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Trade barriers and export growth: Analyzing the US-China trade relationship with the LSDV model

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ABSTRACT

This study employs a gravity model of trade to assess the repercussions of US-China trade frictions on China's export dynamics. Our findings unravel some noteworthy results: First, we find a significant and negative correlation between the variables linked to trade frictions, namely Technical Barriers to Trade (TBT) and Average Tariff (AT), and the volume of China's exports. Secondly, the regression results do not indicate that the SPS has a dampening effect on China's exports. Thirdly, China's exports are more affected by the Average Tariff (AT) than by Technical Barriers to Trade (TBT). Finally, the exports from the previous period positively influenced China's exports to the US. In other words, the US-China trade friction has significantly reduced China's exports to the US. As a policy implication, China should reduce its dependence on the US market, diversify its markets, uphold the principles of free trade and multilateralism, and promote openness in response to the challenges of the trade war.

Contribution/ Originality: This study uniquely uses a gravity model to distinguish the impact of tariff and non-tariff measures on China's exports, offering new insights into export resilience during the US-China trade war.

1. INTRODUCTION

Since Deng Xiaoping's Talks in the South in 1992, China's reform and opening up have entered a period of expansion, and China's international commerce has also entered a period of rapid development. Both of these developments have occurred simultaneously. Ever since the reform and opening up of China in 1978, China's international commerce has progressively shifted from a trade deficit to a trade surplus, and it has continued to rise. Furthermore, Luo & Zhi (2019) have intimately linked China's economic development to other global economic concerns.

Figure 1 illustrates that the total value of China's imports and exports increased from RMB 4.22 trillion in the year 2001 to Renminbi (RMB) 39.1 trillion in the year 2021, exhibiting an average annual growth rate of 12.2%. A further point to consider is that China's market share has significantly increased over the years, going from 4% in the year 2001 to 13.5% in the first three quarters of the year 2021. For the first time, China surpassed all other countries in terms of the amount of goods it traded. In 2021, China's international trade reached a new high of six trillion dollars, marking a milestone in the history of the country. China's entry into the World Trade Organization (WTO) has been a significant contributor to the country's increase in its international commerce (Harper, 2018; Hur, 2018).

Over the last two decades, China's exports have expanded at a rate that is 12.2% higher on average per year. According to the findings of Shuai, Pan, Xu, Tan, and Wang (2018) electromechanical items have emerged as the most significant export products, accounting for 59% of total exports. People often categorize electromechanical items as heavy industrial items, while light industrial items like apparel and plastic materials are considered light industrial products.

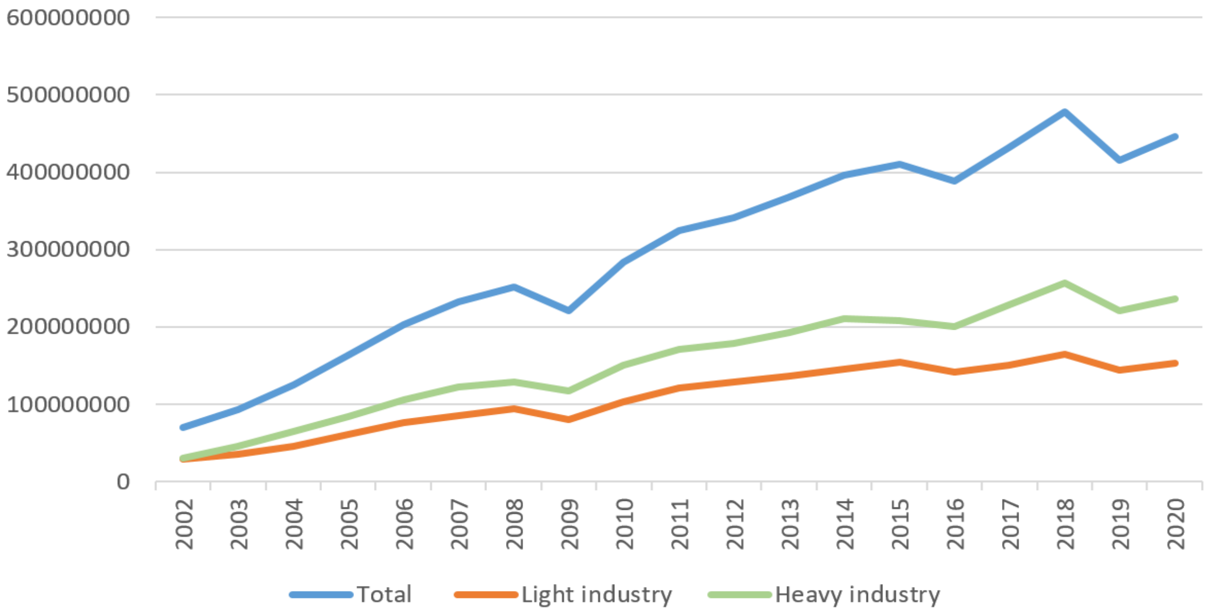

Figure 1. China's export trade to the US (2002 - 2020).

Source: Wind database https://www.wind.com.cn/portal/zh/EDB/index.html.

As China's overseas commerce expands, trade tensions between China and the United States, the world's second and largest economies, have grown. Figure 2 illustrates that the US-China trade imbalance remains a key source of trade friction, with China's exports to the US far exceeding its imports, resulting in a persistent trade surplus for China and a trade deficit for the US, making trade frictions unavoidable (Qiu & Wei, 2019). However, previous research frequently ignores the uneven impact of trade frictions on different export product categories and fails to investigate China's strategic responses in this setting adequately. This lacuna in the research restricts our understanding of how individual product types and trade measures affect US-China trade patterns.

