3966*** (-58.4005)
Inpopulation	1.1388** (2.5757)	-2.5321*** (-3.3519)	2.0295*** (5.1807)
boundary	-0.7597*** (-22.8344)	-0.6433*** (-11.1822)	-0.5888*** (-18.7704)
law	-1.9660*** (-59.7792)	-2.3784*** (-53.4105)	-1.7925*** (-57.1349)
fta	-1.4e + 02*** (-42.7996)	-1.9e + 02*** (-37.4526)	-1.5e + 02*** (-54.7064)
apec	0.5011*** (17.9094)	1.1532*** (19.9614)	0.0975*** (3.3005)
_cons	-1.3e + 03*** (-53.7676)	-1.6e + 03*** (-42.8257)	-1.3e + 03*** (-68.0849)
<i>N</i>	2400	2400	2400

This table reports the regression results using the fixed effects regression model, with *t*-statistics in parentheses.
p* < 0.10; *p* < 0.05; ****p* < 0.01.

used the Pesaran test for further testing. The results showed that the cross-sectional dependence test strongly rejected the null hypothesis of no cross-sectional dependence, at least at the 1% level of significance. The average absolute correlation was 0.478; hence, there is evidence suggesting the presence of cross-sectional dependence in the fixed effect model. Therefore, to improve model robustness, we used the FGLS model to control cross-sectional dependence in the model variables. The results are shown in Table 4.

Comparing the regression results of the FGLS model and the fixed effects model, some differences were discovered in the significance of the explanatory variable between the FGLS regression and the benchmark regression. However, all results for the core explanatory variable pir_{jt} were positive and passed the significance test. Based on the regression results of the FGLS model, the fluctuations in bilateral relations between China and ASEAN countries affect the total trade volume between the two countries. This conclusion is consistent with the theoretical expectation, and Hypothesis 1 is verified. The fluctuations in bilateral relations between China and an ASEAN country mainly affect China's exports to that country. The effect of fluctuations in bilateral relations between China and ASEAN countries on China's imports from ASEAN countries did not pass the significance test. The results of the model verify Hypothesis 2, and indicating that the improvement of bilateral relations helps to

promote China's exports, but without a significant impact on China's imports from that country.

In addition, the larger the market size, the larger the total trade between the two countries. Geographical distance significantly hinders the development of trade between China and ASEAN countries and increases trade costs. In other words, there is room for further optimization of logistics development and infrastructure construction between China and ASEAN countries. There was a positive correlation between population size and bilateral trade between China and ASEAN countries, as well as with China's exports to ASEAN countries. However, the population size of the two trading partners had opposite effects on China's imports from the country. Therefore, an increase in population size expands domestic demand and hinders the growth of China's imports and ASEAN countries' exports.

Furthermore, boundaries and different kinds of legal systems had a negative effect on trade between the two countries. Notably, if countries belonged to the same FTA, there was a negative impact on trade. FTA bilateralism splits the trade relations between two entities into a complex series of preferential trade relations, which is actually detrimental to the development of regionalism and the building of a regional community (Dent, 2013). In addition, as we have seen in China-ASEAN economic relations, the FTA does not seek to change the nature of bilateral relations but rather to strengthen existing relations based on the comparative advantages of each country (Chiang, 2019). This also indicates that China and ASEAN countries should actively address a series of problems, such as border issues, different

legal systems, and FTA development, to further advance bilateral trade. The fact that China and ASEAN countries are members of the same international economic organization promotes the growth of trade between them. Currently, seven ASEAN countries are members of APEC with China, and being members of APEC together is beneficial for promoting bilateral trade.

Moreover, the core explanatory variables were replaced to explore the impact of a country's one-way behaviours on trade between the two countries. In previous studies on international relations on bilateral trade, bilateral relations between two countries were often treated as a whole, and the impact of one-way behaviour fluctuations on bilateral trade was rarely distinguished. In contrast, we sought to consider how the one-way behaviour fluctuations of 'China → ASEAN country' or 'ASEAN country → China' affect bilateral trade.

To test Hypothesis 3, the model-setting formula for analysing this one-way direction of influence was similar to Eq. (3), with the core explanatory variables replaced by the variables of China's one-way behaviour fluctuation towards ASEAN countries ($cpir_{it}$) and ASEAN countries' one-way behaviour fluctuation towards China ($apir_{it}$). Specifically, the monthly average of event Goldstein scores for 'China → ASEAN countries' and 'ASEAN countries → China' was used. The empirical results are presented in Table 5.

As shown in Table 5, in the model, the one-way attitude fluctuation coefficient of China towards ASEAN countries was positive, and both trade volume and export volume passed the significance test. This means that China's political attitude towards ASEAN countries can effectively influence bilateral trade, especially affecting China's exports to that country. The stronger China's willingness to cooperate with ASEAN countries is, the more bilateral trade will occur. However, the one-way fluctuation of ASEAN countries' attitudes towards China has no significant impact on the total trade volume of the two countries or on China's import and export volume.

