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Agricultural Trade Effects of China's Free Trade Zone Strategy: A Multidimensional Heterogeneity Perspective

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Abstract: The purpose of this work is to investigate the varied effects of China's free trade zone (FTZ) strategy on agricultural trade and its underlying mechanisms. This work utilizes the propensity score matching–staggered difference-in-differences (PSM–Staggered DID) approach and synthetic control method (SCM) as its analysis methods. This study analyzes trade volume data between China and various countries alongside diverse economic indicators spanning from 1995 to 2020. The data sources include CEPII_BACI, the China Free Trade Zone Services website, the Penn World Tables, and the CEPII database. The novelty of this work lies in exploring the multidimensional heterogeneity of agricultural product trade effects in FTZs and their underlying mechanisms and extending the application of causal inference methods to the assessment of FTZs' trade effects. Empirical analysis indicates that the establishment of FTZs with partner countries has contributed to the growth of China's agricultural trade. The effects of agricultural trade resulting from China's FTZ strategy exhibit multidimensional heterogeneity in the aspects of agreement terms, years, product categories, and network positions. Specifically, when it comes to the agreement terms, FTZs negotiated by China with broader scope, deeper terms, and stronger constraints have a more significant impact on agricultural trade due to the establishment of FTZs; in terms of years, the agricultural trade effects have gradually expanded over time; in terms of product categories, China has expanded its imports of primary agricultural products and semiprocessed agricultural products from partner countries, thus augmenting its exports of horticultural agricultural products and processed agricultural products. In terms of network positions, China, as a hub country, has greater agricultural trade effects than partner countries after the establishment of the FTZs. Finally, the paper proposes policy recommendations for optimizing the implementation strategy of FTZs.

Keywords: free trade zone; trade effects; agricultural trade; heterogeneity

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1. Introduction

China, with its large population, prioritizes ensuring the food supply for its citizens as a primary and fundamental requirement. International trade in agriculture allows for the redistribution of resources across regions and international boundaries, thus complementing any potential shortages in domestic food production, especially in the face of unpredictable factors such as natural disasters, climate change, or pandemics, thus ensuring the stability of the national food supply [1]. However, as multilateral trade negotiations on agricultural issues have stalled, China has been seeking new models and methods to promote agricultural trade [2], thereby gradually adopting the establishment of free trade zones (FTZs) as a significant approach to agricultural trade activities, thereby ensuring the effective supply of important agricultural products [3]. Since the 17th National Congress of the Communist Party of China first introduced the "implementation of the free trade zone strategy" in 2007, the "14th Five-Year Plan" has further emphasized the need to "construct a high-standard

global network of FTZs, continuously enhancing China's new advantages in international economic cooperation and competition". Consequently, the establishment of FTZs has reached a new historical pinnacle in China, with the number rapidly increasing [4]. Due to the flexibility of FTZs, China has adopted strategies of 'gradual opening', 'one country, one policy', and 'network construction' in their implementation. As a result, there are significant variations in the modes of openness and agreement terms in the FTZs established by China with different countries. Taking the China–ASEAN FTZ as an example, China and ASEAN countries first implemented the Early Harvest Program for agricultural products (January 2004). Subsequently, they successively reached agreements on the "Goods Trade Agreement" (November 2004), "Dispute Settlement Mechanism" (November 2004), "Services Trade Agreement" (January 2007), and "Investment Agreement" (August 2009). In terms of the liberalization process, due to the significant differences in economic development and agricultural structure among ASEAN countries, China has adopted a "one country, one policy" approach by implementing varying tariff reduction arrangements tailored to different countries. In addition, as of February 2021, China has 20 FTZ agreements in force with its partner countries involving 30 countries (or regions). These partner countries span across Asia, Oceania, South America, and Europe. With the increasing number of China's FTZ partner countries, a preliminary network of FTZs has emerged, with China as the hub and partner countries as the spokes (Appendix A).

The enforcement of China's free trade agreements (FTAs) with various countries has created conditions for strengthening agricultural trade between China and its partner countries. Since establishing its first FTZ in 2004, China's trade volume in agricultural products with its partners has grown from 13.94 billion USD in 2004 to 54.12 billion USD in 2020, with an average annual growth rate of 8.85%. In 2020, the trade volume, import, and export values of agricultural products between China and its FTZ partners accounted for 19.38%, 18.14%, and 22.59% of China's total agricultural trade volume, imports, and exports, respectively. Looking at the agricultural trade structure and taking the ASEAN countries as an example, in 2020, the total trade volume of agricultural products between China and the ASEAN countries was 43.01 billion USD. Of this, China's imports from ASEAN countries reached 23.13 billion USD, which mainly included vegetable oils, aquatic products, grain products, and cereals. China's exports to ASEAN countries amounted to 19.88 billion USD, which primarily consisted of fruits, vegetables, and aquatic products. In addition, the implementation effects vary notably. For example, consider the first year after China established FTZs with its partner countries. China's agricultural trade with the ASEAN countries, Chile, Pakistan, New Zealand, Peru, Costa Rica, and Switzerland increased by 18.57%, 12.55%, 13.33%, 23.16%, 38.10%, 20.78%, and 12.88%, respectively. However, trade with Iceland, South Korea, and Australia declined by 15.77%, 6.39%, and 1.42%, respectively (Appendix B). This raises the questions: What are the various aspects of heterogeneity in the impact of China's FTZ strategy on its agricultural trade with partner countries? What are the mechanisms for this heterogeneity? The study of the heterogeneity in the effects of agricultural trade within FTZs and the understanding of its underlying mechanisms hold significant practical value. They not only serve as a basis for optimizing the implementation path of China's FTZ strategy and enhancing the quality of FTZ execution but also facilitate trade diversification and the more efficient utilization of both international and domestic markets and resources to ensure domestic food security in the current context of increasing trade protectionism and restricted regional cooperation.

This study's potential innovations and contributions, compared to the existing literature, mainly lie in two aspects. Firstly, it makes some contributions by considering the heterogeneity of agricultural trade effects in FTZs, which has received relatively less attention in previous research. The existing studies are all based on the assumption of homogeneity [5–7] and that there is no cross-sectional difference between FTZs [8,9]. Since Baier and Bergstrand [5] found non-negligible differences among different FTZs, this has attracted the attention of some scholars. For example, Magee [10] found that FTZs estab-

lished among large, similar, and close countries tend to perform better in terms of trade creation effects.

Although the existing literature has explored the heterogeneous trade effects of FTZs, such studies predominantly focus on a single dimension, thereby overlooking the in-depth investigation into the agricultural trade effects and their mechanisms. This oversight has led to a systematic analysis gap. Therefore, this paper aims to fill this gap by examining the agricultural trade effects of China's FTZ strategy through a multidimensional lens and analyzing their operational mechanisms, thereby offering new insights from a novel research perspective. Secondly, one distinctive feature of this study is the application of causal inference methods in the assessment of trade effects in FTZs. To effectively solve the endogeneity problem, this paper constructs a hierarchical empirical research methodology. Considering the varying points in time at which China's FTAs came into effect with different countries, the study first employs the propensity score matching (PSM) method to mitigate selection bias. It then utilizes a staggered difference-in-differences (Staggered DID) approach for causal inference, which is relatively less common in related research. Furthermore, due to limited data, it is difficult to find a suitable control group in the examination of network position heterogeneity. This paper employs a synthetic control method (SCM) based on a "counterfactual" framework. Existing research often uses the gravity model to examine the trade effects of FTZs. This article uses the causal inference method, which will shed some light on existing research in the use of research methods.

The following sections in this paper are arranged in sequence as follows: Section 2—Literature Review and Research Hypothesis, Section 3—Methodology and Data, Section 4—Results, Section 5—Discussion, and Section 6—Conclusions.

2. Literature Review and Research Hypothesis

2.1. Theoretical Analysis Framework

The traditional FTZ theory, represented by Viner [11], posits that after the establishment of an FTZ, trade among member countries is effectively promoted through channels such as trade creation effects and trade diversion effects as tariffs are progressively reduced. However, the traditional theory falls short of explaining the mechanism behind the heterogeneity of trade effects in agricultural products within FTZs. Consequently, this paper further incorporates theories of trade liberalization, comparative advantage, and the hub-and-spoke FTZs to construct an analytical framework, and it puts forth the research hypothesis of this study.

2.2. Heterogeneity of Agreement Terms

With the gradual development of FTZs, tariff reductions are no longer the focal point of their establishment negotiations. Terms outside the WTO framework, such as investment policies and innovation policies, are increasingly favored by countries. In contrast to tariff reductions, other terms such as investment policies and innovation policies tend to produce dynamic trade effects. Through mechanisms of technological advancement, investment promotion, and deepening division of labor, these terms further boost the growth of agricultural trade among member countries [12–14]. As a result, deep terms have a greater and more enriched effect on agricultural trade than shallow terms [15]. In addition, the presence of legally binding provisions and the existence of a dispute resolution mechanism are essential safeguards to ensure the smooth execution of the agreement and the consistency and credibility of member nations' trade activities [16]. Therefore, in the long run, "strong legally binding" typically has a more pronounced effect than "soft legally binding" in promoting agricultural trade among member countries.

2.3. Heterogeneity of Years

To effectively protect domestic agriculture, each country will provide a certain buffer period. For example, China mainly adopts a gradual tariff reduction in establishing FTZs with partner countries. With increasing liberalization, the scale of agricultural trade

between China and its partner countries has grown year by year, and there is a lag in the impact of China's FTZ strategy. Furthermore, from the perspective of new new trade theory, after the enhancement of trade liberalization, agricultural trade is primarily driven by two channels: the intensive margin (pure quantity expansion) and the extensive margin (product diversification) [17]. Given fixed production costs for businesses, adjustments in agricultural production and trade behaviors, whether at the intensive margin or the extensive margin, take time [18]. Moreover, the growth in agricultural trade resulting from the extensive margin requires an even longer duration [19]. After the establishment of an FTZ, previously less productive agribusinesses will continue to participate in agricultural trade with the FTZ member countries, particularly as trade costs decrease [20]. Therefore, the longer China establishes an FTZ with its partner countries, the faster the growth of agricultural trade effects.