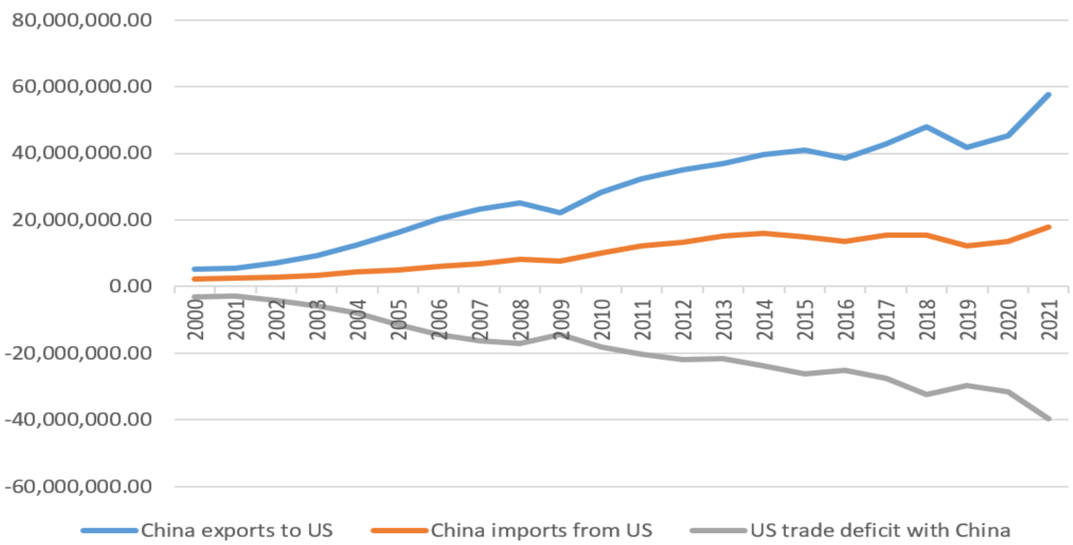

Figure 2. China's export trade to the US (2000 - 2021).

Source: Wind database https://www.wind.com.cn/portal/zh/EDB/index.html.

While popular support for international trade with China in the United States remains high at 76%, Jin, Dorius, and Xie (2022) reveal deeply divided sentiments towards the US-China trade war. Given the complexities of the trade dispute, a thorough examination of its effects on China's export-driven economy is required, including an analysis of whether the impact varies by category of exported products and how China responds from its unique perspective.

This study adds to the literature by using the trade gravity model to examine the impact of US-China trade tensions on Chinese exports, with a special emphasis on identifying the effects across various trade barriers. The findings show that Technical Barriers to Trade (TBT) and Average Tariff (AT) considerably lower China's export volume, with AT having a greater impact than TBT. Surprisingly, Sanitary and Phytosanitary Measures (SPS) do not appear to limit China's exports. Furthermore, previous periods' export levels positively influence China's exports to the US, highlighting the significant impact of trade frictions on reducing China's exports to the US. This paper addresses a gap in existing research by concentrating on the differential effects of various trade barriers, providing new insights into policy implications for more efficient trade friction management.

Following is the format for the remaining parts of the paper: While Section 2 presents research that is pertinent to the topic at hand, Section 3 explains the underlying empirical methodology. In Section 4, we will examine the results based on the technique. The final section presents the conclusion and subsequent recommendations.

2. REVIEW OF THE LITERATURE

2.1. International Commerce and the Expansion of the Economy

Krugman (1979) asserts that international commerce boosts productivity using economies of scale and competitive pressure. Grossman and Helpman (1991) on the other hand, contend that trade encourages the dissemination of new technologies and the development of innovative ideas. According to Coe and Helpman (1995) trade fosters the transfer of technology and increases total factor productivity (TFP) through the importation of capital equipment and novel technologies. Rather than focusing on the nuanced impact of trade barriers, which is becoming increasingly significant in recent trade disputes, these main ideas concentrate on idealized scenarios in which economies will effortlessly profit from trade.

In a seminal paper on the East Asian Newly Industrialized Countries, Kim and Lau (1994) discovered that the accumulation of factors was a more important component in the evolution of the East Asian economy than the introduction of new technologies. Young (1995) hypothesized that the East Asian economic miracle was not the result of innovation but rather the accumulation of capital and manpower. Instead of emphasizing the increase in productivity, these studies fail to clarify how trade frictions or regulatory restraints could have impacted the inputs. As a result of this deficiency, their findings are less applicable to economies that are experiencing problems with global commerce.

The contribution of exports and imports to the growth of total factor productivity (TFP) in ASEAN nations, China, Japan, and South Korea was almost nonexistent. Investments in physical capital, rather than technological advancements, were the primary drivers of Gross Domestic Product (GDP) growth in South Korea and Japan. It is important to note that Ahmed's study does not take into account any existing trade laws or constraints, such as those that have arisen as a consequence of the trade war between the United States and China. These regulations and limitations may have a variety of effects on the pace of productivity development in different nations and sectors. According to Lashaki and Ahmed (2017) the growth of human capital, an increase in exports, and investments in telecommunications were all positive outcomes of foreign direct investment (FDI) in the Asia-Pacific region, which led to an increase in GDP. They do not take into account how trade policies and limits influence productivity channels. More specifically, they do not take into account how protectionist policies or tariff rises may restrict exports and foreign direct investment as drivers of total factor productivity development.

After the trade war between the United States and China, trade policy has become increasingly crucial to the entire world's economy. Bagwell and Staiger (2011) examine the long-term efficiency losses that trade wars cause, while Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020) demonstrate that tariffs imposed during the trade war between the United States and China lowered bilateral commerce, damaged global supply networks, and hindered the growth of the global economy. Despite these findings, the majority of this study focuses on the short-term effects of trade and efficiency rather than the long-term effects that trade wars have on the productivity of economic sectors or specific industries.

Current research rarely examines the impact of contemporary trade wars, particularly those between the United States of America and China, on economic growth and productivity across various industries. By examining the impact that trade barriers have on China's exports, the specific objective of this research is to acquire a more in-depth comprehension of the long-term implications that trade wars have on the levels of productivity and growth in the economy. The Technical Barriers to Trade (TBT), the Average Tariff (AT), and the Sanitary and Phytosanitary Measures (SPS) are all examples of things that might be considered trade hurdles.

2.2. Reasons for the Trade Friction between China and the United States

Since the global financial crisis of 2008, some countries, including the United States of America, have had economic difficulties (Acharya & Schnabl, 2010). Both the United States and the European Union have enacted trade protectionist policies to shield their industries from the threat of competition from other countries. This research, which solely evaluates the short-term economic justifications for protectionism, fails to consider the complex and long-term consequences of bilateral trade connections, particularly between large countries like the United States and China (Hsieh, 2009).

Due to its extensive economic ties with the United States, China, which is one of the countries that is most impacted by protectionist policies in the United States, confronts significant problems (Tam, 2020). There has been previous research that has emphasized the significance of trade between the United States and China; however, very few studies have investigated how protectionist policies influence trade or economic sectors over time. The intensification of global trade dynamics and protectionist measures has led to increased economic friction and conflict between China and the United States, two significant trading partners with interconnected economies.