Possible reasons for these results might be as follows. First, China formally joined the World Trade Organization (WTO) in 2001 and fulfilled its WTO accession commitments through a series of measures, including revising foreign trade regulations, reducing tariffs, opening up the service market, and reducing the

threshold for foreign investment. Seven of the 10 ASEAN countries joined the WTO in 1995, and the remaining three countries, Cambodia, Vietnam, and Laos, joined the WTO in 2004, 2007, and 2013, respectively. After China's accession to the WTO, the scale of its foreign exports developed rapidly, and exports have become a very important driving force for China's rapid economic growth (Zhang and Qu, 2022). The outbreak of the U.S. subprime mortgage crisis in 2008 and its rapid evolution into a global financial crisis profoundly impacted the world economy. Along with the severe contraction of external demand, China's foreign trade fluctuated dramatically, and the uncertainty caused by the financial crisis also affected bilateral trade and bilateral relations.

In addition, the Belt and Road initiative proposed by President Xi Jinping in 2013 has introduced a new pattern of openness for China to build a 'community with a shared future' with countries along the Belt and Road route. The 10 ASEAN countries along the Maritime Silk Road are also developing in conjunction with this initiative. The Belt and Road emphasizes the idea of closer complementarity between China and ASEAN countries, with the goal of strengthening trade exchanges and breaking through the constraints that limit economic growth. However, substantive political attitudes will affect bilateral trade during the implementation of the Belt and Road initiative. Therefore, it is essential for both sides to improve effective communication, objectively consider the contradictions between them, and address existing stereotypes.

Robustness tests. To further examine the robustness of the above results, we conducted additional analyses. The results of the robustness tests are shown in Table 6.

Since bilateral relations affect bilateral trade and bilateral trade can also affect bilateral relations inversely, the endogeneity issues caused by reverse causality are a possible cause of biased estimation results. Therefore, in view of the heteroscedasticity and autocorrelation problems and drawing on previous experience, the estimation method was replaced by 2SLS and GMM methods. Re-estimation was chosen to include the one-period lagged bilateral relationship fluctuation as the instrumental

Table 5 Empirical regression results.

Variables	(1)		(2)		(3)	
	Intrade		Inimport		Inexport	
cpir	0.0176*** (2.7289)		0.0117 (1.2651)		0.0216*** (3.4146)	
apir		0.0093 (1.5777)		0.0016 (0.1944)		0.0070 (1.2625)
N	2400	2400	2400	2400	2400	2400

This table analyses the country's one-way behaviour fluctuation, with the core explanatory variables replaced by the variables of China's one-way behaviour fluctuation towards ASEAN countries (cpir) and ASEAN countries' one-way behaviour fluctuation towards China (apir); t-statistics are in parentheses.
*p < 0.10; **p < 0.05; ***p < 0.01.

Table 6 Robustness test results.

Explained variable: Intrade	(1) 2SLS	(2) GMM	(3) Replaced core explanatory variable	(4) Control MR	(5) PPML
pir	0.3838** (3.2362)	0.8359*** (6.7670)	0.0178*** (3.2388)	0.0229** (2.2102)	0.0130*** (7.1880)
N	2390	2390	2400	2400	2400

t-statistics are in parentheses.
*p < 0.10; **p < 0.05; ***p < 0.01.

variable. As the results in Table 6 (1) and (2) show, the coefficients of the bilateral relationship fluctuation variables were all positive and passed the significance test. In addition, we replaced the core explanatory variable. In the above analysis, event weights were included in the discussion to obtain the monthly average of Goldstein scores as evidence of bilateral relationship fluctuations. However, Yan and Zhou (2004) concluded that even if the event weights are assumed to be the same and only the number of events is counted, the results obtained are still accurate. Therefore, the monthly average of Goldstein scores without event weights was remeasured, meaning that the average of Goldstein scores of all events between China and an ASEAN country was taken as indicating directly the change in relations between China and the ASEAN country in that month. Because of the large number of events included in the analysis, the errors caused by different measurement methods can be mitigated to a certain extent. In Table 6 (3), the new core explanatory variables were brought in, and the results were basically consistent, thus proving the robustness of the empirical results.

The traditional gravity model does not include any consideration of the influence of multilateral resistance. Anderson and Van Wincoop (2003) noted that multilateral resistance is an important cause of changes in bilateral trade. We used the same method as Head and Mayer (2002) to measure the multilateral trade resistance based on the weighted average value of bilateral trade freedom. Specifically, the weight is the proportion of the economic size of the target country to the total economic size of all countries:

$$MRES^{-1} = \sum_{j=1}^k \left(GDP_w / GDP_j \right) \varphi_j \quad (6)$$

In Eq. (6), $MRES^{-1}$ is the reciprocal of multilateral trade resistance, GDP_j represents the market size of the export destination country, and GDP_w represents the world market size. Trade freedom φ_j is calculated according to the formula

$$\varphi_j = \sqrt{\frac{\exp_j \times \text{imp}_j}{e_i \times e_j}} \quad (7)$$

