

Uncovering Economic Drivers and Barriers in Chinese Mainland's Agricultural Imports from Taiwan Region (2012-2022)

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Abstract

This paper explores the factors influencing agricultural trade between Chinese Mainland and Taiwan region, aiming to provide recommendations for cross-strait trade policies. Using a gravity model, we analyze panel data from 2012 to 2022 for agricultural products classified under Harmonized System (HS) Codes 1-24. Our findings indicate that Chinese Mainland's imports of agricultural products from Taiwan region exhibit a significant positive inertia effect, with previous year's imports strongly influencing the current year's import volume. Additionally, there is a significant positive correlation between the imports and the per capita real income gap between the two economies. In contrast, Chinese Mainland's outward foreign direct investment (FDI) in Taiwan region and the exchange rate between the two economies are significantly negatively correlated with import volumes. Specifically, an increase in the income gap favors higher imports, while depreciation of the Chinese Yuan (CNY) against the New Taiwan Dollar (TWD) and increased FDI from Chinese Mainland into Taiwan region are associated with reduced import volumes from agricultural sector in Taiwan region. These findings align with the Heckscher-Ohlin (H-O) theory and Mundell's substitution theory, which suggests that differences in factor endowments drive international trade flows, and that Foreign Direct Investment can substitute for some aspects of international trade. This study suggests that the monetary authorities and financial institutions in the two economies should establish a local currency settlement mechanism between CNY and TWD to enhance cross-strait agricultural trade.

Keywords

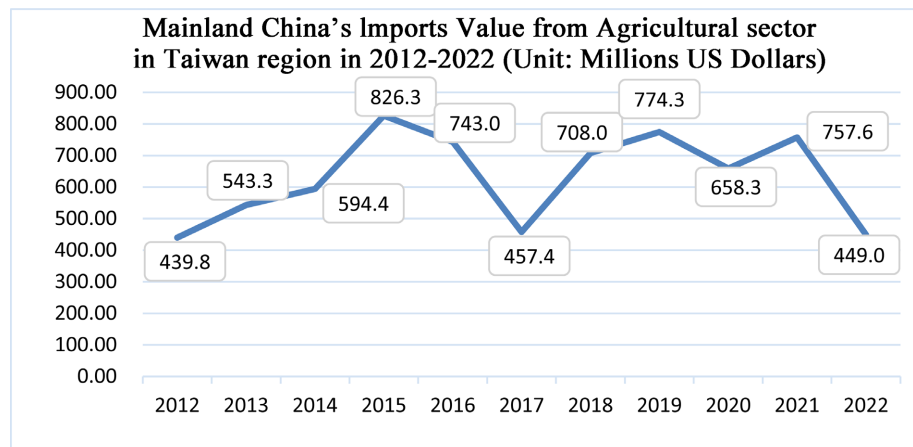
Mainland of China, Taiwan Region, Cross-Strait, Agricultural Trade, Gravity

Equation

1. Introduction

Taiwan region holds a unique significance for Chinese Mainland, not only because it is considered an inseparable part of China politically (Ministry of Foreign Affairs of the People's Republic of China, 2022), but also due to the close economic interrelations between the development in Taiwan region and that of the Chinese mainland's economy (Naughton, 2012; Rosen & Wang, 2010b). The Economic Cooperation Framework Agreement (ECFA), which came into effect on 1st January 2011, has facilitated economic and trade development across Taiwan Cross-Strait (Rosen & Wang, 2010a). Agricultural trade forms a critical component of cross-strait trade relations. High-quality agricultural products in Taiwan region have gained recognition among consumers in Chinese Mainland, providing a long-term and stable market for agricultural sector in Taiwan region (Ministry of Agriculture, 2012).