Trade disputes and protectionist measures by both countries have hampered bilateral trade and the global economy. In contrast, existing research rarely examines how these conflicts affect trade predictability and market confidence, which are essential for an international trading system. When it comes to resolving trade problems and maintaining global business stability, these dynamics highlight the need for diplomacy, negotiation, and multilateral cooperation.

The following are the primary reasons for the trade war between the United States and China:

2.2.1. The Substantial Trade Surplus between China and the US

The imbalance in trade that exists between the United States and China is a significant problem. Even though the amount of commerce that takes place between the two countries has increased, this trade surplus has increased. Kim (2014) highlights the significance of the trade imbalance by pointing out that, as a result of expanding trade volumes, the deficit has expanded. Even though China and the United States have a significant trade surplus, they continue to engage in diverse types of commerce.

The Trump administration places a high priority on reducing the trade deficit with China because of the significant contribution that China makes to the trade imbalance. The volume of trade may occasionally grow as a result of deficit-reduction strategies; however, there is a lack of knowledge about the long-term structural impact that these plans have on the trading relationship (Sharma, Leung, Kingshott, Davcik, & Cardinali, 2020). The strong economic interdependence between the two countries has forced China to take countermeasures and make efforts to find diplomatic trade solutions.

The recurring excess of commerce between these two large countries highlights the need to maintain a balanced economic relationship between them. The current study tends to ignore diplomatic and cooperative efforts in the process of constructing a more equal economic relationship, instead concentrating on policy issues. When it comes to establishing a more stable and balanced environment for business, both countries need constructive trade agreements and bilateral discussions.

2.2.2. Macroeconomic Imbalances within China and the US

The United States and China's economic growth paths diverge greatly due to their fundamentally distinct economic systems. Domestic consumption primarily drives the US economy. Thus, the government has implemented a variety of methods to support consistent development in this sector. However, these measures have contributed to a culture of excessive consumption, resulting in recurrent trade deficits as spending exceeds domestic savings. This mismatch needs higher imports to balance trade accounts. According to Kojima (2000) and Morrison (2013) the private and governmental sectors are significant sources of domestic savings in the United States. Over time, the private sector has maintained a low savings rate, exacerbating the trade deficit.

In 2017, the private sector savings rate in the United States fell by three percentage points to a historic low. Ironically, this time was characterized by significant domestic spending, resulting in a huge imbalance in the private sector's financial accounts. The public sector exhibited a similar tendency. As Holinski, Kool, and Muysken (2012) note, the ongoing imbalance between investment and consumption adds significantly to the US trade deficit. In response to this challenge, President Trump implemented several policies aimed at reducing the deficit; however, these measures inadvertently exacerbated the budgetary situation, demonstrating that the US trade deficit is frequently a natural result of the underlying disparity in domestic savings and investment.

In contrast, Chinese consumers have more frugal spending habits. Historically, China has prioritized measures that reduce consumption to increase investment and limit domestic consumption growth (Gilboy, 2004). As a result, China is experiencing both excessive savings and under-consumption. Furthermore, China's economic growth is strongly reliant on foreign demand and investment, resulting in increasing exports of Chinese goods and a decrease in imports. This reliance worsens the trade surplus problem, as policies targeting encouraging investment exacerbate the imbalance in trade relations with the United States.

2.2.3. The US Direct Investment in China and the Imposition of Export Controls

There has been a gradual decline in the manufacturing sector in the United States, occurring concurrently with the expansion of the service sector. Because of this, a significant number of American businesses have relocated their manufacturing overseas in the expectation of obtaining higher profits. The enormous labor force in China and the low cost at which it produces items have made it the principal destination for these companies. China has been the primary destination for these enterprises.

On the other hand, previous research often does not address the underlying causes of this tendency. These explanations encompass structural developments in the US economy and the influence of firm rules on the selection of relocations. There is a lack of a comprehensive assessment of how these corporations impact trade balances and economic connections between the United States and China in the existing body of research. Thus, even though the presence of Chinese multinational firms may cause the value of Chinese imports and exports to move in different directions, there is a lack of such an assessment in the existing body of research.

Restriction of high-tech exports from the United States contributes to the widening of the economic gap and prevents a more equitable trade relationship. A few studies have examined the long-term effects of these restrictions on the economic ties between the United States and China, specifically in relation to the trade deficit. The differences in economic development between the two countries due to their different stages of industrialization resulted in the availability of complementary trade goods. Despite the acknowledgement of resource inequalities and domestic circumstances by Wong and Zhou (2011) numerous assessments fail to investigate their potential for mutual economic gain.

In the context of bilateral commerce, comparative advantage recommends that the United States and China should concentrate on their respective strengths. The United States sells commodities that need much technology, while China exports things that require much labor (Mayer, Butkevicius, Kadri, & Pizarro, 2003). The impact of this theoretical framework on trade dynamics and export limits, on the other hand, has received very little attention from researchers. The trade deficit between the two countries is growing as a result of differences in product demand as well as limitations imposed by the United States on high-tech products. This trade deficit necessitates having an understanding of how these problems impact the economic connection between the two countries.

2.3. Current Research and Application of Trade Gravity Models

To explain international commerce, Tinbergen (1963) developed the gravity model of business. This hypothesis states that trade between economies is proportional to their sizes and inversely proportional to their gaps. Numerous studies that use gravity models fail to take into account how political stability, regulatory frameworks, and market accessibility influence trade flows. It is because of this mistake that the model is unable to depict international commerce accurately.

Linnemann (1966) expanded upon Tinbergen's work by incorporating three essential components into the gravity model. These components were the exporting nation's supply, trade limitations, and importer demand. Although Linnemann is correct in his assertion that income levels affect supply and demand, he does not examine how income levels interact with other socioeconomic factors, such as income inequality and consumer preferences, which have the potential to impact the outcomes of traded transactions dramatically. However, present trade agreements and geopolitical concerns seldom address the changing nature of trade impediments, such as tariffs and transportation costs, which are obstacles that restrict trade flows.

Huff and Jenks (1968) were among the pioneers who used the gravity model to investigate trade frictions and bilateral commerce. According to the findings of the study, trade frictions reduce both the volume and breadth of commerce. On the other hand, the literature frequently chooses to disregard the more fundamental reasons for these frictions, such as how technological advancements and improvements in logistics offset some of their negative implications. Their findings provide evidence that the generalized gravity model is capable of describing bilateral trade flows, but they do not consider the complexity of current trade exchanges, such as transactions that take place online or through e-commerce.