2.4. Heterogeneity of Product Categories

The principle of comparative advantage is the theoretical foundation of international trade. In the absence of trade barriers, countries export agricultural products in which they have a comparative advantage and import those in which they have a comparative disadvantage. Before the establishment of the FTZ, due to tariffs and nontariff barriers, the high trade costs often deterred less efficient enterprises from engaging in agricultural trade, thus leading them instead to compete in the domestic market. After that, as trade costs decrease, an increasing number of enterprises participate in agricultural trade with member countries, which is more conducive to the play of the comparative advantage of each member country. In the case of China's situation, the continuous rise in land and related costs in recent years has increasingly highlighted the lack of international competitiveness in its primary agricultural products [21]. Compared to its partner countries, China no longer holds a comparative advantage in primary agricultural products like grain; however, it maintains strong international competitiveness in horticultural and processed agricultural products [22]. Therefore, after establishing FTZs with partner countries, China will expand its imports of primary agricultural products from these countries while also increasing its exports of horticultural and processed agricultural products to them.

2.5. Heterogeneity of Network Positions

Based on the theory of the hub-and-spoke FTZ, when a hub country establishes an FTZ with multiple spoke countries that have not reached cooperation with each other, the hub country can access the markets of multiple spoke countries simultaneously, while the trade flows between the spoke countries must be re-exported through the hub countries to enjoy zero-tariff treatment [23]. In this scenario, the hub-and-spoke FTZ model grants the hub country a positional advantage, while the spoke countries are "marginalized" [24]. In the realm of international economics, hub countries leverage their critical positions as centers of trans-shipment trade. They are not only positioned to benefit from direct trade with spoke countries but also stand to gain from facilitating trade flows among spoke countries through their territory. Consequently, while spoke countries can benefit from the establishment of FTZs, the growth of their agricultural trade is significantly smaller compared to that of the hub country. The continuously expanding roster of partner countries within FTZs has preliminarily established a global network of FTZs. Within this network of China's FTZs, the majority of partner countries have not established FTZs amongst themselves. Thus, in the hub-and-spoke FTZ scenario, there are asymmetric gains for the spoke and hub countries [23]. Figure 1 presents the hub-and-spoke FTZ structure.

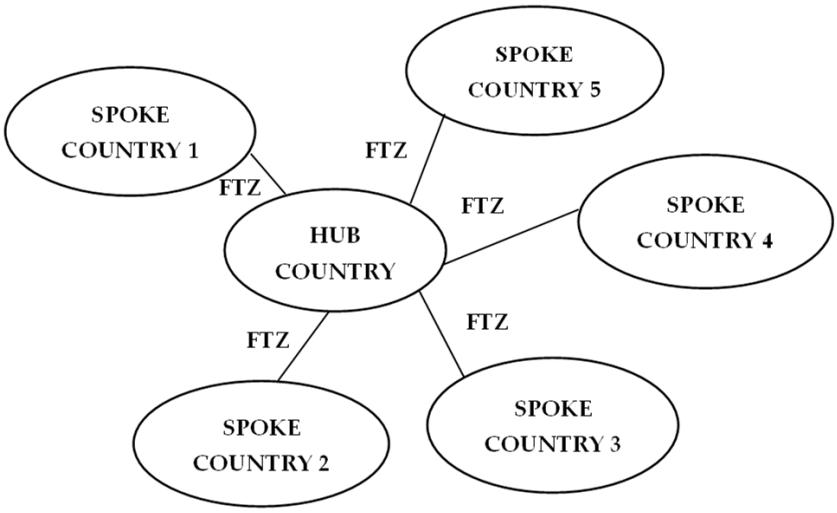


Figure 1. Hub-and-spoke FTZ structure.

2.6. Research Hypothesis

Since China adopts a strategy of 'gradual opening', 'one country, one policy', and 'network construction', the impact of China's FTZ strategy on agricultural trade with partner countries will be heterogeneous in terms of agreement terms, years, product categories, and network positions. Specifically, compared to shallow provisions, deep provisions often bring about dynamic trade effects. Therefore, there is heterogeneity in the agricultural trade effects of FTZs across agreement terms. The implementation of China's FTZ strategy has a certain lag effect on its agricultural trade with partner countries, thereby indicating heterogeneity in the agricultural trade effects of the FTZs across different time windows. After the establishment of FTZs, they are more conducive to the realization of the comparative advantages of the member countries, thereby leading to heterogeneity in the agricultural trade effects of the FTZs across product categories. Hub countries can simultaneously enter the markets of multiple spoke countries, and trade between spoke countries must go through the hub country to enjoy zero-tariff treatment. Therefore, there is heterogeneity in the agricultural trade effects of FTZs based on the network positions. The mechanism of heterogeneity generation is shown in Figure 2. Based on the above theoretical analysis, this paper proposes the following research hypotheses:

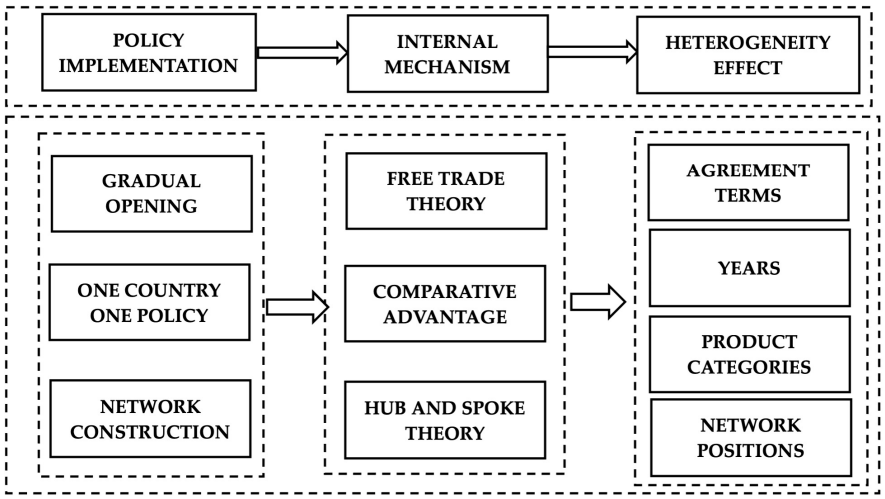


Figure 2. Heterogeneity analysis framework of agricultural trade effects in FTZs.

Hypothesis 1. *The establishment of the FTZs has promoted agricultural trade between China and its partner countries.*

Hypothesis 2. *The effects of China's FTZ strategy on agricultural trade exhibit multidimensional heterogeneity across aspects such as agreement terms, years, product categories, and network positions.*

3. Methodology and Data

3.1. Methodology

3.1.1. Fixed Effects Model and Poisson Pseudo Maximum Likelihood Estimation Method

In studying the trade effects of FTZs using the gravity model, an increasing number of scholars are recognizing that the gravity model may potentially suffer from endogeneity issues [25,26]. Fixed effects models, including the DID, PSM, and SCM, are all important approaches to dealing with endogeneity issues. To examine the heterogeneity of agreement terms and considering the continuous nature of the policy variable, this paper employs a fixed effects model to address the endogeneity issue. Additionally, the gravity model posits that bilateral trade flows are directly proportional to the economic sizes of the exporting and importing countries and inversely proportional to the geographical distance between them. The greater the geographical distance, the higher the trade costs between the two countries [27]. Consequently, this paper includes economic size and geographical distance as control variables in the model. The model is constructed as shown in Equation (1):

$$Trade_{ijt} = \beta_0 + \beta_1 Depth_{it} + \lambda X + \gamma_t + \mu_i + \eta_j + \varepsilon_{ijt} \quad (1)$$

Due to the issues of heteroscedasticity and the zeros presented by the use of HS six-digit-code product trade data, this study draws on the research of Silva and Tenreyro [28], Arvis and Shepherd [29], and Fally [30] in employing the Poisson pseudo maximum likelihood (PPML) method as a robust alternative to traditional OLS regression. Dai et al. [31] argue that incorporating bilateral fixed effects into the structural gravity model can address the endogeneity issue of trade effects within FTZs. Consequently, this paper incorporates product fixed effects and time-varying fixed effects for destination countries into the model. This paper employs the PPML form of the structural gravity model for estimation as follows:

$$Trade_{ijt} = \exp\left(\beta_0 + \beta_1 Depth_{it} + \lambda X + \pi_{i,t} + \eta_j\right) + \varepsilon_{ijt} \quad (2)$$

3.1.2. PSM–Staggered DID

In examining the heterogeneity of years and product categories, where the policy variables are represented as dummy variables, this paper uses the PSM–Staggered DID method. The PSM–Staggered DID method is primarily utilized for addressing causality inference issues in empirical research, especially when evaluating the impact of a certain policy, intervention, or event on specific outcomes. PSM approximates randomized controlled trial conditions by reducing bias and confounding factors; it is mainly aimed at reducing data bias and interference from confounding factors. To make the sample satisfy the common trend assumption, this study draws on Baier and Bergstrand [32] and Foster et al. [33] to use factors such as economic sizes, geographic locations, and factor endowments as matching covariates. The PSM method is employed to screen and match the original sample using one-to-one matching, as suggested by Wang Guijun and Lu Xiaoxiao [34]. The Staggered DID method is a difference-in-differences analysis technique that considers the incremental impact unfolding over the course of the intervention; this is unlike the traditional DID method, which assumes the intervention effects to be immediate and uniformly affecting all subjects. The Staggered DID introduces time as a crucial variable. It contemplates the variation in intervention effects at different points in time, thereby allowing the effects of the intervention to emerge progressively. Therefore, given that China has established FTZs with various partner countries at different points in time, this study adopts the Staggered