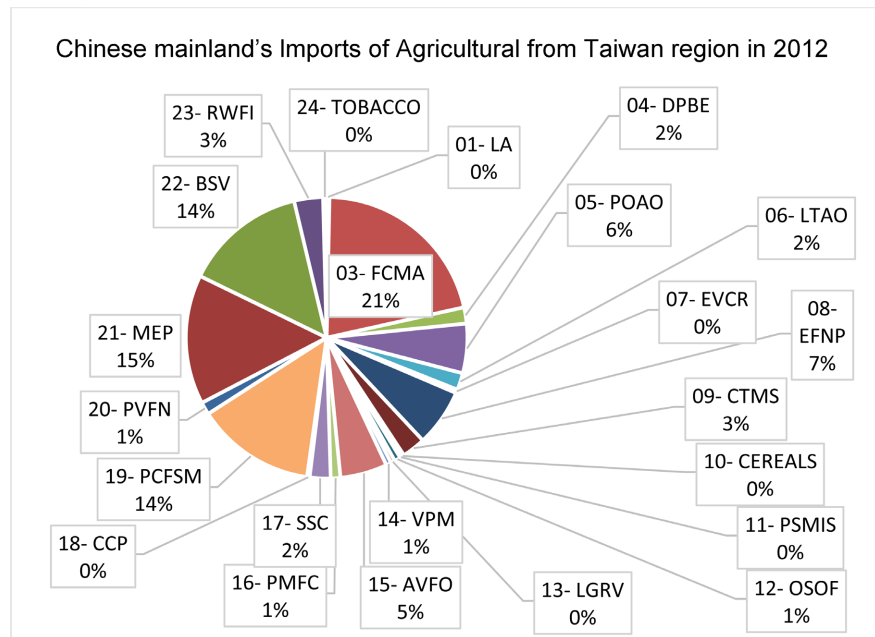
According to Figure 1, from 2012 to 2022, the import of agricultural products from Taiwan region to Chinese Mainland initially showed a gradual increase, reaching a peak in 2015. Subsequently, the trend demonstrated a wave-like pattern.



Source: General Administration of Customs of China, <http://stats.customs.gov.cn/indexEn>.

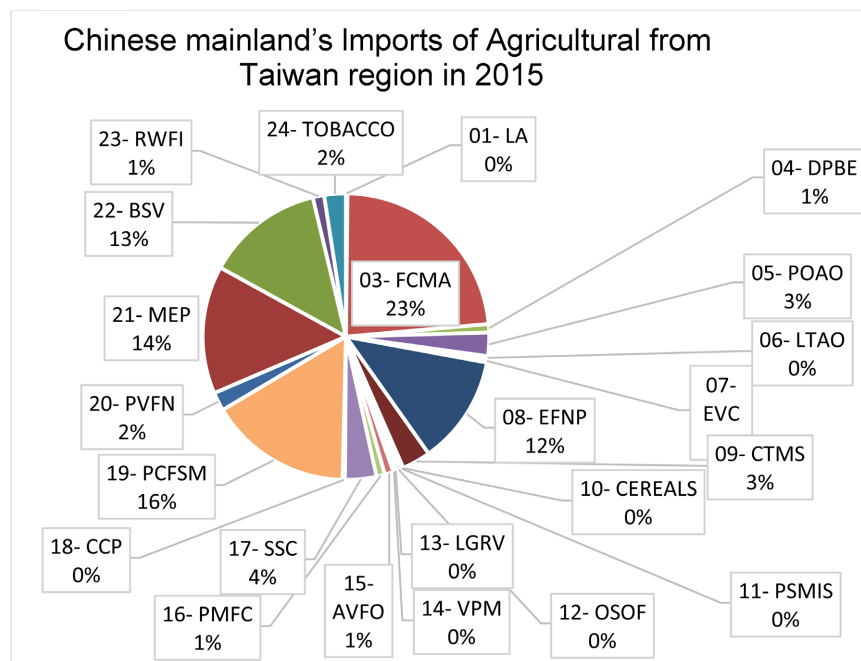
Figure 1. Chinese Mainland's imports value of agriculture from Taiwan region from 2012-2022.

Figures 2-5 respectively illustrate Chinese Mainland's import of agricultural products from Taiwan region for the years 2012, 2015, 2019, and 2022. Our analysis reveals that these chapters of the Harmonised Commodity Description and Coding System (HS) Codes, 03 (Fish and crustaceans, molluscs, and other aquatic invertebrates), 19 (Preparations of cereals, flour, starch or milk; pastrycooks' products), 21 (Miscellaneous edible preparations), and 22 (Beverages, spirits, and



Source: Author own work, referenced in the Appendix.