In Eq. (7), \exp_j represents China's exports to country j ; imp_j represents the amount of China's imports from country j ; and e_i and e_j represent the domestic trade volume of China and country j , respectively, calculated by subtracting total exports from total domestic output. During the collection of national export data, official data for Myanmar from 2001 to 2010 could not be fully obtained from various databases such as the CEIC database, the UN Comtrade Database, the World Bank database, the WTO Stats portal, and the official website of the Central Statistical Organization of Myanmar. As a result, the analysis of multilateral trade resistance includes only nine ASEAN countries, excluding Myanmar due to this unavailability of partial export data. Table 6 (4) shows that the coefficient of fluctuations in bilateral relations was 0.0229 after controlling the multilateral resistance item, which is higher than 0.0174 in column (1) of Table 4. This result indicates that the presence of multilateral resistance increased the impact of bilateral relationship fluctuations on trade.

In addition, Boehmer et al. (2011) emphasized that the phenomenon of zero values in trade statistics has a dual meaning, as it could indicate either that no trading occurred or that no statistical record was obtained. Silva and Tenreyro (2006) demonstrated that the Poisson pseudo-maximum-likelihood method (PPML) is a more reliable estimator and showed that PPML estimation can be used to deal with zero trade flows. To ensure the robustness of the regression results, Table 6 (5) uses PPML estimation for regression to avoid large deviations in the

regression results due to different regression methods. Notably, in the PPML method, the interpreted variables are not logarithmically processed. Judging from the PPML estimation results, when controlling for other variables, the regression result in Column (5) is positive at the 1% significance level. Judging from the sign and significance level of the regression coefficient, the results of using the PPML method when considering the zero trade flows problem are consistent with the above regression, indicating that the regression results are robust and that Hypothesis 1 is further proven.

Further discussion

In the post-pandemic period, global trade and investment frictions continue to intensify. The Chinese government should establish a policy of "new regionalism" and strengthen regional heterogeneous cooperation with countries in Southeast Asia (Hou et al., 2022). The above analysis discussed the impact of fluctuations in bilateral relationships and unilateral behaviour on bilateral trade. In contrast, the trade intensity between the two countries and their trade dependence can reflect the bilateral relationship between the two countries.

In addition, China's average Goldstein scores with Laos, Cambodia, Singapore, and Thailand were all above 2 from 2016 to 2020, indicating that bilateral relations with these countries have shown good development in the last 5 years. However, the average Goldstein score for China and Brunei had a negative score of -0.196 over the 5 years, indicating that bilateral relations between the two countries have developed slowly. Furthermore, the standard deviation of the Goldstein scores of the interaction events between China and the 10 ASEAN countries did not exceed 1 during the 5 years, indicating that both the frequency and magnitude of fluctuations in bilateral relations between China and ASEAN countries changed less during this period. Here, we further analyse bilateral trade using the trade intensity and Hubness Measurement (HM) indexes to explore the relationship between bilateral trade and the bilateral relationship.

Trade intensity index between China and ASEAN countries.

The trade intensity (TI) index measures the closeness of bilateral trade relations. The index is presented as

$$TI_{ij} = \frac{\exp_{ij} / \exp_i}{\text{imp}_j / (\text{imp}_w - \text{imp}_i)} \quad (8)$$

where TI_{ij} indicates the trade intensity between country i and country j , \exp_{ij} indicates the export trading volume from country i to country j , \exp indicates the overall export trading volume of a country, imp indicates the overall import volume of a country, and imp_w indicates the world total import volume, where i indicates China and j indicates the 10 ASEAN countries. When the TI_{ij} index is >1 , the export level from country i to country j is greater than the export level expected by the country's share in world trade, and the trade relationship between the two countries is closer than expected; if the TI_{ij} index is <1 , the trade relationship between the two countries is not as close as expected. Based on the availability of data and the closeness of the obtained results to the present time, this part of the analysis measures the quarterly trade intensity index between China and 10 ASEAN countries from 2016 to 2020, and the results of the calculation are shown in Fig. 2.

Overall, these results indicate that China's trade with ASEAN countries is relatively intensive, with the trade intensity index exceeding the critical value of 1 for most ASEAN countries. China's trade intensity with Myanmar, Cambodia, Vietnam, and the Philippines has been relatively high over the last 5 years. Among ASEAN countries, only Singapore and Brunei did not