DID model, which captures multiperiod policy shocks, to examine the trade effects on agricultural products. The model is constructed as presented in Equations (3) and (4):

$$Trade_{ijt} = \beta_0 + \beta_k FTZ^k \times time_{it} + \lambda X + \gamma_t + \mu_i + \eta_j + \varepsilon_{ijt} \quad (3)$$

$$Trade_{ijt} = \beta_0 + \beta_1 FTZ_i \times time_{it} + \lambda X + \gamma_t + \mu_i + \eta_j + \varepsilon_{ijt} \quad (4)$$

3.1.3. Synthetic Control Method

Given that policy-implemented areas often share common characteristics, directly applying the DID method may substantially produce errors in constructing 'counterfactuals'. The synthetic control method (SCM) can effectively address these deficiencies. It allows for unobserved random disturbances to vary over time. At its core, the SCM constructs a synthetic control group by linearly weighting multiple control units that have not been intervened, thereby simulating the potential outcomes of the treatment unit had the intervention not occurred. In examining the heterogeneity of network positions, due to the need to construct the "counterfactual" before the implementation of the policy, this paper adopts the SCM. The model construction is shown in Equation (5):

$$Trade_{it}{}^N = \gamma_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it} \quad (5)$$

The value i represents the ith country (i = 1, 2, 3...), j represents the jth agricultural product (j = 1, 2, 3...), and t represents the t-th year (t = 1, 2, 3...). The dependent variable $Trade_{ijt}$ represents China's trade volume. $Trade_{it}{}^N$ represents the "counterfactual" in the absence of the FTZ strategy synthesized by the SCM. X represents the control variables, mainly including factors such as economic sizes, geographic locations, and factor endowments, among others. μ_i, η_j, and γ_t are country-level, product-level, and year-level fixed effects, respectively. ε is a random error term. In Equation (1) and (2), $Depth_{it}$ denotes the heterogeneity index of the agreement terms of the FTZs, including $wtop_{it}$, $wtox_{it}$, $wtoz_{it}$, and $wtol_{it}$. In Equation (3), FTZ^k is the annual dummy variable, and k takes the values of 2004–2020. β_k is the coefficient of focus in the model, which identifies the heterogeneity of the impacts of the FTZs on China's agricultural trade with partner countries over the given years. In Equation (4), the coefficient β_1 of the interaction term $FTZ_i \times time_{it}$ indicates the impact of the establishment of the FTZs on the trade of different categories of agricultural products between China and its partner countries after controlling for other intervening factors. In Equation (5), γ_t and μ_i are unobservable time-level and region-level fixed effects, respectively. λ_t is an unobservable time-varying common factor. θ_t is a parameter variable. Z_i represents observable covariates that are not affected by the implementation of the FTZ strategy, including economic sizes, geographical locations, and factor endowments, among others.

3.2. Measurement and Variables

3.2.1. Dependent Variable

In the examination of the agricultural products trade effects of China's FTZ strategy, the main dependent variables are the trade value ($Trade_{ijt}$), export value ($Export_{ijt}$) and import value ($Import_{ijt}$) between China and other countries. The categorization of agricultural products in this paper refers to the classification by Regmi et al. [35]. It is mainly divided into four categories: primary products, semiprocessed products, horticultural products, and processed products. The primary products include raw coffee, tea, wheat, rye, barley, etc. The semiprocessed products include live animals, lard, aquatic products, hair, animal products, dried bean shells, etc. The horticultural products include planting materials, flower arrangements, vegetables, tubers, coconuts, etc. Processed products include frozen meat, processed meat, aquatic products, poultry eggs, dairy products, etc.

3.2.2. Independent Variables

(1) The heterogeneity index of the agreement term: These indices mainly include the "WTO+" index ($wtop_{it}$), the "WTO-X" index ($wtox_{it}$), the term coverage index ($wtoz_{it}$), and the term binding index ($wtol_{it}$). The most widely applied measure for the heterogeneity of agreement terms in existing research is the method proposed by Horn et al. [36], which has also received endorsement from the WTO [16,37].

Following the measurement of Horn et al. [36], this study categorized the existing FTAs into 52 policy areas. These areas were then divided into two groups. One group, "WTO+" provisions, primarily refers to the provisions that have already been agreed upon under the WTO framework. The FTZs have achieved further trade liberalization based on the WTO foundation. Topics mainly include FTZ industrial product concessions, FTZ agricultural product concessions, customs procedures, export tariffs, etc., that total 14 items. The other group, "WTO-X" provisions, refers mainly to topics not yet included under the WTO framework, encompassing issues like anticorruption, innovation policies, competition policies, cultural cooperation, etc., that total 38 items. Additionally, beyond the differences in the coverage of provisions across various FTZs, whether the content of these provisions is "legally binding" is also an essential indicator of the "depth" of integration. Therefore, based on the above classification, this study further distinguished whether the provisions possess "legally binding force". Before measuring the heterogeneity index of the agreement terms, it is necessary to conduct a textual analysis of the FTAs between China and various countries. To be specific, when assessing whether an agreement covers a particular provision if the FTA text directly or indirectly includes that provision and describes the obligations of the member countries, the provision is assigned a value of 1; otherwise, it is assigned a value of 0. When evaluating whether an agreement has "legally binding force," if the FTA text uses clear and explicit "legal terminology" and precisely defines and mandates the obligations of each member country, it is assigned a value of 1. If it explicitly states that the dispute resolution mechanism is available, it is given a value of 2; otherwise, it is assigned a value of 0. In this paper, based on the above textual analysis, we constructed a heterogeneity index of the agreement terms, including the "WTO+" index, the "WTO-X" index, the provision coverage index, and the provision binding index, which are calculated by the following formulae:

$$wtop_{it} = \frac{\frac{\sum_{1}^{14} provisionz_{itj}}{Max(wtopz_{it})} + \frac{\sum_{1}^{14} provisionl_{itj}}{Max(wtopl_{it})}}{2}$$

$$wtox_{it} = \frac{\frac{\sum_{15}^{52} provisionz_{itj}}{Max(wtoxz_{it})} + \frac{\sum_{15}^{52} provisionl_{itj}}{Max(wtoxl_{it})}}{2}$$

$$wtoz_{it} = \frac{\frac{\sum_{1}^{14} provisionz_{itj}}{Max(wtopz_{it})} + \frac{\sum_{15}^{52} provisionz_{itj}}{Max(wtoxz_{it})}}{2}$$

$$wtol_{it} = \frac{\frac{\sum_{1}^{14} provisionl_{itj}}{Max(wtopl_{it})} + \frac{\sum_{15}^{52} provisionl_{itj}}{Max(wtoxl_{it})}}{2}$$

Among them, $provisionz_{itj}$ and $provisionl_{itj}$ represent the coverage of each provision without and with the consideration of the binding provision, respectively.

(2) Whether the FTZ is established ($time_{it}$): The value $time_{it}$ is a dummy variable that takes a value of 1 when the country i and China establish an FTZ. In all other cases, the value is set to 0.

(3) Whether the country is a partner country of the China FTZ (FTZ_i): FTZ_i is also a dummy variable that takes a value of 1 if country i is a partner country in China's FTZ; otherwise, it takes the value of 0.

3.2.3. Control Variables

According to the "Natural Trading Partners" hypothesis, the factors affecting the establishment of FTZs between China and partner countries, such as economic sizes (*RGDP*), factor endowments (*DKL* and *SQDKL*), and geographical locations (*NATURAL*, *REMOTE*, and *BORDER*), are used as control variables in this paper [5]. Specifically, *RGDP* is measured by the sum of the economic size of China and each country; *DKL* is measured using GDP per capita following Cao [38]; *NATURAL* is measured by the inverse of the distance between China and the largest city in each country; *REMOTE* is measured by the average distance between China and each country from the rest of the world (Appendix C).

3.3. Data Description

The data on trade value, export value, and import value of various agricultural products between China and other countries from 1995–2020 in this paper are sourced from the CEPII_BACI database. In measuring the heterogeneity index of the agreement terms, the text information on China's FTAs with other countries was obtained from the China Free Trade Zone Services website. Data for the control variables of economic sizes (*RGDP*), factor endowments (*DKL* and *SQDKL*), and geographical locations (*NATURAL*, *REMOTE*, and *BORDER*) were obtained from the Penn World Tables and the CEPII database. Table 1 shows the descriptive statistical analysis of the variables.

Table 1. Descriptive statistical analysis of variables.

Variables	Observations	Average	Standard Deviation	Maximum	Minimum	Variable Description
Trade	779,003	3.406	3.424	17.120	−6.908	Agricultural trade value
Export	667,254	3.072	3.332	14.189	−6.908	Export value of agricultural products
Import	283,687	3.561	3.413	17.120	−6.908	Import value of agricultural products
wtop	779,003	0.207	0.405	1.000	0.000	"WTO+" Index
wtox	779,003	0.117	0.321	1.000	0.000	"WTO-X" Index
wtoz	779,003	0.493	1.334	4.615	0.000	Provision coverage index
wtol	779,003	0.284	0.818	3.838	0.000	Provision binding index
time	779,003	0.450	1.222	4.470	0.000	Whether the FTZ is established
FTZ	779,003	0.407	1.111	4.096	0.000	Whether the country is a partner country of the FTZ
RGDP	779,003	2.396	0.839	4.000	1.000	The sum of the economic size of China and the countries
DKL	778,836	28.71	1.954	33.667	20.179	Differences in factor endowments between China and other countries
SQDKL	778,498	1.163	0.681	4.204	0.000	The squared term of DKL
NATURAL	778,498	1.817	1.729	17.676	0.000	The inverse of the distance between China and the largest cities of various countries
REMOTE	779,003	−8.799	0.648	−6.862	−9.868	Average distance between China and countries from the rest of the world
BORDER	779,003	3.406	3.424	17.120	−6.908	Whether China shares a border with various countries.