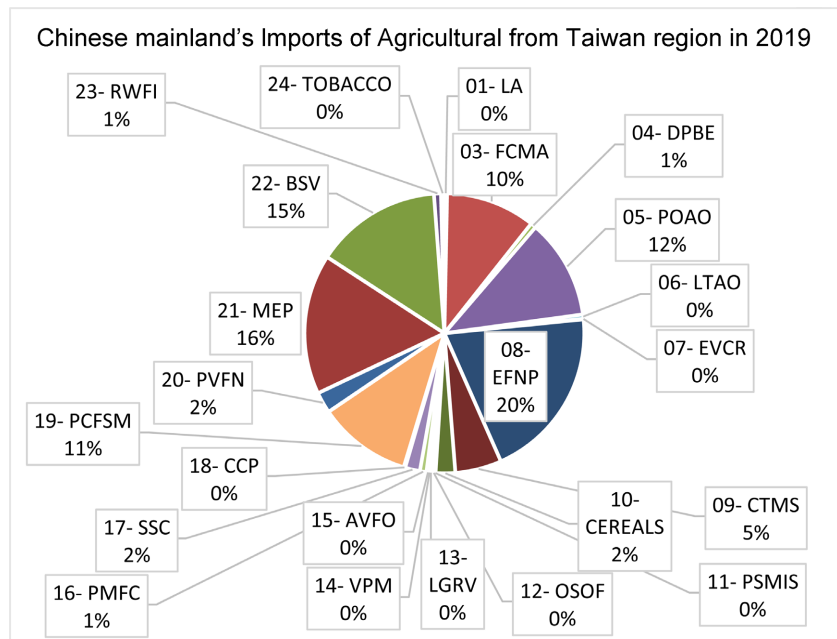
Figure 2. Chinese Mainland's import of agricultural products from Taiwan region in 2012.



Source: Author own work, referenced in the Appendix.

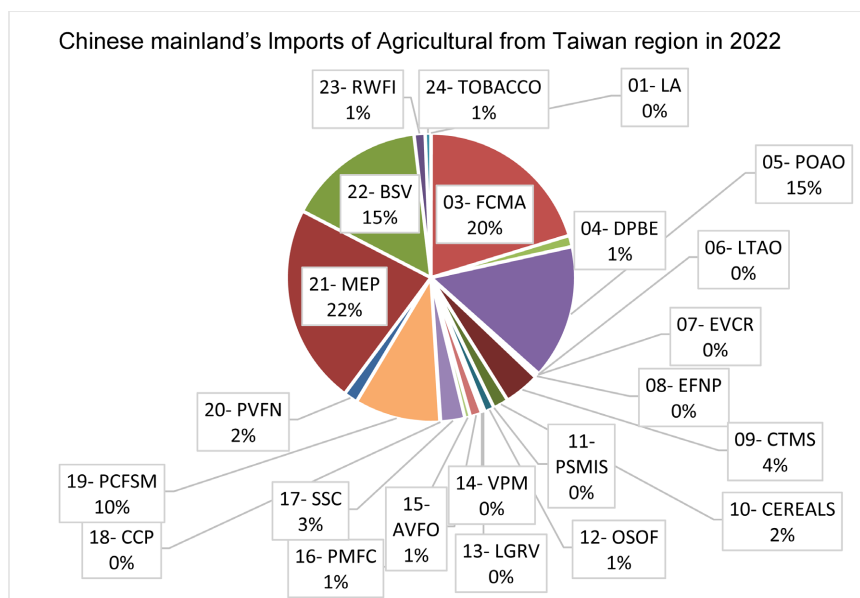
Figure 3. Chinese Mainland's import of agricultural products from Taiwan region in 2015.

vinegar), each accounted for more than 10% of the total import volume, collectively comprising over half of Chinese Mainland's imports from the agricultural sector in Taiwan region. Notably, Chapter 05 (Products of animal origin, not elsewhere specified or included) exhibited significant growth, reaching 15% of the import volume in 2022. The import volume of Chapter 08 (Edible fruit and nuts; peel of



Source: Author own work, referenced in the Appendix.

Figure 4. Chinese Mainland's import of agricultural products from Taiwan region in 2019.



Source: Author own work, referenced in the Appendix.

Figure 5. Chinese Mainland's import of agricultural products from Taiwan region in 2022.

citrus fruit or melons) peaked at 20% in 2019 but dropped to nearly zero by the year 2022. The monetary value of the agricultural products exported from Taiwan region to Chinese Mainland in 2022 was comparable to that of 2012.

Chen et al. (2009) note that agricultural trade across the Taiwan Cross-Strait, particularly fruit trade, is closely linked with economic factors such as per capita income, market size, and trade liberalization policies. Differences in per capita

income and market size between Chinese Mainland and Taiwan region positively affect intra-industry trade in agricultural products (Wu, 2010).