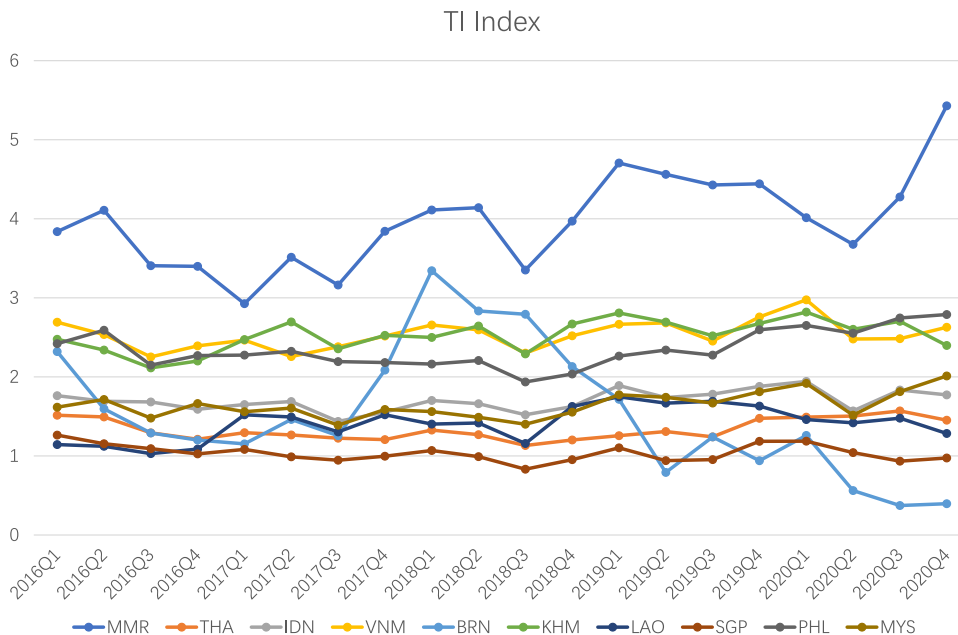


Fig. 2 Quarterly trade intensity index between China and ASEAN countries from 2016 to 2020. The horizontal axis represents time, with a total of 20 quarters from 2016 to 2020. The vertical axis represents the TI index, which indicates China’s trade relations with the 10 ASEAN countries. Source: World Bank Statistical database, CEIC database, and authors’ calculations.

exceed the critical value in individual quarters. Among these countries, China had the highest TI index with Myanmar, reaching 5.429 in the fourth quarter of 2020, far exceeding the export level corresponding to China’s share of world trade and thus indicating that Myanmar has a high trade dependence on Chinese exports.

Based on the change in time trends, we can infer that the trade intensity index between China and ASEAN countries is fluctuating. Although China’s trade relations with ASEAN countries are intensive, they are also vulnerable to changes in the international environment, and trade relations are volatile. These results reaffirm that bilateral trade is affected by fluctuations in bilateral relations to a certain extent.

HM index between China and ASEAN countries. The HM index predicts potential axis economies in a network of free trade agreements by measuring the degree of trade dependence between countries, which is calculated as follows:

$$HM_{ij} = \frac{\exp_{ij}}{\exp_i} \times \left(1 - \frac{\text{imp}_{ij}}{\text{imp}_i} \right) \times 100 \quad (9)$$

The HM index ranges from 0 to 100, and a larger value indicates a greater dependence of China’s exports on ASEAN countries’ markets. Based on the availability of data and the closeness of the obtained results to the present time, this part of the analysis measures the quarterly HM index between China and 10 ASEAN countries from 2016 to 2020, and the calculation results are shown in Fig. 3.

Figure 3 shows that China had a relatively high HM index during these five years with Vietnam, Singapore, Thailand, Malaysia, and Indonesia, all of which exceed 1. Among them, China had the highest bilateral trade dependence with Vietnam, with the HM index reaching a high of 4.39 in the fourth quarter of 2020. According to the 2021 country (region) guide for foreign investment and cooperation in ASEAN, China has been Vietnam’s top trade partner for 16 consecutive years (Ministry of Commerce of the People’s Republic of China, 2021). Moreover, both sides have signed a series of cooperation agreements, further developing infrastructure construction and cross-border

cooperation zones. With the optimization and upgrading of China’s industrial structure, labour-intensive industries are gradually moving to Southeast Asia in the upgrade process. As an essential partner of China, Vietnam has undertaken considerable development of low-end manufacturing industries. The relevant features are also highlighted in the export structure. With the support of regional cooperation frameworks such as the Belt and Road Initiative and the Regional Comprehensive Economic Partnership (RCEP) agreement, China–Vietnam trade cooperation will be further enhanced in the future.

Regarding time trends, the trade dependence level between China and most ASEAN countries has maintained stable growth over time, indicating that the trade relations between China and ASEAN countries have shown continuous improvement. However, some countries, such as Brunei, Laos, Cambodia, and Myanmar, have had a low level of trade dependence with China, indicating that there is still more room for trade development between China and these four countries. Existing studies have shown that Myanmar’s foreign economic relations in the 2010s can be summarized as a process of reintegration with the outside world, thus paving the way for diversification away from dependence on its main neighbour, China. There is a complex set of dynamics in Myanmar–China economic relations, particularly in the area of trade. Myanmar’s trade dependence on China rose quite rapidly at the beginning of the 21st century and then stopped due to the lifting of Western sanctions. The findings suggest that while the lifting of sanctions was key, the improvement in Myanmar’s diplomatic relations with the West in the 2010s did not reduce the country’s economic dependence on China in a linear manner (Oh, 2022). This finding is basically consistent with the results of the present article. Countries with relatively low trade dependence should continue to deepen cooperation and mutual understanding in their daily trade transactions so as to further improve their bilateral relations.