Note: All variables in this paper are logarithmically treated, except for dummy variables.

4. Results

4.1. Benchmark Regression Results

This study employed the PSM–Staggered DID method for baseline regression. Columns (1), (2), and (3) in Table 2 respectively present the regression results on the effects of China's FTZ strategy on its agricultural trade, exports, and imports with partner countries. To address the issues of heteroscedasticity and the zeros inherent in traditional OLS regression, Columns (4) through (6) employ PPML with the high-dimensional fixed effects method for analysis. The positive policy variables in Columns (1) and (4) pass the significance test at the 1% level, thereby validating Hypothesis 1. Additionally, the implementation of

China's FTZ strategy has primarily increased the scale of imports of agricultural products from partner countries. Given the rising costs of agricultural production and the declining international competitive advantage of agricultural products in recent years in China, the establishment of FTZs with partner countries is increasingly beneficial for China to import agricultural products from these countries.

Table 2. Regression results of the impact of agricultural trade on the implementation of China's FTZ strategy.

	(1)	(2)	(3)	(4)	(5)	(6)
	Trade	**Export**	**Import**	**Trade**	**Export**	**Import**
FTZ × time	0.191 ***	0.096 ***	0.282 ***	0.507 ***	−0.019	0.888 ***
	(0.02)	(0.02)	(0.03)	(0.036)	(0.024)	(0.054)
Constant	−11.144 **	−13.754 ***	−43.777 ***	−8.759 ***	−4.836 ***	−16.290 ***
	* (1.42)	(1.44)	(6.58)	(0.767)	(0.319)	(1.342)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Country–year fixed effects	NO	NO	NO	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	NO	NO	NO
Year fixed effects	Yes	Yes	Yes	NO	NO	NO
Sample size	634,426	536,390	266,932	634,426	634,426	634,426

Note: Columns (1) to (3) present the results estimated using the PSM–Staggered DID method, while Columns (4) to (6) are estimated using PPML with the high-dimensional fixed effects method. Robustness standard errors in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% significance levels, respectively. The data used in the empirical analysis consist of HS six-digit-coded product trade data; Control variables in the empirical model include economic sizes (*RGDP*), factor endowments (*DKL* and *SQDKL*), and geographical locations (*NATURAL*, *REMOTE*, and *BORDER*).

4.2. Empirical Results on the Heterogeneity of Agreement Terms

To verify the existence of heterogeneity in the agreement terms, this article examined the effects of different types of FTZ agreement terms on agricultural trade, exports, and imports between China and its partner countries. Specifically, Table 3 presents the regression results for the effects of different FTZ agreement terms.

Table 3. Regression results of the heterogeneity of the agreement terms on the agricultural trade effects of the implementation of China's FTZ strategy.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Trade	**Trade**	**Trade**	**Trade**	**Trade**	**Trade**	**Trade**	**Trade**
wtop	0.054 ***				0.115 ***			
	(0.00)				(0.014)			
wtox		0.061 ***				0.171 ***		
		(0.01)				(0.018)		
wtoz			0.058 ***				0.124 ***	
			(0.00)				(0.015)	
wtol				0.060 ***				0.137 ***
				(0.00)				(0.016)
Constant	14.478 ***	14.459 ***	14.496 ***	14.451 ***	−11.410 ***	−11.505 ***	−11.430 ***	−11.424 ***
	(2.06)	(2.06)	(2.06)	(2.06)	(0.751)	(0.753)	(0.749)	(0.753)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country–year fixed effects	NO	NO	NO	NO	Yes	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	NO	NO	NO	NO
Year fixed effects	Yes	Yes	Yes	Yes	NO	NO	NO	NO
Sample size	778,498	778,498	778,498	778,498	778,498	778,498	778,498	778,498

Note: Columns (1) to (4) present the results estimated using the PSM–Staggered DID method, while Columns (5) to (8) are estimated using PPML with the high-dimensional fixed effects method. Robustness standard errors in parentheses. *** indicates significance at 1% significance levels; The data used in the empirical analysis consist of HS six-digit-coded product trade data. Control variables in the empirical model include economic sizes (*RGDP*), factor endowments (*DKL* and *SQDKL*), and geographical locations (*NATURAL*, *REMOTE*, and *BORDER*).

Columns (1), (2), (3), and (4) show the effects of WTO+, WTO-X, provision coverage, and provision binding indices on China's agricultural trade with partner countries, respectively. The effects of these indices pass the significance test at a 0.01 significance level. In terms of the impact size, each 1% increase in the WTO+ index, WTO-X index, provision coverage index, and provision binding index respectively led to a 5.4%, 6.1%, 5.8%, and 6.0% increase in China's agricultural trade with partner countries. This indicates that the provisions related to "WTO-X", which cover issues not included in the WTO framework, such as anticorruption, innovation policy, competition policy, and cultural cooperation, have a greater promoting effect on the growth of agricultural trade between member countries than traditional tariff reductions. Moreover, both the strength and breadth of the agreement can effectively promote the growth of agricultural trade among member countries, and the effect resulting from provision binding was shown to be significantly greater than that of provision coverage. To address the issues of heteroscedasticity and zero-trade values, Columns (5) to (8) present the empirical results using PPML with the high-dimensional fixed effects method, thus further validating the conclusions drawn above.

Table 4 shows the regression results of the effects of different types of FTZ agreement terms on China's agricultural exports and imports with partner countries. The policy variables in each model pass the significance test at the 0.01 significance level. In terms of impact size, each 1% increase in the WTO+ index, WTO-X index, provision coverage index, and provision binding index was shown to boost China's agricultural exports to partner countries by 3.0%, 3.1%, 3.2%, and 3.3%, respectively, and these increases boosted China's agricultural imports from partner countries by 7.9%, 8.1%, 8.4%, and 8.8%, respectively. The "WTO-X" index had a greater effect than the "WTO+" index, and the provision binding index had a greater effect than the provision coverage index, thus further verifying the above findings.

Table 4. Regression results of the heterogeneity of agreement terms on the export and import effects of the implementation of China's FTZ strategy for agricultural products.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Export	**Export**	**Export**	**Export**	**Import**	**Import**	**Import**	**Import**
wtop	0.030 ***				0.079 ***			
	(0.00)				(0.01)			
wtox		0.031 ***				0.081 ***		
		(0.01)				(0.01)		
wtoz			0.032 ***				0.084 ***	
			(0.00)				(0.01)	
wtol				0.033 ***				0.088 ***
				(0.00)				(0.01)
Constant	0.081	0.117	0.089	0.091	−5.506 ***	−5.767 ***	−5.518 ***	−5.524 ***
	(0.53)	(0.53)	(0.53)	(0.53)	(0.22)	(0.22)	(0.22)	(0.22)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	666,827	666,827	666,827	666,827	283,559	283,559	283,559	283,559
R^2	0.451	0.451	0.451	0.451	0.263	0.263	0.263	0.263

Note: Columns (1) to (8) present the results estimated using the PSM–Staggered DID method. Robustness standard errors in parentheses. *** indicates significance at 1% significance levels. The data used in the empirical analysis consist of HS six-digit-coded product trade data. Control variables in the empirical model include economic sizes (*RGDP*), factor endowments (*DKL* and *SQDKL*), and geographical locations (*NATURAL*, *REMOTE*, and *BORDER*).

4.3. Empirical Results on the Heterogeneity of Years

This paper employed the event study methodology proposed by Jacobson et al. [39] to empirically examine the temporal heterogeneity of the effects of China's FTZ strategy implementation on agricultural trade. The regression results can be found in Table 5. The results show that the coefficient of the interaction term ($FTZ \times time$) is positive, thereby indicating the beneficial impact of China's FTZ establishment on the growth of agricultural trade

with partner countries. Based on the estimated coefficients β_k, the impact of China's FTZ strategy implementation on its agricultural trade—both exports and imports—exhibited an increasing trend annually.

Table 5. Regression results of the heterogeneity of years of agricultural trade effects of the implementation of China's FTZ strategy.