In summary, most of the gravity models investigate how the distance effect influences business. Using data from 1962–1996 from 130 different countries, Brun, Carrère, Guillaumont, and De Melo (2005) discovered that distance had an 11% negative impact on the model's ability to explain phenomena. This research rarely addresses the factors responsible for the diminishing results over time. These aspects include transportation and communication technologies, both of which have the potential to lessen the impact that geographical distance has on economic transactions.

With data spanning the years 1992–2001 and 2002–2016, Goh and Lau (2020) applied the concept of the gravity model. After China entered the World Trade Organization (WTO), GDP and foreign direct investment (FDI) became more relevant trade factors. In doing so, they disregard the economic and political context surrounding China's participation in the World Trade Organization (WTO), as well as how trade policy and international relations influence it.

The gravity model may help us better understand tariffs and other trade barriers, which frequently lead to trade wars. According to Charandabi, Ghashami, and Kamyar (2021) nationalism, unilateralism, and protectionism are frequently the root causes of these disagreements, which, in turn, impede the progression of business. Their research does not take into account global supply networks or how trade conflicts affect various industries. The imposition of higher tariffs can significantly diminish the economic benefits and sales volume of a nation's trade partners, which can result in retaliation and economic losses for both parties involved. When it comes to trade battles, the research frequently fails to take into account the long-term repercussions that these retaliatory acts have on global trade patterns and economic stability.

2.4. Hypothesis

This study investigates the impact that trade friction has on China's exports. Using the findings of prior research, the Treaty on the Elimination of Technical Barriers to Trade (TBT Agreement). Villarreal (2018) states that the World Trade Organization oversees this trade deal.

Chen and Bao (2023) study how trade barriers to trade (TBT) influenced the performance of Chinese exports between 2001 and 2006. Examining both restrictive and beneficial effects. The TBT raises the price of compliance and hinders commercial activity. In addition to lowering uncertainty and enhancing product quality, TBT brings about an increase in demand and commerce.

As a result of China's global position and the globalization of its economy, the country's international trade is expanding. Since China became a member of the World Trade Organization (WTO), trade policy has increased its use of technical trade barriers, and the volume and economic significance of international commerce have both significantly increased. Exporters from China have been experiencing difficulties as a result of recent trade obstacles imposed by industrialized countries (Gu, 2017).

The preceding line suggests considering the performance of technical barriers to trade (TBT). The investigation's findings support the following theory:

Hypothesis H_1: There was a negative impact on China's exports due to the TBT.

The SPS Agreement boasts the most stringent regulations on domestic regulatory measures of any WTO agreement. When governments enact policies aimed at safeguarding the health and welfare of people, animals, and plants, they must abide by a plethora of commitments that surpass the guidelines in the GATT and TBT (Rigod, 2013).

Henson and Loader (1999) investigate the function and implications of the GATT's Sanitary and Phytosanitary Agreement (SPS) on developing countries' export trade prospects. They make recommendations on how developing countries can benefit even more from the Sanitary and Phytosanitary Measures (SPS) Agreement's operation and look at how individual national standards can act as trade barriers for exports from these countries.

The preceding statement calls for an examination of the performance of Sanitary and Phytosanitary Measures (SPS). Therefore, this study proposes the following hypothesis:

Hypothesis H_2: Sanitary and Phytosanitary Measures (SPS) have a negative impact on China's exports.

Raising tariffs is a crucial instrument in a trade war, but the effects of higher US tariffs on trade are a contentious issue. According to Amiti, Redding, and Weinstein (2020) US consumers and businesses primarily bear the costs associated with tariffs, which include higher prices for imported goods, increased production costs for companies reliant on foreign raw materials, and reduced profit margins for firms unable to pass these costs on to consumers fully. This observation is especially true in the steel business, where tariffs have forced foreign exporters to reduce their pricing drastically. China's trade with the United States has grown as a result of lower tariffs.

Feenstra and Kee (2007) study the expansion of China's export variety from 1990 to 2001 and compare their findings with those of Mexico. Among other findings, we demonstrate that the expansion of Chinese export varieties due to lower US tariffs has had a negative competitive market impact on Mexico's export varieties.

Will rising tariffs in China, a major manufacturer of goods, lead to the migration of manufacturing plants for processing trade to the United States? By comparing factor payments in the Chinese and US manufacturing sectors, the average tariff rate necessary to shift processing trade enterprises is 48.15%, which is significantly higher than the existing rate of 25% (Wang & Hewings, 2020).

Based on the statement above, Average US tariffs on China (AT) performance should be considered. Therefore, this study proposes the following hypothesis:

Hypothesis H_3: Average tariffs (AT) have a negative impact on China's exports.

3. METHODOLOGY AND DATA

3.1. International Trade and the Gravity Model

Researchers have studied commerce and cross-border data flows over the past 50 years using the gravity model of international trade, which is based on Newton's law of gravity. Tinbergen (1963) initially applied the gravity model of international trade to examine the difficulties related to international trade. Their research revealed that the economic scale and spatial distance are the primary determinants of the data flows of trade between the two nations or areas; more precisely, the trade volume has a negative correlation with spatial distance and a positive correlation with economic scale. They developed the first gravity model of international trade, which looks like this:

$$F_{ij} = G \times \frac{M_i^{\alpha} \times M_j^{\beta}}{D_{ij}^{\theta}} \qquad (1)$$

In model (1), F_{ij} can be used to show the volume of commerce that goes from country i to country j, the volume of trade that goes from country j to country i, or the overall volume of trade that goes back and forth between country i and country. The economic scale of countries i and j is represented by M_i and M_j, respectively, and is typically the GDP of the two nations. D_{ij} denotes the spatial separation between countries i and j, which is often the geographic separation between their major ports or economic hubs: G, α, β, and θ are constant. Unlike the gravitational equation in physics, the elasticity of space, or the elasticity of distance to trade data flows, and the elasticity of economic scale to trade flows are unclear in the equation of trade data flows (α and β are not necessarily 1, θ is not necessarily 2). Since the model (1) has the form of a product, to facilitate the analysis, the logarithm of both sides of the equation of the model (1) can be taken to convert it into a linear form, and the original equation can be expressed as:

$$In\, F_{ij} = \Phi + \alpha In\, M_i + \beta In\, M_j - \theta In\, D_{ij} + \varepsilon_{ij} \qquad (2)$$

In model (2), Φ is a constant, ε_{ij} is a random error term, and the meanings of other symbols are the same as above. Subsequent academics have consistently expanded and adapted the gravity model of international commerce to various trade concerns. Researchers extended the gravity model of international commerce to include additional elements that impact Western trade, such as trade obstacles, population, culture, policy, and history. We aim to explore the impact of different factors on bilateral trade to achieve our research objectives. We can ignore the geographical distance variable in this analysis, as it solely focuses on business between China and the US and assumes a constant physical distance (Ding, Zhang, Zheng, Wang, & Zhang, 2019). We conduct an analysis using data from 2002 to 2020 to assess the long-term impact of trade frictions between the US and China on bilateral commerce.