Conclusion

With the advent of information-sensing internet such as mobile devices, remote sensing, microphones and software logs, the so-

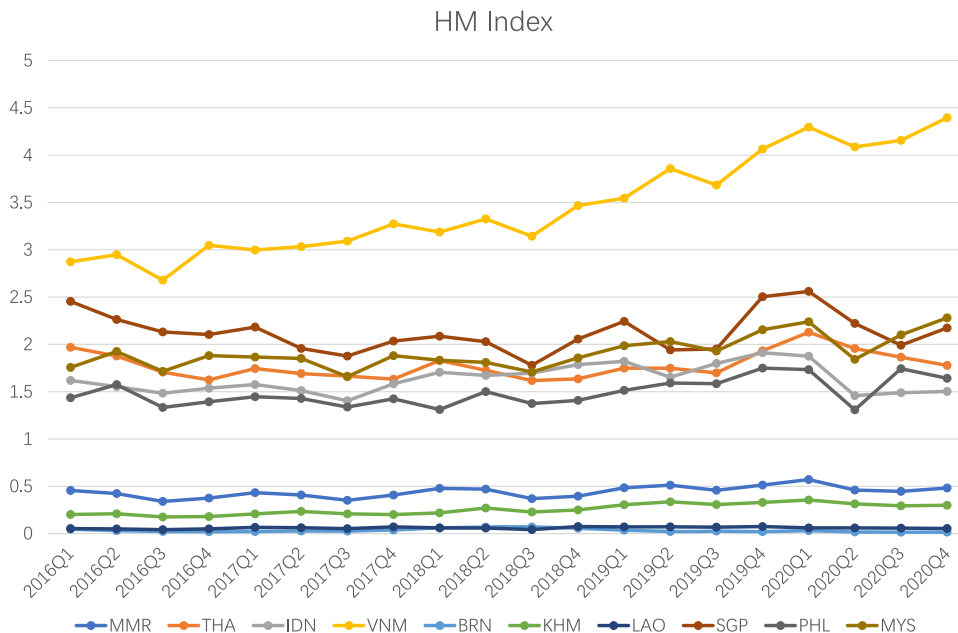


Fig. 3 Quarterly HM index between China and ASEAN countries from 2016 to 2020. The horizontal axis represents time, with a total of 20 quarters from 2016 to 2020. The vertical axis represents the HM index, which indicates the degree of trade dependence between China and ASEAN countries. Source: CEIC database and authors' calculations.

called big data revolution has had an enormous impact not only on the natural sciences but also on social science research (Zhang et al., 2019). This article provides an empirical basis for an in-depth understanding of international relations and trade cooperation by assessing the importance of the state of bilateral relations for trade. It uses massive event data from GDELТ to empirically analyse the impact of fluctuations in bilateral relations between China and 10 ASEAN countries on trade flows and to explore the effects of changes in a country's one-way behaviour on bilateral trade in the context of national relations. In addition, the TI index of trade intensity and the HM index of trade dependence are also used to provide an indirect analysis of the impact of fluctuations in bilateral relations on bilateral trade. The empirical evidence supports a better understanding of international relations and national trade cooperation analysis.

The main findings are as follows. First, using China and ASEAN countries as an example, empirical analysis suggests that the fluctuation of bilateral relations is positively correlated with bilateral trade. That is, if bilateral relations develop favourably, trade between the two countries increases, and vice versa. However, this effect is more strongly reflected in influencing China's export trade, while the impact of bilateral relations fluctuation on China's import trade is not significant. Second, the change in China's one-way political attitude towards ASEAN countries significantly affects bilateral trade, but ASEAN countries' one-way political attitude towards China does not have a significant impact on bilateral trade. Third, analysing the TI and HM indexes shows that China's trade relations with ASEAN countries are intensive but vulnerable to changes in the international environment; China's trade dependence level with most ASEAN countries maintains a trend of steady growth, and trade relations show a positive trend. These results also show that bilateral trade is affected by fluctuations in bilateral relations to a certain extent.

In recent years, the economic and trade flows between China and ASEAN countries have gradually deepened, and China has become a major trading partner of ASEAN countries. However, with the continued downturn of the world economy, the continued impact of COVID-19, and the complex global governance

environment, trade protectionism and 'deglobalization' have emerged, causing increased worldwide uncertainty and impeding China's deep integration into the world market. There have also been fluctuations in bilateral relations between China and ASEAN countries, and the trend of bilateral relations will also directly affect the development of bilateral trade. Therefore, while cooperating with ASEAN countries, China should attempt to maintain stable bilateral or even multilateral relations with them, deepen mutual understanding, strengthen policy communication, effectively enhance mutual understanding and trust, and provide a stable, favourable, and long-term trade development environment for further cooperation.