Variables	(1)	(2)	(3)
	Trade	Export	Import
$FTZ^{2004} \times$ time	0.124 ***(0.04)	0.098 **(0.04)	−0.016(0.07)
$FTZ^{2005} \times$ time	0.189 ***(0.04)	0.127 ***(0.04)	0.227 ***(0.07)
$FTZ^{2006} \times$ time	0.112 ***(0.04)	0.081 **(0.04)	0.087(0.07)
$FTZ^{2007} \times$ time	0.097 **(0.04)	0.082 **(0.04)	0.147 **(0.07)
$FTZ^{2008} \times$ time	0.080 **(0.04)	−0.008(0.04)	0.239 ***(0.07)
$FTZ^{2009} \times$ time	0.088 **(0.04)	−0.014(0.04)	0.279 ***(0.07)
$FTZ^{2010} \times$ time	0.103 **(0.04)	0.004(0.04)	0.281 ***(0.07)
$FTZ^{2011} \times$ time	0.084 **(0.04)	−0.044(0.04)	0.265 ***(0.07)
$FTZ^{2012} \times$ time	0.148 ***(0.04)	0.085 **(0.04)	0.378 ***(0.07)
$FTZ^{2013} \times$ time	0.285 ***(0.04)	0.175 ***(0.04)	0.520 ***(0.07)
$FTZ^{2014} \times$ time	0.282 ***(0.04)	0.204 ***(0.04)	0.493 ***(0.07)
$FTZ^{2015} \times$ time	0.336 ***(0.04)	0.231 ***(0.04)	0.583 ***(0.07)
$FTZ^{2016} \times$ time	0.260 ***(0.04)	0.170 ***(0.04)	0.461 ***(0.07)
$FTZ^{2017} \times$ time	0.309 ***(0.04)	0.236 ***(0.04)	0.428 ***(0.07)
$FTZ^{2018} \times$ time	0.367 ***(0.04)	0.203 ***(0.04)	0.556 ***(0.07)
$FTZ^{2019} \times$ time	0.445 ***(0.04)	0.286 ***(0.04)	0.485 ***(0.07)
$FTZ^{2020} \times$ time	0.444 ***(0.03)	0.318 ***(0.03)	0.519 ***(0.06)
Constant	−10.496 ***(1.42)	−13.280 ***(1.44)	−40.127 ***(6.58)
Control variables	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes
Sample size	634,426	536,390	266,932
R^2	0.390	0.427	0.261

Note: Columns (1) to (3) present the results estimated using the PSM–Staggered DID method. Robustness standard errors in parentheses. **, and *** indicate significance at 5%, and 1% significance levels, respectively. The data used in the empirical analysis consist of HS six-digit-coded product trade data. Control variables in the empirical model include economic sizes (*RGDP*), factor endowments (*DKL* and *SQDKL*), and geographical locations (*NATURAL*, *REMOTE*, and *BORDER*).

Since China has adopted a gradual tariff reduction approach, the impact of China's FTZ strategy on its agricultural trade with partner countries has some lag. In addition, with the increasing liberalization of agricultural trade, a "virtuous circle" of agricultural trade between China and its partner countries has gradually formed. The longer the FTZ has been established, the greater the promotional effect on the growth of agricultural trade among member countries.

4.4. Empirical Results on the Heterogeneity of Product Categories

Table 6 presents the estimated impacts of the establishment of the FTZ on trade in primary agricultural products, semiprocessed agricultural products, horticultural products, and processed agricultural products between China and its partner countries. All regressions in the table utilize product-level data and control for country, product, and time-fixed effects. The interaction term ($FTZ \times time$) represents the policy effect variable focus in this paper. From the regression results in Table 6, the policy variables in Columns (1), (2), (4), (5), (6), and (7) pass the test at the 1% significance level, while the policy effects in Column (8) do not meet the significance threshold. Assessing the average effects, the implementation of China's FTZ strategy has led to increases of 28.5% and 26.9% in its imports of primary agricultural products and semiprocessed agricultural products, respectively, from partner

countries. Concurrently, its exports of horticultural agricultural products and processed agricultural products to partner countries increased by 44.4% and 36.8%, respectively.

Table 6. Regression results of product categories heterogeneity of agricultural trade effects of the implementation of China's FTZ strategy.

	Primary Agricultural Products		**Semi-Processed Agricultural Products**		**Horticultural Agricultural Products**		**Processed Agricultural Products**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	Export	**Import**	**Export**	**Import**	**Export**	**Import**	**Export**	**Import**
FTZ × time	0.253 ***	0.285 ***	0.083 ***	0.269 ***	0.444 ***	0.110 ***	0.368 ***	0.020
	(0.04)	(0.09)	(0.02)	(0.03)	(0.09)	(0.04)	(0.07)	(0.04)
Constant	−9.504 ***	−10.339 ***	9.413 ***	−34.354 ***	40.492 ***	−9.989	−11.422	58.663 ***
	(0.41)	(0.89)	(2.47)	(9.47)	(4.90)	(24.85)	(19.33)	(5.82)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	498.63	156.87	409,805	189,833	104,074	286.02	469.86	986.16
R^2	0.365	0.220	0.455	0.267	0.467	0.275	0.285	0.437

Note: Columns (1) to (8) present the results estimated using the PSM–Staggered DID method. Robustness standard errors in parentheses. *** indicates significance at 1% significance levels. The data used in the empirical analysis consist of HS six-digit-coded product trade data. Control variables in the empirical model include economic sizes (*RGDP*), factor endowments (*DKL* and *SQDKL*), and geographical locations (*NATURAL*, *REMOTE*, and *BORDER*).

Overall, the establishment of the FTZ has led to significant variations in the impact on different categories of agricultural products trade between China and its partner countries. This creates a more conducive environment for member nations to leverage their comparative advantages. Primarily, China has expanded its imports of primary and semiprocessed agricultural products, in which partner countries possess a comparative advantage, and increased its exports of horticultural and processed agricultural products, where partner countries exhibit a comparative disadvantage.

4.5. Empirical Results on the Heterogeneity of Network Positions

To examine the differences in agricultural trade effects among member countries with varying network positions, this paper employed the SCM to measure the agricultural trade effects for each member country. The core idea of the SCM involves treating countries (or regions) such as China, the ASEAN countries, Chile, or Pakistan as the treatment group, while other non-FTZ member countries (or regions) serve as the control groups (Appendix D). Using data-driven approaches, predictor variables are used to assign weights to the control group countries, thus constructing a counterfactual under the absence of policy implementation (Appendix E). The trade effect on agricultural products is subsequently derived by subtracting this counterfactual from the observed values.

The trade effect on agricultural products resulting from the FTZ in China is described here as follows. Within China's FTZ network, given that the majority of partner countries have not signed FTAs amongst themselves, China can be viewed as a hub country, with partner countries acting as spoke countries. As the hub country, China can benefit from the preferential trade conditions granted by each of the spoke countries; its trade effect on agricultural products resulting from the establishment of the FTZ is equivalent to the sum of the trade effects between China and each of its partner countries. This paper used China's agricultural trade with all countries in the world, as well as data on the size of each country's economy size, factor endowment, and geographical location as predictor variables to synthesize the "counterfactual" in the absence of policy implementation. Table 7 gives the reference countries (or regions) and their weights for the synthesis of the ASEAN countries, Chile, Pakistan, New Zealand, Peru, and Costa Rica.

Table 7. Reference countries and their weights in synthetic objects.

Experimental Group		Control Group 1	Control Group 2	Control Group 3	Control Group 4	Control Group 5
ASEAN	Reference Countries	Japan	United States	Uzbekistan	Brazil	Russia
	Weights	0.656	0.280	0.052	0.002	0.009
Chile	Reference Countries	Japan	Ukraine	Latvia	Cape Verde	Burkina Faso
	Weights	0.399	0.205	0.136	0.118	0.063
Pakistan	Reference Countries	India	Canada	Ecuador	Angola	Qatar
	Weights	0.276	0.193	0.183	0.141	0.099
New Zealand	Reference Countries	Japan	Brazil	Malta	Uzbekistan	Zimbabwe
	Weights	0.349	0.272	0.085	0.050	0.046
Peru	Reference Countries	Japan	Angola	Ecuador	Mozambique	Brazil
	Weights	0.486	0.151	0.137	0.100	0.070
Costa Rica	Reference Countries	Kyrgyzstan	Colombia	Belarus	Azerbaijan	Ecuador
	Weights	0.330	0.258	0.205	0.160	0.029
Iceland	Reference Countries	Niger	Japan	Dominican Republic	Ghana	Estonia
	Weights	0.258	0.139	0.116	0.112	0.099
Switzerland	Reference Countries	Japan	Ecuador	Kazakhstan	Guinea	Tajikistan
	Weights	0.232	0.134	0.122	0.116	0.081
Korea	Reference Countries	Japan	Argentina	United States	Mozambique	Iraq
	Weights	0.629	0.156	0.097	0.033	0.028
Australia	Reference Countries	Japan	Brazil	United States	Bahrain	Ecuador
	Weights	0.409	0.233	0.158	0.079	0.066
Georgia	Reference Countries	Nicaragua	Ethiopia	Cape Verde	Republic of Moldova	Liberia
	Weights	0.320	0.226	0.153	0.120	0.105

Note: Due to space constraints, this paper only lists the top five countries (or regions) in the synthetic control group based on their weights.

Figure 3 depicts the trajectories of agricultural trade between China and its FTZ partner countries, as well as their respective synthetic counterparts. The vertical dashed line represents the point in time when China established FTZs with each partner country. The solid line denotes the actual trade of agricultural products between China and its partner countries, while the dotted line signifies the counterfactual. Before the establishment of the FTZ, the trajectory of agricultural trade between synthetic China and partner countries nearly aligns perfectly with the actual trajectory, thus indicating that the SCM effectively captures the evolution of agricultural trade between China and its partner countries in the absence of the FTZ.

To more vividly discern the trade effect on agricultural products resulting from the establishment of the FTZ, this study computes the differences between the actual agricultural trade of China with countries (or regions) like the ASEAN countries, Chile, and Pakistan, etc., and their corresponding synthetic agricultural trade. On average, after the establishment of the FTZ, China's agricultural trade with the ASEAN countries, Chile, New Zealand, Costa Rica, South Korea, Australia, etc., has grown rapidly. Examining the trend, due to the gradual liberalization strategy adopted by most countries and the requisite time for enterprises to adjust their production behaviors, the trade effect on agricultural products between China and most of its partner countries was initially modest or even negative in the early stages of the FTZs. However, with the gradual advancement of the establishment of the FTZ, the agricultural trade effect has grown significantly. In aggregate, following the establishment of the FTZ, China's agricultural trade effect has become larger and demonstrates a year-on-year increase, thus averaging an annual rise of 2.67 units, as shown in Table 8.