3.2. Panel Data Regression

It is common practice to employ panel data regression as a technique of analysis when dealing with complex datasets such as this one, which includes both time series and cross-sectional data. Having the ability to distinguish between balanced and unbalanced panel data examples is an incredibly vital skill to possess. It is important to note that the research in question uses balanced panel data to prevent the formation of skewed random effect error terms. In the realm of panel data regression, there are a few different interpretations from which one might pick. To begin, it takes into account individual variability, which is also known as unobserved unit differentiators. If the estimates of the explanatory variables are reliable, any changes in the key variables could potentially affect these estimates. Two-panel data techniques, dummy variables and differencing can reduce the amount of unobserved variability in the model. These methods help control for unobserved factors, thereby improving the accuracy of the estimates.

Researchers are able to include more data when they use panel data. It is a significant step forward to combine individual and temporal characteristics in order to enhance the size of the sample. Compared to time series data, panel data often exhibits a higher degree of cross-sectional variation within units. When there is collinearity, the regression results become unstable due to the substantial association between the explanatory variables. The diverse nature of the dataset provides a solution to this problem. There is a wide variety of estimation approaches for panel data analysis. Regularly used methods include pooled ordinary least squares, random, and fixed ordinary least squares. Utilizing statistical tests such as the F-test, LM (Lagrange Multiplier) test, and Hausman test, one may decide which model is the most accurate. Due to the fact that they take into account endogeneity, omitted variables, and unobserved heterogeneity, these tests assist in selecting the most appropriate data model.

It is necessary to incorporate a number of critical components in order to generate realistic panel data models. These components include intensive data analysis, extensive testing of model assumptions, and empirical results from a range of diagnostic techniques. It was because of this that the model provided accurate and useful insights into variable correlations.

3.3. Selection of Panel Data Regression

The POLS method analyzes the dataset without taking into account panels. The assumption that all disturbances are the same and independently distributed may make it more difficult to discern individual and temporal variation. The Fixed Effect (FE) and Random Effect (RE) models are able to avoid these limits since they allow for unit and period intercepts, slopes, and unobserved heterogeneity.

The FE model makes use of individual-specific intercepts in order to consider unit-specific components that have the potential to influence the relationship. FE lets you look at the relationship between variables while also taking into account how different the panel is by accounting for these unobserved individual-specific effects.

Both slopes and intercepts are examples of random variables that are based on distributions in the RE model. Over time, the connections between variable units change. The use of random effects draws attention to dynamic relationships, which, in turn, makes panel data studies more comprehensive. The following equation divides the error term into two composite error components to account for volatility.

$$\varepsilon_t = \lambda_i + u_{it} \qquad (3)$$

The symbol λ is used in panel data analysis to represent the individual-specific effect or unobserved heterogeneity. This individual-specific effect captures the characteristics unique to each unit in the panel, such as firm-specific features, country-specific factors, and any other unobserved factors that may influence the outcome under examination. It is assumed that the individual-specific effect is time-invariant, meaning that it remains constant during the observed periods.

In the context of Random Effects (RE) models, the parameter λ is considered a random variable with a mean and variance of zero. Of greater significance, it is assumed to not correlate with the regressor. The unique impact is denoted as being stochastic. We posit that λ is integrated into the combined error term. This error term exhibits serial correlation within individual units, leading to the inefficiency of Ordinary Least Squares (OLS) through the introduction of autocorrelation. Consequently, OLS standard errors become unreliable.

On the other hand, Fixed Effect (FE) models assume that the individual-specific effect is constant for each unit. FE models often represent the individual-specific effect as an intercept that varies across units. This intercept captures the unit-specific characteristics that influence the outcome variable. The fixed effect estimator removes the individual-specific effect from the model and then estimates it using ordinary least squares (OLS) on the transformed data. There are two common variations of FE: within-group FE and Least Squares Dummy Variables (LSDV) FE. Within-group FE subtracts the mean of each unit's observations from the original data, transforming the model into a within-group variation. OLS is then applied to the transformed data. However, this method does not allow for the identification of the effects of time-invariant variables.

LSDV FE explicitly introduces the unobserved effect λ into the model by using individual-specific dummy variables. Each unit has its dummy variable that represents the individual-specific effect. While this approach is conceptually straightforward, it can become impractical when dealing with a large number of units, leading to a high number of dummy variables and potential loss of degrees of freedom. In summary, both RE and FE models aim to capture the effects of individual-specific characteristics in panel data analysis. Whereas FE believes the individual-specific effect is constant across units, RE views it as a random variable. The underlying presumptions and properties of the data determine which of these models to use.

In this work, we applied the Least Squares Dummy Variables (LSDV) method and its bias-corrected variation to obtain our model estimate. When a lagged dependent variable is present, there is a specific restriction on the LSDV estimator known as Nickell's (1981) bias, which must be taken into consideration. This bias, independent of sample size (N), is more likely to be evident when the period (T) is short. However, when T rises, this bias becomes less pronounced. For this investigation, the slope coefficients are the main focus. Fortunately, prior work has demonstrated that the bias in slope coefficient estimates with LSDV is negligible, most notably by Judson and Owen (1999). Because of its focus on slope coefficients, we consider the LSDV approach appropriate for our research.