Our findings also indicate that countries are members of the same international economic organization promotes the growth of trade between them. It is recommended that not only China but also ASEAN countries should continue to exploit the United Nations, the Asia-Pacific Economic Cooperation, the Shanghai Cooperation Organization, the 'Belt and Road' initiative, and regional economic and trade cooperation agreements to deepen their contacts in the multilateral arena. Maintaining a stable level of bilateral and multilateral relations will enable trading partners to have more confidence in China, and China will have a better understanding of its trading partners, thus actively promoting cooperation in trade, investment, and trade facilitation to better complement each other's advantages and inject new momentum into trade development.

Furthermore, the impact of fluctuations in bilateral relations on bilateral trade is also reflected by the analysis of the changes in the intensity of trade relations between China and ASEAN countries and the fluctuations in the level of trade dependence between them in recent years. Among them, China's trade intensity with Myanmar, Cambodia, Vietnam, and the Philippines is high, and only Singapore and Brunei among the ten countries have individual quarters below the critical value. China's trade intensity index with Vietnam, Singapore, Thailand, Malaysia, and Indonesia is relatively high, while Brunei, Laos, Cambodia, and Myanmar have lower levels of trade dependence with China. Combined with the Goldstein score, in terms of the Goldstein score mean score,

China's bilateral relations with Laos, Cambodia, Singapore, and Thailand have shown good development during the five years. In addition, the standard deviation of the Goldstein scores of interactive events between China and the ten ASEAN countries during the five years does not exceed 1, indicating that both the frequency and magnitude of changes in the fluctuation of bilateral relations between China and ASEAN countries during this period have been relatively small. This is consistent with the fact that China and ASEAN countries have had few substantive political conflicts and apparent contradictions. Those fluctuations that have occurred in bilateral relations did not shake the foundations of relations between China and ASEAN countries.

China's Belt and Road initiative, proposed in 2013, aims to connect regions outside China, promote consensus on development among countries along the route, and enhance high-level and wide-ranging regional economic cooperation in trade and investment facilitation, infrastructure construction, and free flow of economic factors (Huang, 2016). ASEAN countries are members of the Belt and Road Initiative. As this article has shown, if the bilateral relationship between China and ASEAN countries improves, the trade between the two countries will increase. Therefore, it is recommended that China and ASEAN deepen economic and trade exchanges through the Belt and Road initiative to further consolidate the foundation of bilateral relations. Although some countries still oppose and reject the Belt and Road initiative (Colley and Van Noort, 2022), China should actively promote it with ASEAN countries amidst a complex external environment, support integration and community building, and help ASEAN achieve connectivity in a mutually beneficial way, fully leveraging the radiating and driving role of connectivity for the overall ASEAN economy.

In today's relatively complex and volatile international environment, the use of big data in research can contribute to the analysis of bilateral relations and bilateral trade. The research methodology used in this article is applicable not only to the relationship between China and ASEAN countries but also to the exploration of other interregional political and economic relationships and efforts to promote sustainable bilateral and multilateral development. Amidst the various potential sources of resistance and uncertainty in interregional cooperation, deepening trade exchanges between regions can further consolidate the foundation of bilateral relations, continue to optimize cooperation with ASEAN countries, and promote high-quality and high-level sustainable regional development.

Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author upon reasonable request.

Received: 15 April 2023; Accepted: 11 December 2023;