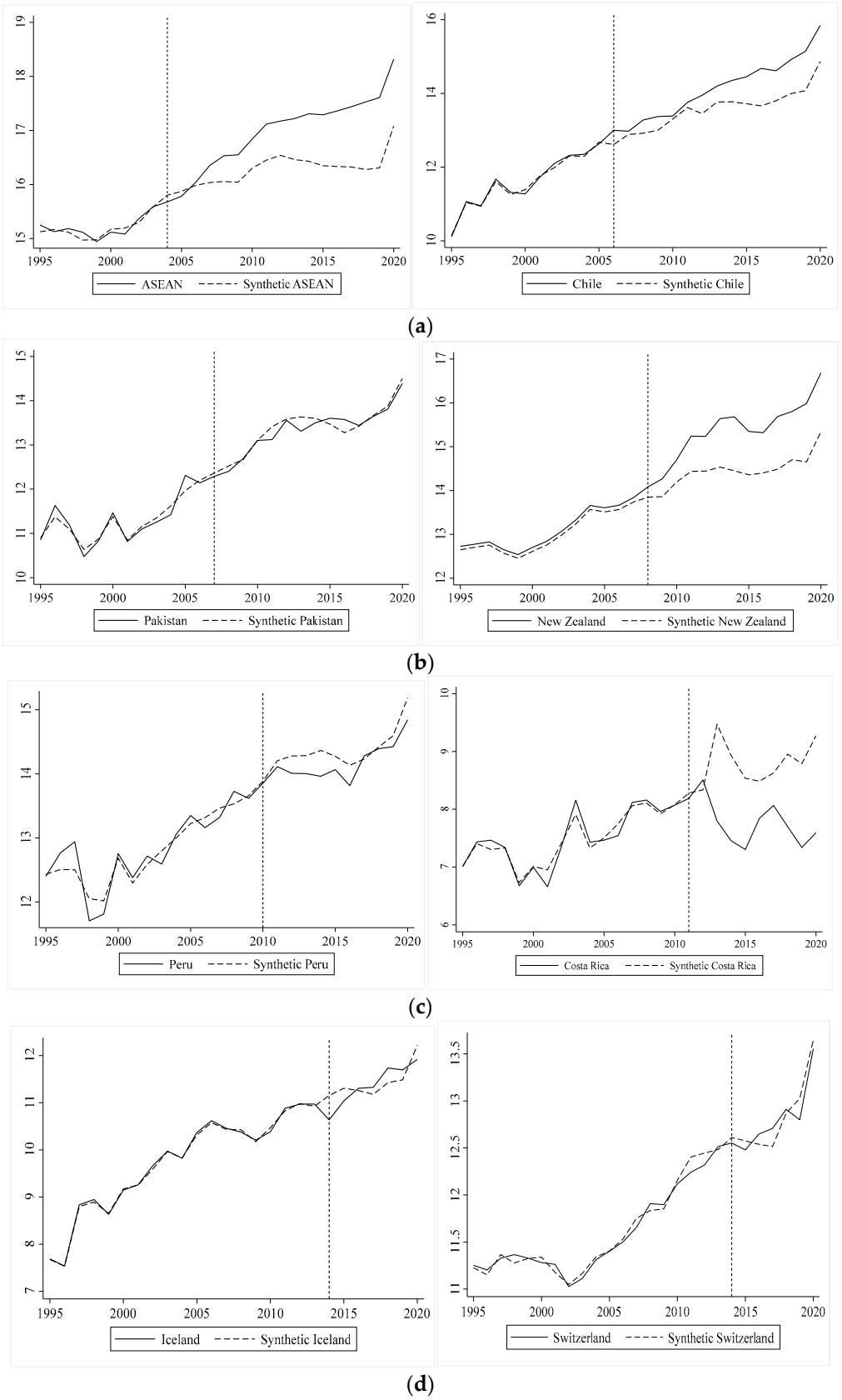
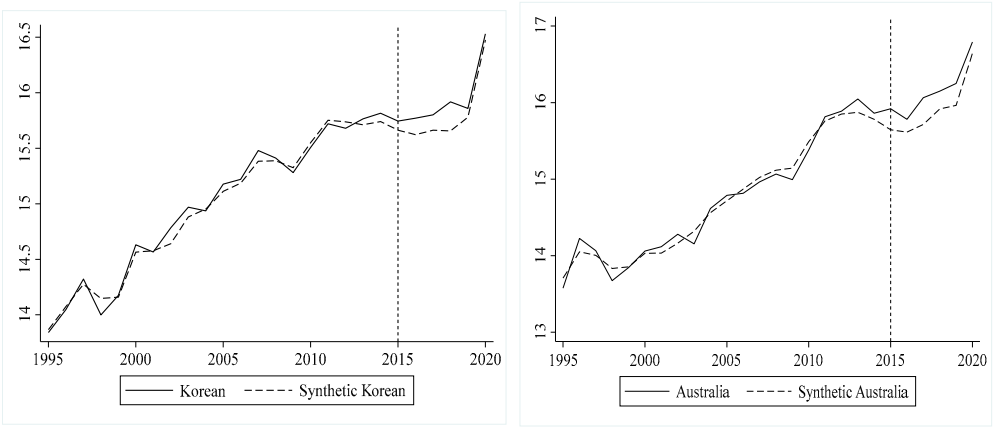


Figure 3. *Cont*.



(**e**)

Figure 3. Synthesis of the scale of agricultural trade between China and (**a**) ASEAN countries and Chile; (**b**) Pakistan and New Zealand; (**c**) Peru and Costa Rica; (**d**) Iceland and Switzerland; and (**e**) South Korea and Australia. Note: The meaning of the dotted lines is the time when each free trade area was established. the China–ASEAN FTZ (establish 2004), the China–Chile FTZ (establish 2006), the China–Pakistan FTZ (establish 2007), the China–New Zealand FTZ (establish 2008), the China–Peru FTZ (establish 2010), the China–Costa Rica FTZ (establish 2011), the China–Iceland FTZ (establish 2014), the China–Switzerland FTZ (establish 2014), the China–Korea FTZ (establish 2015), and the China–Australia FTZ (establish 2015).

Table 8. Size of China's agricultural trade effects from the implementation of China's FTZ strategy.

	ASEAN	Chile	Pakistan	New Zealand	Peru	Costa Rica	Iceland	Switzerland	Korea	Australia	Georgia	Total
2004	−0.12	-	-	-	-	-	-	-	-	-	-	−0.12
2005	−0.09	-	-	-	-	-	-	-	-	-	-	−0.09
2006	0.06	0.38	-	-	-	-	-	-	-	-	-	0.44
2007	0.32	0.09	−0.08	-	-	-	-	-	-	-	-	0.33
2008	0.48	0.36	−0.12	0.23	-	-	-	-	-	-	-	0.95
2009	0.51	0.37	0.02	0.41	-	-	-	-	-	-	-	1.31
2010	0.54	0.08	0.00	0.51	−0.03	-	-	-	-	-	-	1.10
2011	0.66	0.14	−0.29	0.80	−0.09	−0.05	-	-	-	-	-	1.17
2012	0.64	0.50	−0.03	0.79	−0.27	0.10	-	-	-	-	-	1.73
2013	0.76	0.43	−0.32	1.11	−0.28	0.66	-	-	-	-	-	2.36
2014	0.88	0.58	−0.10	1.23	−0.40	0.12	−0.52	−0.06	-	-	-	1.73
2015	0.94	0.73	0.13	0.99	−0.21	−0.09	−0.27	−0.10	0.08	0.27	-	2.47
2016	1.03	1.02	0.30	0.92	−0.32	−0.01	0.05	0.11	0.15	0.17	-	3.42
2017	1.11	0.81	0.02	1.20	0.05	0.49	0.15	0.19	0.14	0.35	-	4.51
2018	1.25	0.92	−0.02	1.10	−0.03	0.56	0.31	0.04	0.26	0.23	−0.12	4.50
2019	1.30	1.07	−0.07	1.33	−0.17	−0.05	0.21	−0.23	0.08	0.29	0.39	4.15
2020	1.24	0.98	−0.11	1.34	−0.34	0.17	−0.30	−0.09	0.05	0.15	0.52	3.61
Average	0.68	0.56	−0.05	0.92	−0.19	0.19	−0.05	−0.02	0.13	0.24	0.26	2.67

Note: "-" indicates that the FTZ is not established, and data are missing; the same as below.

The trade effect on the agricultural products of partner countries resulting from the establishment of the FTZ is described as follows. Given that each spoke country has established an FTZ exclusively with the hub country, the post establishment effect for each partner country equates to the "net growth" in agricultural trade between the partner country and China. Similarly, following the method above, we calculated the "counterfactual" in the absence of the FTZ and then calculated the agricultural trade effects of each FTZ partner country. The results are shown in Table 9 (Appendix F). On average, after the establishment of the FTZ, the agricultural trade effects of the ASEAN countries, Chile, Pakistan, New Zealand, Peru, Costa Rica, Iceland, Switzerland, South Korea, Australia, and Georgia were 0.78, 1.17, 0.60, 1.50, 0.47, 0.97, 0.86, 0.41, 0.78, 1.20, and 0.81, respectively, which are all smaller than China's agricultural trade effects. Overall, the

formation of the hub-and-spoke FTZ network has granted China the privilege to access all partner country markets simultaneously. The 'net growth' in China's agricultural trade consistently surpassed that of the FTZ partner countries, thereby thoroughly validating China's relative advantageous position within the hub-and-spoke FTZ network.