Furthermore, the bias-corrected LSDV (LSDVC) technique, which was suggested by Bun and Kiviet (2003); Judson and Owen (1999); Kiviet (1995) and Bruno (2005) was also used in this research for precision. A lot of Monte Carlo simulations by Kiviet, Judson, Owen, Bun, and Bruno show that LSDVC works better than other panel estimators, like the Anderson-Hsiao Instrumental variable, first-difference GMM, and system GMM estimators. This phenomenon is especially true when it comes to bias and root mean square errors for balanced panel data. Furthermore, the efficacy of LSDVC in comparison to alternative estimators is further demonstrated by Bruno's (2005) application to imbalanced panel settings. The findings of Flannery and Hankins (2013) show that LSDVC works better than common fixed-effect panel estimators and widely used GMM estimators, especially in small cross-sectional units (N).

Table 1. List of variables.

Type of variables	Description	Name of variables	Unit of measurement	Sources
Explained variables	China's export trade to the US	Export	Hundred million USD	WIND
Trade gravity model variables	GDP growth of China	CGDP growth	Hundred million RMB	WIND
	GDP growth of US	UGDP growth	Billion USD	WIND
Trade friction variables	Average US tariffs on China	AT	Percentage	WIND
	Technical barriers to trade	TBT	Number	WTO/TBT-SPS notification and enquiry of China
	Sanitary and phytosanitary measures	SPS	Number	

3.4. Data

This study uses balanced panel data from China's heavy and light industries. Table 1 presents the list of variables from 2002 to 2020 that are used in our study. The dependent variable is China's exports to the US. The main independent variables used to proxy for trade friction are Technical barriers to trade (TBT) and the Tariff (AT). Although there are no industry-level trade friction variables, there is reason to believe that changes in national-level trade friction data will have a significant impact on the export performance of China's heavy and light industries?

Throughout the modeling process, all data will be processed in logarithmic form. Since this study only examines trade between China and the United States, and the distance between the two countries is constant (about 14,000 kilometers in a straight line), the geographical distance variable can be ignored (Ding et al., 2019).

3.4.1. CNGDP and USGDP

The value of China's exports to the US increases in direct proportion to China's GDP, which also increases domestic production and makes Chinese exports more competitive. The country's GDP growth positively correlates with the US's purchasing power and demand for imports, thereby impacting China's exports to the US market. The US has a bigger purchasing capacity for goods and a stronger demand for imports, the higher its GDP.

3.4.2. Tariffs

To contain China's rapid growth, the US has imposed widespread tariffs on its products. These tariff barriers will curtail or even prevent Chinese products from entering the US market. This tariff will reduce or even prevent Chinese products from entering the US market, thereby protecting trade. The imposition of tariffs reflects, to a certain extent, the level of trade friction between the US and China. The imposition of tariffs by the US partially reflects the extent of trade friction between the US and China, resulting in a negative impact on Chinese exports. On the other hand, the tariff transmission theory predicts that an increase in US tariffs on China will result in higher prices for Chinese products in the US, thereby dampening Chinese exports.

3.4.3. TBT

The WTO/TBT, as it is known, allows members to protect their national security interests, human, animal, and plant life, and the environment by raising the technical standards of imported goods. TBT is currently one of the most effective tools used by WTO members, especially developed countries, to erect trade barriers and protect trade. In the bilateral trade between the US and China, the US has always been cautious about importing high-tech products from China due to its fear of China and frequently restricts its imports by setting high standards. Therefore, technical barriers to trade can, to a certain extent, reflect the degree of trade friction between the US and China. Technical barriers to trade (TBT) measures typically arise from the development, adoption, or implementation of technical standards or assessment procedures that deviate from their predecessors.

3.4.4. SPS

The full name of the WTO/SPS is the WTO Agreement on the Application of Sanitary and Phytosanitary Measures. However, SPS primarily refers to quarantine and animal and plant inspection procedures. Agricultural product trade significantly influences bilateral trade between the US and China, accounting for around 20% of China's total import and export of agricultural products. Since 2002, China's trade in agricultural products with the US has been in deficit, which has made trade friction between the two countries prominent in the agricultural industry. Therefore, this paper proposes to use SPS notifications to represent the implementation of SPS measures in the US and to analyze the impact of SPS measures on China's exports to the US.

Table 2. Variable descriptive statistics.

Variables	Mean	Standard deviation	Observations
Export	18.909	0.623	54
Ugdp growth	0.036	0.022	54
Cgdp growth	0.118	0.046	54
TBT	5.167	0.684	54
SPS	5.169	0.460	54
AT	1.148	0.431	54

4. RESULT

4.1. Tests of the Unit Root and Descriptive Statistics

In this study, there are several different variables, and Table 2 provides the descriptive data for each of those components. This set of descriptive statistics provides a comprehensive description of the Mean, Standard Deviation, and Observations of the variables that are the focus of the investigation. These statistics are of utmost significance since they help to offer a condensed overview of the data, and they also assist in the interpretation of the findings of the study.

Table 3. Results of the panel unit root test.

Variables	Im-Pesaran-Shin (IPS) test	Fisher PP	Fisher ADF	I(d)
Export	-0.721	-4.692***	-0.769	I(1)
ΔExport	-3.430***	-3.669***	-3.217***	I(0)
Ugdp growth	-0.166	-0.511	-0.291	I(1)
ΔUgdp growth	-2.278**	-2.065**	-2.325***	I(0)
Cgdp growth	-2.540***	-5.244***	-2.655***	I(0)
TBT	-2.331***	-6.442***	-2.363***	I(0)
SPS	-3.091***	-4.712***	-3.096***	I(0)
AT	6.141	-4.075***	6.140	I(1)
ΔAT	-13.144***	-7.275***	-7.275***	I(0)

Note: The asterisks **and *** indicate statistical significance at 5%, and 1% levels, respectively. The W-t-bar test statistics are reported for the Im-Pesaran-Shin (IPS) test. The inverse normal Z statistics are reported for the Fisher PP and ADF tests. All three-panel unit root tests are estimated by including a constant and trend. The optimal lag length for the Im-Pesaran-Shin (IPS) and Fisher ADF tests is selected based on the Schwarz information criterion (SIC). The optimal bandwidth for the Fisher PP test is selected using the Newey-West criteria.

However, given the relatively long period in this study, the issue of nonstationarity may arise. For practical reasons, the Im, Pesaran, and Shin (2003) and Fisher ADF and Phillips-Perron (Choi, 2001) panel unit root tests are used to check the stationarity properties of the variables. Table 3 shows the panel unit root test results. The EXPORT, Ugdp growth, and AT are found to follow the I(1) process. Therefore, these two variables are incorporated into the model specification as the initial differences. We find that the rest of the variables follow the I(0) process.