Published online: 03 January 2024

References

- Anderson JE (1979) A theoretical foundation for the gravity equation. *Am Econ Rev* 69(1):106–116
- Anderson JE, Van Wincoop E (2003) Gravity with gravitas: a solution to the border puzzle. *Am Econ Rev* 93(1):170–192
- Anwar DF (2020) Indonesia and the ASEAN outlook on the Indo-Pacific. *Int Aff* 96(1):111–129
- Arad RW, Hirsch S (1981) Peacemaking and vested interests: international economic transactions. *Int Stud Q* 25(3):439–468
- Baier SL, Bergstrand JH (2009) Bonus vetus OLS: a simple method for approximating international trade-cost effects using the gravity equation. *J Int Econ* 77(1):77–85
- Bailey MA, Strezhev A, Voeten E (2017) Estimating dynamic state preferences from United Nations voting data. *J Confl Resolut* 61(2):430–456
- Boehmer CR, Jungblut BM, Stoll RJ (2011) Tradeoffs in trade data: do our assumptions affect our results? *Confl Manag Peace Sci* 28(2):145–167
- Che Y, Du J, Lu Y, Tao Z (2015) Once an enemy, forever an enemy? The long-run impact of the Japanese invasion of China from 1937 to 1945 on trade and investment. *J Int Econ* 96(1):182–198
- Cheng B, Liu S, Xiong L, Wang F, Qin G, Yue D, Zhang H, Yu C (2019) Identifying the influencing factors on the quality of China's forestry exports: based on the exports from China to ten developed countries. *Econ Rev* 1(1):2–16
- Chiang MH (2019) China–ASEAN economic relations after establishment of free trade area. *Pac Rev* 32(3):267–290
- Colley T, Van Noort C (2022) Rejecting the belt and road initiative: the US and India. In: Colley T, Van Noort C (eds) *Strategic narratives, ontological security and global policy: responses to China's belt and road initiative*. Springer, Cham, Switzerland, pp. 135–171
- Davis CL, Fuchs A, Johnson K (2019) State control and the effects of foreign relations on bilateral trade. *J Confl Resolut* 63(2):405–438
- Dent CM (2013) Paths ahead for East Asia and Asia–Pacific regionalism. *Int Aff* 89(4):963–985
- Du Y, Ju J, Ramirez CD, Yao X (2017) Bilateral trade and shocks in political relations: evidence from China and some of its major trading partners, 1990–2013. *J Int Econ* 108:211–225
- Egberink F, Van der Putten FP (2010a) ASEAN and strategic rivalry among the great powers in Asia. *J Curr Southeast Asian Aff* 29(3):131–141
- Egberink F, Van der Putten FP (2010b) Introduction: what is ASEAN's relevance for geopolitical stability in Asia? *J Curr Southeast Asian Aff* 29(3):91–94
- Enderwick P, Buckley PJ (2020) Rising regionalization: will the post-COVID-19 world see a retreat from globalization? *Transnatl Corp J* 27(2):99–112
- Fan J, Lu B (2021) The impact of summit visits on bilateral trade: empirical evidence from China. *World Econ* 44(12):3583–3608
- Fuchs A, Klann NH (2013) Paying a visit: the Dalai Lama effect on international trade. *J Int Econ* 91(1):164–177
- Garman G, Petersen J, Gilliard D (1998) Economic integration in the Americas: 1975–1992. *J Appl Bus Res* 14(3):1–12
- Gartzke E (2007) The capitalist peace. *Am J Political Sci* 51(1):166–191
- Germer DJ, Schrodt PA, Yilmaz O, Abu-Jabr R (2002) The creation of CAMEO (conflict and mediation event observations): an event data framework for a post cold war world. Paper presented at the annual meeting of the American Political Science Association, American Political Science Association, Montreal, Quebec, 15–18 September 2002
- Ghifari M (2020) An uncertainty of cross-straits relations and its implication towards ASEAN. *Thai J East Asian Stud* 24(2):1–19
- Glick R, Taylor AM (2010) Collateral damage: trade disruption and the economic impact of war. *Rev Econ Stat* 92(1):102–127
- Gowa J, Mansfield ED (1993) Power politics and international trade. *Am Political Sci Rev* 87(2):408–420
- Head K, Mayer T (2002) Illusory border effects: distance mismeasurement inflates estimates of home bias in trade. Working paper 2002-01. CEPII Research Center, Paris, France
- Hirschman AO (1980) *National power and the structure of foreign trade*. University of California Press, Berkeley, CA
- Hou J, Cheng Z, Gong X (2022) The effect of exports and two-way foreign direct investment between China and Pan-East Asian countries. *Sustainability* 14(24):16975
- Huang Y (2016) Understanding China's belt and road initiative: motivation, framework and assessment. *China Econ Rev* 40:314–321
- Keshk OM, Pollins BM, Reuveny R (2004) Trade still follows the flag: the primacy of politics in a simultaneous model of interdependence and armed conflict. *J Politics* 66(4):1155–1179
- Li Q, Sacko DH (2002) The (ir)relevance of militarized interstate disputes for international trade. *Int Stud Q* 46(1):11–43
- Li Y, Jian Z, Tian W, Zhao L (2021) How political conflicts distort bilateral trade: firm-level evidence from China. *J Econ Behav Organ* 183:233–249
- Linnemann H (1966) *An econometric study of international trade flows*. North-Holland Publishing Company, Amsterdam, Netherlands
- Lu Y, Zhang Y, Cao X, Wang C, Wang Y, Zhang M, Ferrier RC, Jenkins A, Yuan J, Bailey MJ (2019) Forty years of reform and opening up: China's progress toward a sustainable path. *Sci Adv* 5(8):eaau9413
- Martin P, Mayer T, Thoenig M (2008) Make trade not war? *Rev Econ Stud* 75(3):865–900
- Ministry of Commerce of the People's Republic of China (2021) 2021 country (region) guide for foreign investment and cooperation: ASEAN. <http://www.mofcom.gov.cn/dl/gbdqzn/upload/dongmeng.pdf>. Accessed 19 Sept 2022
- Mitchener KJ, Weidenmier M (2008) Trade and empire. *Econ J* 118(533):1805–1834
- Morrow JD (1999) How could trade affect conflict? *J Peace Res* 36(4):481–489