However, some scholars argue that the sharp decline in agricultural exports in Taiwan region to Chinese Mainland is largely associated with Chinese Mainland's restrictions on certain agricultural imports from Taiwan region (He, 2022; Thornell, 2022; Zhou & Chau, 2022). In 2022, Japan and the United States replaced Chinese Mainland as Taiwan region's largest export markets for agricultural products (Yang & Chin, 2022).

Research Problem: What are the drivers and barriers that affect Chinese Mainland's imports of agricultural products from Taiwan region?

According to the Heckscher-Ohlin (H-O) theory, differences in factor endowments drive international trade, with countries tending to export goods that intensively use their abundant factors and import goods that require scarce factors (Blaug, 1992).

However, Kemp & Linder (1965) proposed an alternative view, suggesting that international trade is more likely to occur between countries with similar per capita incomes because their demand structures are similar, leading to a higher volume of overlapping demand.

The first research question is therefore: Does agricultural trade between Chinese Mainland and Taiwan region align more closely with the factor endowment theory or the overlapping demand theory?

Furthermore, based on the H-O model, Mundell (1957) proposed the substitution relationship between foreign direct investment (FDI) and trade, suggesting that free capital movement leads to investment substituting for trade. In contrast, Kojima (1975) argued that FDI and international trade are complementary, as investment can promote trade, particularly by opening new markets and enhancing product competitiveness.

The second research question is: Is Chinese Mainland's investment in Taiwan region complementary to or a substitute for its imports of agricultural products from Taiwan region?

Given that international economic theory suggests that a country's currency depreciation generally promotes exports and suppresses imports (Pettinger, 2020), the third research question is: Does this effect also apply to agricultural products with low price elasticity? Specifically, how does the depreciation of the Chinese Yuan (CNY) against the New Taiwan Dollar (TWD) influence the trade of low-price-elastic agricultural products between Chinese Mainland and Taiwan region?

Examining these questions not only helps distinguish the applicability of these theories, deepens our understanding of the driving factors behind agricultural trade across the Taiwan Strait but also provides a theoretical basis for more effective cross-border investment and trade policies.

This paper employs the trade gravity model as the primary analytical tool. The trade gravity model is used to explain the trade flows between two economies, positing that trade volume is directly proportional to the economic size of the trading

partners and inversely proportional to their geographic distance (Capoani, 2023).

Isard (1954) and Tinbergen (1962) applied this model to empirical studies of international trade, introducing econometric methods to economics to address practical problems. This not only expanded the research methodologies in international trade but also established a foundational quantitative analysis framework for the study of international trade. Particularly in the unique political and economic context of Cross-Strait relations, the gravity model provides an ideal framework for analyzing the dynamics of Cross-Strait agricultural trade.

The remainder of this paper is organized as follows: Section 2 reviews the relevant trade literature and the theoretical background of the gravity model. Section 3 describes the sources of the data and the construction of the analytical tools, specifically the gravity model used. Section 4 presents the empirical results and discussion. Section 5 concludes the study by summarizing the findings, offering policy recommendations, and acknowledging the limitations of the research.

2. Literature Review

In recent years, research on agricultural trade between Chinese Mainland and Taiwan region has significantly declined, particularly in English-language literature, where studies on this topic are notably scarce. Ahn et al. (2014) note that the tariff reduction rules under the ECFA have expanded Taiwan region's grouper fish exports to Chinese Mainland. They suggest that to increase agricultural trade flows across the Cross-Strait, authorities need to negotiate new agreements that continue to expand the range of agricultural products under HS Code headings eligible for tariff reductions. Wei (2013) identifies that political factors have influenced Cross-Strait fruit trade. However, these studies primarily focus on policy aspects, with limited attention given to the impact of specific economic variables on agricultural trade.

Around 2010, there was a surge of interest in Chinese-language literature, with studies mainly focusing on the impact of the Economic Cooperation Framework Agreement (ECFA) on cross-strait trade and industrial development. Chen et al. (2009) find through a general equilibrium analysis that a free trade agreement between Mainland and Taiwan region positively affects Cross-Strait trade flow and increases Taiwan region's GDP. Chen et al. (2011) contend that the signing of the ECFA has facilitated an increase in cross-strait trade flow. Armstrong (2013) believes that the ECFA provides Taiwan region with significant opportunities to integrate into the East Asian economy and enhances its ability to attract foreign direct investment. Huang & Soong (2016) indicate that four years after the implementation of the ECFA, trade flows between the straits increased, enhanced regional economic integration with Chinese Mainland and Southeast Asian countries.