4.2. Regression Results

Based on the variable descriptions and unit root tests mentioned above, our basic equation can be expressed as:

$$\Delta EXPORT\ it = \alpha_0 + \alpha_1 \Delta EXPORT\ it - 1 + \alpha_2 \Delta Ugdpgrowth\ t + \alpha_3 Cgdpgrowth\ t + \alpha_4 TBT\ t + \alpha_5 SPS\ t + \alpha_6 \Delta AT\ t + \varepsilon\ t$$

Nickell's (1981) bias occurs when a model links the lagged dependent variable with the individual-specific effect. Estimation based on Random Effects (RE) assumes that there is no association between the independent variable and the individual-specific effect. On the other hand, the Fixed Effects (FE) estimate allows for the accounting of such correlations.

Given the model's inclusion of a lagged dependent variable, the RE approach is not suitable, as it leads to biased outcomes. Consequently, FE becomes the preferred choice. However, it is important to note that FE does not eliminate this bias. As a solution, the use of the bias-corrected LSDV method becomes necessary. This approach is needed to address and rectify the underlying issues associated with the model's structure.

Differentiating essentially eliminates the constant term in LSDV models by eliminating time-invariant components, including intercepts. This approach helps control for potential endogeneity issues, especially when there are individual-specific characteristics that do not vary over time but could influence the dependent variable.

Table 4 reveals three types of LSDV. The Blundell-Bond, Arellano-Bond, and Anderson-Hsiao methods are not distinct variations of the Least Squares Dummy Variables (LSDV) method. Instead, they refer to specific dynamic panel data estimation techniques that commonly address endogeneity and serial correlation issues in panel data analysis. We frequently apply these methods in econometrics to estimate models with lagged dependent variables, correct for individual-specific effects, and account for potential endogeneity in panel data sets.

In dynamic panel data models, the Blundell-Bond estimator manages endogeneity, serial correlation, and unobserved effects that are unique to each person. It refines the classic Arellano-Bond technique by incorporating additional moment requirements, resulting in more precise parameter estimates. Biases from typical FE or RE estimators can occur when there is a relationship between individual-specific effects and lagged dependent variables.

Table 4. Regression result of China's export trade to the US.

Dependent variable	ΔEXPORT（Export from China to the US)			
Specifications	**(1)**	**(2)**	**(3)**	**(4)**
Estimation methods	**FE (Fixed-effects)**	**LSDV (Blundell-Bond)**	**LSDV (Arellano-Bond)**	**LSDV (Anderson-Hsiao)**
$\Delta EXPORT_{it-1}$	0.153** (0.028)	0.230** (0.043)	0.228** (0.039)	0.233* (0.077)
ΔUgdp growth $_t$	3.012*** (0.000)	3.077*** (0.000)	3.063*** (0.000)	3.121*** (0.000)
Cgdp growth $_t$	0.378** (0.043)	0.346 (0.244)	0.354 (0.210)	0.319 (0.338)
TBT_t	-0.085*** (0.006)	-0.079*** (0.001)	-0.078*** (0.000)	-0.078*** (0.002)
SPS_t	0.007 (0.771)	-0.000 (0.996)	-0.000 (0.999)	-0.000 (0.991)
ΔAT_t	-0.114*** (0.001)	-0.119*** (0.000)	-0.119*** (0.000)	-0.119*** (0.000)
CONSTANT	0.451*** (0.079)	- -	- -	- -
No. obs	51	51	51	51

Note: Robust t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Δ denotes the first difference.

Dynamic panel data approaches, using the Arellano-Bond estimator, employ instrumental factors based on lagged independent variables to tackle the issue of serial correlation. Lagged dependent variable panel data are less likely to exhibit endogeneity and serial correlation as a result of this. Another dynamic panel data approach for serial correlation and endogeneity analysis is the Anderson-Hsiao estimator. This estimator employs more lagged dependent variable levels as instruments. The ability to account for endogeneity and serial correlation via the use of lag-dependent variable values may improve the results.

A powerful framework for derivations is the generalized method of moments (GMM). This model is especially true for dynamic panel data models that have endogenous variables, lagged dependent variables, and serial correlation. Within the context of panel data analysis, they address basic FE and RE problems. The type of estimator chosen depends on the characteristics of the data and the nature of the research problem.

4.3. Summary of Statistical Results

This study uses a fixed effects panel data regression and three LSDV panel data regressions. Remarkably, the regression outcomes derived from these different methods exhibit a high degree of similarity. This congruence underscores the robustness and reliability of the regression analyses conducted.

The coefficients of the variable $\Delta EXPORT_{t-1}$ exhibit values of 0.153, 0.230, 0.228, and 0.233 across the analysis. All these coefficients are statistically significant. This finding indicates a positive correlation between the export volume in the previous period and the export volume in the later period. This positive correlation could also be the result of export industry-specific patterns or cyclical effects. For example, an increase in the number of exports in a previous period may be due to a continued increase in a country's demand for its exports, a trend that may continue for some time.

The coefficients of the variable ΔUgdp growth exhibit values of 3.012, 3.077, 3.063, and 3.121 across the analysis. Interestingly, at the 0.01 level, every one of these coefficients shows statistical significance. This observation underscores the significant impact of US GDP growth on China's export trade. The analysis reveals that the growth of US GDP significantly influences the expansion of China's export trade. This relationship is due to the direct impact of US economic growth on variables such as domestic consumption levels and consumer demand for imported goods. Therefore, there is a positive correlation between China's exports to the US market and US GDP growth. The strong significance of the coefficient validates the claim that US economic development significantly influences China's export trade dynamics.

Technical Barriers to Trade (TBT) exert a direct impact by serving as barriers that obstruct the entry of foreign products into specific markets. The coefficients associated with the TBT variables are as follows: -0.085, -0.079, -0.078, and -0.078The above coefficients all reach statistical significance at the 0.01 level, proving their importance in the analysis. It is worth noting that the upgrade of the TBT level has a more significant impact on the export volume of heavy industrial products. US TBT's inhibitory effect on China's exports manifests in two distinct dimensions: firstly, it consistently prevents Chinese export products from entering the US market, resulting in a significant quantitative inhibitory effect; secondly, it requires Chinese exports to comply with US technical standards, regulations, and conformity assessment procedures. Chinese export Enterprises are forced to carry out technological innovation and improve production processes, which inevitably increases the operating costs of export enterprises and has a significant inhibitory effect (H1 cannot be rejected).