- Morrow JD, Siverson RM, Tabares TE (1998) The political determinants of international trade: the major powers, 1907–1990. *Am Political Sci Rev* 92(3):649–661
- Nitsch V (2007) State visits and international trade. *World Econ* 30(12):1797–1816
- Nitsch V, Schumacher D (2004) Terrorism and international trade: an empirical investigation. *Eur J Political Econ* 20(2):423–433
- Nye Jr JS (2020) Power and interdependence with China. *Wash Q* 43(1):7–21
- Oh YA (2022) Assessing Myanmar's trade dependence on China during the reform period of the 2010s: a sectoral value chain approach. *Pac Rev*. <https://doi.org/10.1080/09512748.2022.2160797>
- Oneal JR, Russett B, Berbaum ML (2003) Causes of peace: democracy, interdependence, and international organizations, 1885–1992. *Int Stud Q* 47(3):371–393
- Polachek SW (1978) Dyadic dispute: an economic perspective. *Pap Peace Sci Soc Int* 28:67–80
- Polachek SW (1980) Conflict and trade. *J Confl Resolut* 24(1):55–78
- Pollins BM (1989a) Conflict, cooperation, and commerce: the effect of international political interactions on bilateral trade flows. *Am J Political Sci*. <https://doi.org/10.2307/2111070>
- Pollins BM (1989b) Does trade still follow the flag? *Am Political Sci Rev* 83(2):465–480
- Pöyhönen P (1963) A tentative model for the volume of trade between countries. *Weltwirtsch Arch* 90:93–100
- Reuveny R (2000) The trade and conflict debate: a survey of theory, evidence and future research. *Peace Econ Peace Sci Public Policy* 6(1):23–49
- Reuveny R, Kang H (1996) International trade, political conflict/cooperation, and Granger causality. *Am J Political Sci* 40(3):943–970
- Shen C (2023) The impact of infrastructure development on China–ASEAN trade: evidence from ASEAN. *Sustainability* 15(4):3277
- Silva JS, Tenreiro S (2006) The log of gravity. *Rev Econ Stat* 88(4):641–658
- Sohn CH (2001) A gravity model analysis of Korea's trade patterns and the effects of a regional trading arrangement. *Korea Inst Int Econ Policy Work Pap Ser* 9(1):35
- Su CW, Song Y, Tao R, Hao LN (2020) Does political conflict affect bilateral trade or vice versa? Evidence from Sino–US relations. *Econ Res* 33(1):3238–3257
- Tinbergen J (1962) *Shaping the world economy: suggestions for an international economic policy*. Twentieth Century Fund, New York
- Wall HJ (1999) Using the gravity model to estimate the costs of protection. *Federal Reserve Bank of St. Louis, St. Louis, MO*
- Wang YC, Tsai JJ, You E (2022) The impact of RMB internationalization on the exchange rate linkages in China and ASEAN countries. *Appl Econ* 54(43):4961–4978
- White H (2013) *The China choice: why we should share power*. Oxford University Press, Oxford, UK
- Whitten G, Dai X, Fan S, Pang Y (2020) Do political relations affect international trade? Evidence from China's twelve trading partners. *J Shipp Trade* 5:1–24
- Xu Q, Chen S (2014) The impact of China–Japan relations on bilateral trade. *Q J Int Politics* 1:1–24
- Yan X, Zhou F (2004) A quantitative measurement of international bilateral political relations. *Soc Sci China* 6:90–103
- Yang J, Chen C (2008) The economic impact of the ASEAN–China free trade area: a computational analysis with special emphasis on agriculture. In: Chen C, Duncan R (eds) *Agriculture and food security in China: what effect WTO accession and regional trade arrangements?* ANU E Press, Canberra, Australia, pp. 372–407
- Yang L, Liu X, Zhang J (2016) How do bilateral political relations affect outward direct investment—based on a perspective of binary margins and investment failure. *China Ind Econ* 11(1):56–72
- Yang S, Martinez-Zarzoso I (2014) A panel data analysis of trade creation and trade diversion effects: the case of ASEAN–China free trade area. *China Econ Rev* 29:138–151
- Yeats AJ (1990) Do African countries pay more for imports? Yes. *World Bank Econ Rev* 4(1):1–20
- Yu H (2017) Motivation behind China's 'One Belt, One Road' initiatives and establishment of the Asian Infrastructure Investment Bank. *J Contemp China* 26(105):353–368
- Zhang C, Xiao C, Liu H (2019) Spatial big data analysis of political risks along the Belt and Road. *Sustainability* 11(8):2216
- Zhang R, Qu Y (2022) The impact of US trade policy uncertainty on the trade margins of China's export to the US. *Sustainability* 14(22):15101
- Zhou Y, Wang L (2019) The analysis of the impact of international political conflict on trade: a case study on China–Japan relation. *China Econ Stud* <https://doi.org/10.19365/j.issn1000-4181.2019.03.05>

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Conceptualization: YW and YT; data curation: YW; analysis: YW; writing—original draft: YW; software: YW; writing—review and editing: YW and YT. Both authors read and approved the final manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

This research did not require any ethical approval because it did not involve human research participants and because no primary data were collected.

Informed consent

This article does not involve any studies with human participants performed by any of the authors.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-023-02525-w>.

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