Several earlier Chinese-language studies have explored Cross-Strait agricultural trade. Yang (2012) utilized a gravity model, analyzing data from 1996 to 2011, to demonstrate that Taiwan region's agricultural trade flows with APEC members were significantly higher than those with non-APEC members, with Chinese

Mainland's preferential import policies playing a direct role. Su (2018), through a case study on agricultural cooperation between Fujian Province and Taiwan region, identified inconsistencies in inspection and quarantine standards as major barriers to further development in Cross-Strait agricultural trade. Cheng (2016) also employing a gravity model to analyze Cross-Strait agricultural trade from 1993 to 2013, concluded that tariffs had a negligible impact on Chinese Mainland's imports of agricultural products in Taiwan region. From a sociological perspective, Lei (2019) examined Chinese Mainland's procurement of surplus agricultural products from Taiwan region, noting that administrative intervention often outweighed market-driven behavior. Lastly, Lin et al. (2016) found, through a gravity model analysis, that the short-term impact of the ECFA on Cross-Strait agricultural trade was limited, with economic scale being the dominant factor influencing trade flows.

As discussed in the first section, the past decade has witnessed new developments and challenges in Chinese Mainland's imports of agricultural products from Taiwan region. Given that much of the existing literature was published earlier, there is a pressing need to reexamine the factors influencing these imports in the current context. Foreign direct investment (FDI) has played a significant role in shaping cross-strait trade dynamics.

Chang (2010) discovers, through interviews with Taiwan region-funded enterprises, that Taiwan region and Chinese Mainland enjoy a mutually beneficial import-export relationship, with direct investments from Taiwan region to Chinese Mainland positively correlating with Taiwan region's GDP. Chuang (2015) finds that FDI is a major driving force in enhancing intra-industry trade across the Cross-Strait. Institutional arrangements, such as bilateral or multilateral free trade agreements, have accelerated economic integration in the East Asian region.

The relationship between FDI and international trade—whether FDI serves as a substitute for or a complement to trade—remains a topic of ongoing debate. However, existing research has seldom focused specifically on how Chinese Mainland's direct investment in Taiwan region affects agricultural import volumes, particularly in the context of the Economic Cooperation Framework Agreement (ECFA). This area warrants further investigation to better understand the dynamics at play.

Exchange rate fluctuations are a critical factor influencing international trade flows. However, there has been relatively limited research on the specific impact of fluctuations in the Chinese Yuan-New Taiwan Dollar (CNY-TWD) exchange rate on cross-strait agricultural trade. Zhang (2011) finds that shifting from a fixed to manage floating exchange rate system has worked in the interest of benefiting Cross-Strait trade volume. Yang et al. (2023) state that the exports from Taiwan region to Chinese Mainland are determined nonlinearly by the Industrial Production Index of Taiwan region and the fluctuations in the CNY/TWD exchange rate. Besides, the trends of the exchange rates between the TWD and the CNY also influence the choice of currency that enterprises in Taiwan region use while investing in Chinese Mainland (Tu & Chen, 2011).

In gravity equation, the geographic distance between two economies is typically

treated as a fixed constant when analyzing trade flow determinants. As a time-invariant variable, geographic distance cannot be estimated for its effects in a fixed-effects model. Consequently, the fixed-effects model is not well-suited for estimating the impact of geographic distance on trade flows. Therefore, some scholars argue that using geographic distance as an independent variable in the study of cross-strait agricultural trade may not be entirely appropriate (Lin et al., 2016; Yang, 2012).

From the perspective of consumer demand, the Linder hypothesis explains the occurrence of intra-industry trade between developed countries. In contrast, the H-O theory, which focuses on producer supply factors, accounts for inter-industry trade between developed and developing countries. However, the impact of the per capita GDP disparity between Chinese Mainland and Taiwan region on agricultural trade remains unclear.

In summary, most existing studies are relatively dated and lack in-depth analysis of recent economic variables such as GDP, per capita income disparity, exchange rate fluctuations, and FDI. By incorporating these specific economic factors into the analytical tool, and analyzing how changes alter trade flows, this study contributes to a deeper and more comprehensive understanding of the economic nexus across the Cross-Strait agricultural trade. It provides empirical insights for policymakers on the authorities across the Taiwan Strait for developing policies related to Cross-Strait agricultural trade.