Table 9. Effect sizes of agricultural trade in partner countries for the implementation of China's FTZ strategy.

Year	ASEAN	Chile	Pakistan	New Zealand	Peru	Costa Rica	Iceland	Switzerland	Korea	Australia	Georgia
2004	0.64	-	-	-	-	-	-	-	-	-	-
2005	0.85	-	-	-	-	-	-	-	-	-	-
2006	0.91	0.47	-	-	-	-	-	-	-	-	-
2007	0.82	0.28	0.10	-	-	-	-	-	-	-	-
2008	0.42	0.30	0.10	0.23	-	-	-	-	-	-	-
2009	0.61	0.75	0.63	0.69	-	-	-	-	-	-	-
2010	0.68	0.62	1.06	0.96	0.52	-	-	-	-	-	-
2011	0.61	0.83	0.72	1.15	0.04	0.56	-	-	-	-	-
2012	0.58	0.84	1.03	1.34	−0.11	0.45	-	-	-	-	-
2013	0.56	1.29	0.70	2.13	0.11	1.05	-	-	-	-	-
2014	0.65	1.46	0.57	1.82	0.33	1.00	0.02	0.09	-	-	-
2015	0.78	1.49	0.73	1.56	0.96	0.76	1.08	0.12	0.80	1.05	-
2016	0.83	1.85	0.70	1.56	0.63	0.76	1.19	0.41	0.79	1.04	-
2017	0.76	1.51	0.30	1.91	0.88	0.84	0.96	0.48	0.71	1.21	-
2018	0.95	1.78	0.40	1.98	0.98	1.44	1.15	0.67	0.76	1.22	0.62
2019	1.23	2.16	0.68	2.14	0.54	1.40	1.12	0.54	0.78	1.32	0.77
2020	1.30	1.99	0.64	2.10	0.26	1.40	0.51	0.58	0.85	1.36	1.05
Average value	0.78	1.17	0.60	1.50	0.47	0.97	0.86	0.41	0.78	1.20	0.81

In summary, the establishment of the FTZs has effectively contributed to the growth of China's agricultural trade with partner countries. Furthermore, this impact is heterogeneous in terms of the agreement terms, years, product categories, and network positions, thus validating Hypothesis 2 proposed in this study.

5. Discussion

5.1. Similarities and Differences with Existing Studies

The implementation of China's FTZ strategy is expected to bring significant trade effects for agricultural products. As the strategy progresses, the scale of agricultural trade between China and its partner countries continues to grow. This indicates that the implementation of China's FTZ strategy is playing an increasingly important role in strengthening the trade of agricultural products between China and its partner countries. These conclusions are consistent with the research of Baier and Yang [5,7]. The reality reflects this as well, as exemplified by the establishment of an FTZ between China and the ASEAN countries in 2004. From 2004 to 2021, the trade volume of agricultural products between China and the ASEAN countries grew from 5.83 billion USD in 2004 to 53.03 billion USD in 2021.

The trade effects of agricultural products resulting from the implementation of China's FTZ strategy exhibit heterogeneity across agreement terms, product categories, time windows, and network positions. Baier et al. [17] argue that the depth of the agreement terms leads to varying trade effects in FTZs. Zhang and Sun [22] suggest that the trade effects in FTZs vary across product categories. Magee [10] found that FTZs established between major powers, similar countries, and close allies often perform better in terms of trade creation effects. Regarding the existing literature, firstly, it mainly elucidates the heterogeneity from a single aspect and does not deeply explain the mechanisms behind this heterogeneity. Secondly, most of the literature focuses on individual FTZs, whereas this study specifically addresses all the FTZs established between China and its partner countries. Thirdly, the existing literature often overlooks China's FTZ implementation strategies of "gradual opening", "one country, one policy", and "network construction".

This paper provides a focused analysis and links these strategies to the heterogeneity in trade effects of the agricultural products in FTZs. The conclusions drawn from this paper have significant practical implications. They offer substantial policy insights on how to optimize the selection of China's FTZ partner countries, the choice of agreements to open, and the modes of opening in the context of promoting the trade of agricultural products between China and its partner countries.

5.2. Limitations and Future Recommendations

On the one hand, although the sample data of this study extended to 2020, the availability of data has limited the study's coverage. As a result, some newly established FTZs were not included in the scope of research. For example, China established FTZs with Mauritius, Nicaragua, and Ecuador after 2020. Additionally, in 2022, the Regional Comprehensive Economic Partnership (RCEP) came into effect. These developments may influence the trade in agricultural products between China and these countries. Therefore, future research should aim to expand the sample range to include these FTZs, thereby conducting in-depth analysis on the impact of China's FTZ strategy on agricultural trade and revealing more diverse heterogeneities in trade effects.

On the other hand, given the constraints of the article length, the discussion on the heterogeneity of the trade effects of agricultural products in FTZs based on the network positions of the FTZs is constrained. Based on the implementation of China's FTZ strategy, the article focuses solely on the hub-and-spoke model within FTZs. As the number of FTZs established between China and other countries continues to grow, the network structure of the FTZs will become more complex. The impacts of varying network structures on trade dynamics and welfare are slated to be a pivotal area of future investigations in this domain.

6. Conclusions

This paper first provides a theoretical explanation for the heterogeneous generation mechanism of agricultural trade effects in FTZs. Then, based on the implementation of China's FTZ strategy and using agricultural trade data between China and various countries from 1995 to 2020, the study investigated the agricultural trade effects of FTZs and their multidimensional heterogeneity. The study found that the implementation of China's FTZ strategy significantly contributed to the growth of agricultural trade with partner countries, and this impact exhibits heterogeneity in terms of agreement terms, years, product categories, and network positions.

Firstly, there exists heterogeneity in the agricultural trade effect based on the agreement terms. The broader the scope of FTAs that China negotiates and the stronger the legally binding power of the terms, the greater the promotional effect of the FTZ on China's agricultural trade with its partner countries. Furthermore, compared to traditional tariff reductions under the WTO framework, issues not encompassed by the WTO, such as anticorruption measures, innovation policies, competition policies, and cultural collaborations, were shown to more significantly foster the growth of agricultural trade among member countries.

Secondly, there exists heterogeneity in the agricultural trade effect based on years. Given the gradual liberalization approach adopted by China and its partner countries and the fixed costs associated with businesses adjusting their production and trade behaviors, the influence of the establishment of the FTZ on agricultural trade between China and its partner countries exhibited some lag. The agricultural trade effect tended to expand progressively over time.

Thirdly, there exists heterogeneity in the agricultural trade effect based on product categories. The establishment of FTZs between China and its partner countries is more conducive to leveraging their respective comparative advantages. Specifically, China primarily amplified its imports of primary and semiprocessed agricultural products from partner countries while increasing its exports of horticultural and processed agricultural products to them.

Finally, the agricultural trade effects also vary based on network positions. As China has benefitted from preferential trade terms extended by all the spoke countries, while trade barriers remain among partner countries themselves, once the hub-and-spoke FTZ network was established, the agricultural trade effect for China surpassed that of each partner country.

The conclusions drawn from this study bear significant policy implications for enhancing China's trade effects, as well as for better leveraging the two markets and resources to ensure domestic food security through optimizing the implementation strategy of the FTZs. In the process of advancing its FTZ strategy, China should not only solely focus on increasing the number of FTZs but also prioritize enhancing the quality of these FTZs. Specifically, future policy recommendations on FTZs should cover the following important aspects:

- In terms of partner selection, China should concentrate on neighboring countries by integrating the major sources of China's agricultural imports into its FTZ network. This approach not only effectively mitigates the negative impacts of trade diversion effects but also reduces risks and uncertainties associated with agricultural imports, thus further bolstering domestic food security.
- When deciding on the terms of open agreements, there should be an emphasis on broadening the scope of agreement terms and fortifying their legal bindingness. Given that contents not covered under the WTO framework are more conducive to the growth of agricultural trade among member countries, negotiations between member countries should extend beyond tariff reductions and nontariff barrier eliminations, thereby placing more weight on cooperation in areas such as phytosanitary measures, competition policies, and investment policies that are not encompassed by the WTO.
- Concerning the modalities of liberalization, given the national implications of agriculture on food security, China should adopt a flexible liberalization approach. For example, it should provide higher tariffs or exceptional arrangements for products such as grain while adopting a flexible tariff reduction model and allowing a certain buffer period for domestic agricultural industry adjustment.

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Data Availability Statement: The data on the trade value, export value, and import value of various agricultural products between China and other countries from 1995–2020 in this paper are sourced from the CEPII_BACI database (website link: http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=37, accessed on 1 December 2023). In measuring the heterogeneity index of the agreement terms, the text information on China's FTAs with other countries has been obtained from the China Free Trade Zone Services website (website link: http://fta.mofcom.gov.cn/, accessed on 1 December 2023). The data for the control variables of economic sizes (RGDP), factor endowments (DKL and SQDKL), and geographical locations (NATURAL, REMOTE, and BORDER) were obtained from the Penn World Tables (website link: https://www.rug.nl/ggdc/productivity/pwt/?lang=en, accessed on 1 December 2023) and the CEPII database (website link: http://www.cepii.fr/cepii/en/bdd_modele/bdd_modele.asp, accessed on 1 December 2023). Table 1 shows the descriptive statistical analysis of the variables.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

The "hub-and-spoke" FTZ is used to describe a particular arrangement of FTZs. The hub: This is the central country that has individual FTZs with two or more other countries. The hub benefits the most in this system, as it has access to multiple markets without those markets necessarily having access to each other. The spokes: These are the countries that have an FTZ with the hub but not necessarily with each other. They benefit from access to the hub's market but may not have the same level of access to the markets of other spokes.