The regression findings reveal that Sanitary and Phytosanitary Measures (SPS) exhibit a positive impact on China's exports, although the p-values associated with this variable are not statistically significant. Upon examining the SPS data, we observe that the values of SPS were 379 and 374 in 2006 and 2007, respectively. In contrast, these values declined to 86 and 84 in 2017 and 2018. When considering the data across different years, it is apparent that the SPS variable does not exhibit a consistent upward trend akin to variables such as AT or TBT. The nature of SPS measures, primarily related to food safety and animal and plant health quarantine regulations, elucidates this trend. Importantly, most of the trade disputes between China and the US revolve around high-tech, high-value-added industrial products rather than SPS-related matters. Therefore, we can attribute the positive coefficient in the statistical results to this specific contextual dynamic, which underscores the intricate relationship between SPS measures and the trade dynamics between the two nations. (H2 cannot be received).

The coefficients associated with the variable ΔAT reveal values of -0.114, -0.119, -0.119, and -0.119 across the analysis. Interestingly, each of these coefficients exhibits statistical significance at the 0.01 level. By comparing the absolute values of the coefficients, AT has a greater impact on China's exports than TBT. This finding underscores the substantial impact of tariff increases imposed by the US on China's export values. The study highlights that the US's escalation of tariffs on China has a profound and adverse impact on various dimensions of China's export landscape. (H3 cannot be rejected).

This study contributes to the current literature on international trade by illustrating the major impact of trade barriers during US-China tensions. The finding supports Krugman (1979) and Grossman and Helpman (1991) claim that there is a positive link between previous export performance and economic productivity, as well as Bagwell and Staiger (2011) claim that technical barriers to trade generate efficiency losses. Furthermore, the negative association between Average Tariffs (AT) and China's exports highlights the harmful consequences of protectionist policies.

The findings demonstrate the intricate relationship that exists between trade barriers and export dynamics, further emphasizing the need to gain an understanding of these connections in order to enhance trade policy and achieve a more equitable economic relationship among significant trading partners.

5. DISCUSSION

The increase in trade tensions between the United States and China has led to a decline in the amount of goods that China sells to the United States. Both nations' exports suffer as a result of this adverse situation. China faces challenges in selling its products to the United States as a result of trade disputes between the United States and China. The implementation of tariffs and the technological barriers to trade (TBT) both have a substantial influence on this occurrence.

The most significant factor that impacts the dynamics of exports is the negative relationship that exists between Chinese exports and TBT and AT indices. This connection is the most crucial part of the equation. Therefore, it is crucial to fully understand how the ongoing trade conflicts between the United States and China impact the commerce between the two countries. It is difficult to ignore the impact trade tensions will have on China's export efforts to the United States, given that the United States is China's primary trading partner. Decision-makers in government and those involved in the sector need to do a thorough analysis of the implications of this circumstance.

The trade deficit between China and the US sparked the trade war (Moosa, Ramiah, Pham, & Watson, 2020). To resolve this issue, the Chinese government does not need to focus on a drastic increase in imports. Instead, a strategic approach could involve reducing the share of exports in GDP while increasing the proportion of imports in the overall economy. Efficient market oversight techniques can meet this goal.

The two main goals of the previous regulatory actions are first to promote RMB appreciation and then dramatically reduce export tax rebates. These initiatives could include mild tariff reductions. By applying these measures, the government can create a more balanced trade pattern and an environment that optimizes import and export dynamics following economic stability and growth objectives. We design this method to reduce existing contradictions and build a more sustainable and equitable trade ecology.

The Chinese government needs to compile two comprehensive lists of potential actions and negotiating strategies in order to handle trade frictions. Making these lists calls for thoughtful deliberation rather than a hasty acceptance of the criteria. China had to analyze the impact that increased tariffs would have on products of the United States, including automobiles, airplanes, and soybeans. Once you have completed the assessment, you will be able to make smarter selections. In addition, we must examine how sanctions affect service and investment trade in the larger economy.

On the negotiation agenda, China should prioritize active participation and identify measures that promote service trade expansion, tariff reduction, intellectual property protection, and transparency. These measures should be consistent with China's strategic interests in developing a modern, open economy. Subsequently, China should quickly initiate dialogue and negotiations to resolve issues through cooperative consultation. By taking this two-pronged approach, China can strategically respond to trade frictions, ensure the effective use of retaliatory measures and constructive negotiations to safeguard its economic interests, and promote a balanced trade relationship. Suppose the US adopts appropriate policies in the future. In that case, China can still make concessions for the interests of the US on trade and security issues (Zeng & Meng, 2020).

Amid these dynamics, China should actively seek to expand alternative markets to reduce its dependence on the US market. By diversifying its trading partners and routes, China can enhance its resilience to economic uncertainties. This diversification strategy is essential to maintaining a stable growth trajectory for foreign trade. Furthermore, China must consistently support the principles of free trade and multilateral cooperation. In the face of trade protectionism and unilateralism, China must promote free markets, fair competition, and a rules-based global trading system. By rejecting protectionism, China can foster an environment that benefits all countries engaged.

In parallel, China's "One Belt, One Road" initiative provides an opportunity to strengthen its economic links with a variety of countries, building a more diverse and linked trade network. By broadening its ties outside North America and Europe, China can join new markets, enhance economic contacts with developed countries, and boost economic collaboration between its trade businesses and peers throughout the world. With these tactics, China can handle the complexity of global trade, keeping its economy dynamic and robust in the face of changing trade dynamics and obstacles (Liefu, 2020).

The implications of this study extend well beyond the commercial ties between the United States and China. Countries have a responsibility to evaluate the impact that trade restrictions and levies have on exports and the overall health of the economy. In order to limit adverse impacts and cultivate a balanced trading climate, policymakers should proactively adopt trade policies. When a corporation diversifies its business partners, it lessens its reliance on a single market and strengthens its resistance to the effects of global economic shocks.

Encouragement of international collaboration and free trade are examples of best practices. One way for countries to strengthen their positions and protect themselves from the negative impacts of unilateral trade policies is to participate in debates about international trade and to place an emphasis on the protection of intellectual property and transparency. China's "One Belt, One Road" plan serves as an example of how to enhance economic connections and broaden distribution networks for commerce. Within the context of a global economy that is becoming more protectionist, such frameworks may be of assistance to other countries in managing complex trade dynamics and maintaining their competitiveness.

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