Appendix B

The FTZs established between China and various countries examined in this paper include the China–ASEAN FTZ (effective 1 January 2004), the China–Chile FTZ (effective 1 July 2006), the China–Pakistan FTZ (effective 1 July 2007), the China–New Zealand FTZ (effective 1 October 2008), the China–Singapore FTZ (effective January 1, 2009), the China–Peru FTZ (effective March 1, 2010), the China–Costa Rica FTZ (effective August 1, 2011), the China–Iceland FTZ (effective 1 July 2014), the China–Switzerland FTZ (effective 1 July 2014), the China–Korea FTZ (effective 20 December 2015), and the China–Australia FTZ (effective 20 December 2015).

Appendix C

The formula for calculating $REMOTE$ is $Remote = dcont \times \{[log(\sum_{k=1,k\neq j}^{N} \frac{d_{ik}}{N-1}) + log(\sum_{k=1,k\neq j}^{N} \frac{d_{jk}}{N-1})]/2\}$.

Appendix D

For the sake of model simplification, this paper treats the ASEAN region as a whole and does not consider intra-ASEAN trade among ASEAN countries.

Appendix E

The predictor variables chosen in this paper are $RGDP$ (the sum of China's and countries' economic size), DKL (the difference in factor endowments between China and countries), $NATURAL$ (the inverse of the distance between China and the largest city in each country), $REMOTE$ (the average distance between China and countries to the world), and the size of member countries' agricultural trade before the policy was implemented.

Appendix F

In using the synthetic control methods, this paper excludes the effects of the establishment of other FTZs in partner countries, i.e., the control group does not include the respective FTZ partner countries established by China's FTZ members.

References

1. Bertsatos, G.; Tsounis, N. Assessing the Impact of Trade Barriers on Energy Use in Turbulent Times: Current Conditions and Future Outlook for Greece. *Energies* **2023**, *16*, 5806. [CrossRef]
2. Fu, J.; Tong, G. The State of Grain Trade between China and Russia: Analysis of Growth Effect and Its Influencing Factors. *Agriculture* **2023**, *13*, 1407. [CrossRef]
3. Fu, J.; Chen, L.; Xue, H. The Impacts of Trade Facilitation Provisions on Fresh Agricultural Products Trade between China and the BRI Countries. *Agriculture* **2023**, *13*, 272. [CrossRef]
4. Yin, X.; Xing, L.; Cui, C. The Impact of Multi-Dimensional Vectors on China's Agricultural Products Export: Based on fsQCA. *Agriculture* **2023**, *13*, 1760. [CrossRef]
5. Baier, S.L.; Bergstrand, J.H. Do free trade agreements actually increase members' international trade? *J. Int. Econ.* **2007**, *71*, 72–95. [CrossRef]
6. Baier, S.L.; Bergstrand, J.H. Approximating General Equilibrium Impacts of Trade Liberalizations Using the Gravity Equation. In *The Gravity Model in International Trade: Advances and Applications*; Sucharita, G., Ed.; Cambridge University Press: Cambridge, UK, 2010; pp. 88–134.
7. Yang, S.; Martinez-Zarzoso, I. A Panel Data Analysis of Trade Creation and Trade Diversion Effects: The Case of ASEAN–China Free Trade Area. *China Econ. Rev.* **2014**, *29*, 138–151. [CrossRef]

8. Tong, G.; Hong, R.; Shi, L. The Growth Effect and Its Influencing Factors: Empirical Evidence Regarding China's Fruit and Vegetable Exports to RCEP Countries. *Agriculture* **2023**, *13*, 1908. [CrossRef]
9. Yang, F.; Zou, C.; Li, C. The Impact of Carbon Tariffs on China's Agricultural Trade. *Agriculture* **2023**, *13*, 1013. [CrossRef]
10. Magee, C.S.P. New Measures of Trade Creation and Trade Diversion. *J. Int. Econ.* **2008**, *75*, 349–362. [CrossRef]
11. Viner, J. *The Customs Union Issue*; Oxford University Press: New York, NY, USA, 2014.
12. Baldwin, R.; Low, P. (Eds.) *Multilateralizing Regionalism: Challenges for the Global Trading System*; Cambridge University Press: Cambridge, UK, 2009.
13. Plummer, M.G.; Cheong, D.; Hamanaka, S. *Methodology for Impact Assessment of Free Trade Agreements*; Asian Development Bank: Metro Manila, Philippines, 2010.
14. Baldwin, R. *Multilateralising 21st Century Regionalism, Global Forum on Trade Reconciling Regionalism and Multilateralism in a Post-Bali World*; OECD: Paris, France, 2014.
15. Mattoo, A.; Mulabdic, A.; Ruta, M. Trade Creation and Trade Diversion in Deep Agreements. *Can. J. Econ./Rev. Can. D'Économique* **2022**, *55*, 1598–1637. [CrossRef]
16. Kohl, T.; Brakman, S.; Garretsen, H. Do Trade Agreements Stimulate International Trade Differently? Evidence from 296 Trade Agreements. *World Econ.* **2016**, *39*, 97–131. [CrossRef]
17. Baier, S.L.; Bergstrand, J.H.; Clance, M.W. Heterogeneous Effects of Economic Integration Agreements. *J. Dev. Econ.* **2018**, *135*, 587–608. [CrossRef]
18. Chen, Z.; Voia, M.C. Short-Term and Long-Term Margins of International Trade: Evidence from the Canada-Chile Free Trade Agreement. *Front. Econ. China* **2018**, *13*, 93–115.
19. Mayer, T.; Melitz, M.J.; Ottaviano, G.I.P. Market Size, Competition, and the Product Mix of Exporters. *Am. Econ. Rev.* **2014**, *104*, 495–536. [CrossRef]
20. Arkolakis, C. Market Penetration Costs and the New Consumers Margin in International Trade. *J. Polit. Econ.* **2010**, *118*, 1151–1199. [CrossRef]
21. Fojtíková, L. China's Trade Competitiveness in the Area of Agricultural Products After the Implementation of the World Trade Organization Commitments. *Agric. Econ.* **2018**, *64*, 379–388. [CrossRef]
22. Zhang, D.; Sun, Z. Comparative Advantage of Agricultural Trade in Countries along the Belt and Road and China and Its Dynamic Evolution Characteristics. *Foods* **2022**, *11*, 3401. [CrossRef] [PubMed]
23. Deng, H.H.; Sang, B.C. Welfare Analysis of the Hub-and-Spoke System Within Global FTA Networks: A New Economic Geography Perspective. *Financ. Trade Econ.* **2012**, *7*, 88–94.
24. Hur, J.; Alba, J.D.; Park, D. Effects of Hub-and-Spoke Free Trade Agreements on Trade: A Panel Data Analysis. *World Dev.* **2010**, *38*, 1105–1113. [CrossRef]
25. Krugman, P. The Move Toward Free Trade Zones. *Econ. Rev.* **1991**, *76*, 5.
26. Egger, P.; Larch, M.; Staub, K.E.; Winkelmann, R. The trade effects of endogenous preferential trade agreements. *Am. Econ. J. Econ. Policy* **2011**, *3*, 113–143. [CrossRef]
27. Tinbergen, J. *Shaping the World Economy: Suggestions for an International Economic Policy*; Twentieth Century Fund: New York, NY, USA, 1962.
28. Silva, J.; Tenreyro, S. The Log of Gravity. *Rev. Econ. Stat.* **2006**, *88*, 641–658. [CrossRef]
29. Arvis, J.; Shepherd, B. The Poisson Quasi-maximum Likelihood Estimator: A Solution to the 'Adding up' Problem in Gravity Models. *Appl. Econ. Lett.* **2013**, *20*, 515–519. [CrossRef]
30. Fally, T. Structural Gravity and Fixed Effects. *J. Int. Econ.* **2015**, *97*, 76–85. [CrossRef]
31. Dai, M.; Yotov, Y.; Zylkin, T. On the Trade-diversion Effects of Free Trade Agreements. *Econ. Lett.* **2014**, *122*, 321–325. [CrossRef]
32. Baier, S.L.; Bergstrand, J.H. Economic Determinants of Free Trade Agreements. *J. Int. Econ.* **2004**, *64*, 29–63. [CrossRef]
33. Foster, N.; Poeschl, J.; Stehrer, R. The Impact of Preferential Trade Agreements on the Margins of International Trade. *Econ. Syst.* **2011**, *35*, 84–97. [CrossRef]
34. Wang, G.J.; Lu, X.X. Can the Belt and Road Initiative Promote China's Corporate Innovation? *J. Financ. Econ.* **2019**, *45*, 43–61.
35. Regmi, A.; Gehlhar, M.; Wainio, J.; Vollrath, T.; Johnston, P.; Kathuria, N. Market Access for High-Value Foods. Agricultural Economic Report No. AER-840; 2005; pp. 1–48. Available online: https://www.ers.usda.gov/publications/pub-details/?pubid=41734 (accessed on 1 December 2023).
36. Horn, H.; Mavroidis, P.C.; Sapir, A. Beyond the WTO? An Anatomy of EU and US Preferential Trade Agreements. *World Econ.* **2010**, *33*, 1565–1588. [CrossRef]
37. Limão, N. Preferential trade agreements. In *Handbook of Commercial Policy*; North-Holland: Amsterdam, The Netherlands, 2016; Volume 1, pp. 279–367.
38. Cao, J. The Consideration of Hub-and-Spoke Status in FTA Formation. *Bull. Econ. Res.* **2015**, *67*, 382–392. [CrossRef]
39. Jacobson, L.S.; LaLonde, R.J.; Sullivan, D.G. Earnings Losses of Displaced Workers. *Am. Econ. Rev.* **1993**, *83*, 685–709.