3. Methodology

3.1. The Specific Gravity Model

The previous section discussed how scholars frequently use the gravity model to analyze bilateral trade. Building on this foundation, the current study employs the trade gravity model but with specific modifications to suit our analysis. The basic formulation of the gravity model is as follows:

$$Trade_{ij} = \alpha * (GDP_i * GDP_j) / Dis_{ij} \quad (1)$$

In Equation (1), $Trade_{ij}$ represents the bilateral trade flow between country i and country j . GDP_i and GDP_j denote the gross domestic products of countries i and j respectively. The constant term is denoted by α and Dis_{ij} represents the geographical distance between country i and country j .

Taking the logarithm of both sides of the equation is a classical approach to evaluate the basic gravity model, as it transforms the model into a linear form that is more amenable to regression analysis. Therefore, Equation (1) can be expressed in its logarithmic form as follows:

$$\ln(Trade_{ijt}) = \alpha + \beta_1 \ln(GDP_{it}) + \beta_2 \ln(GDP_{jt}) - \beta_3 \ln(Dis_{ijt}) + \varepsilon_{ij} \quad (2)$$

In Equation (2), $\ln(Trade_{ijt})$ represents the natural logarithms of bilateral trade flow between countries i and j in year t . The indices i and j denote different trading partners, and t denotes the year. $\ln(GDP_{it})$ and $\ln(GDP_{jt})$ represent the natural logarithms of the gross domestic products of countries i and j in year

t , respectively. $\ln(Dis_{ijt})$ is the natural logarithm of the geographic distance between countries i and j . The constant term α represents the intercept, which captures effects in the model that do not vary with the explanatory variables. The coefficients β_1 , β_2 , and β_3 , are the estimated parameters that measure the impact and direction of the respective explanatory variables (GDP and distance) on trade flow. ε_{ij} is the error term, representing the impact of other factors not observed in the model.

Given the constant geographic distance across the Taiwan Strait, this study excludes the impact of geographical distance on bilateral trade flows. It instead examines the effects of the economic sizes of the regions on either side of the Taiwan Strait, Chinese Mainland's FDI in Taiwan region, and the exchanges in the exchange rate between the CNY and TWD on Chinese Mainland's imports of agricultural products from Taiwan region. Consequently, Equation (2) is modified to focus on these variables as follows:

$$\ln(Trade_{ijt}) = \alpha + \beta_1 \ln(GDP_{ijt}) + \beta_2 \ln(FDI_t) + \beta_3 \ln(Exch_{ijt}) + \varepsilon_{ij} \quad (3)$$

Per capita real income is a crucial indicator for measuring the average economic level and purchasing power of a population within an economy. The disparity in per capita real income between two economies can significantly impact bilateral trade flows. In this study, per capita real income is represented by GDP per capita at constant US dollar values. The focus is on examining the impact of the GDP per capita gap between Chinese Mainland and Taiwan region on agricultural trade. The equation to model the GDP per capita gap's effect on agricultural trade flows is formulated as follows:

$$DGDP_{ijt} = |Per\ capita\ GDP_i - Per\ capita\ GDP_j| \quad (4)$$

Consequently, incorporating the per capita GDP disparity as an explanatory variable, the trade gravity model for this study is specified as follows:

$$\ln(T_{ijt}) = \alpha + \beta_1 \ln(GDP_{ijt}) + \beta_2 \ln(DGDP_{ijt}) + \beta_3 \ln(FDI_t) + \beta_4 \ln(Exch_{ijt}) + \varepsilon_{ij} \quad (5)$$

In Equation (5), $\ln(T_{ijt})$ represents the natural logarithm of the agricultural trade flow from Chinese Mainland to Taiwan region in year t . Here, i denotes Chinese Mainland and j denotes Taiwan region. $\ln(GDP_{ijt})$ denotes the natural logarithm of the product of GDPs of Chinese Mainland and Taiwan region in year t . $\ln(DGDP_{ijt})$ represents the natural logarithm of the absolute value of the difference in per capita GDP between Chinese Mainland and Taiwan region in year t . $\ln(FDI_t)$ is the natural logarithm of the stock of direct investments from Chinese Mainland to Taiwan region in year t . $\ln(Exch_{ijt})$ denotes the natural logarithm of the exchange rate between the Chinese Yuan and the New Taiwan Dollar in year t . The constant term α captures the effects in the model that do not vary with the explanatory variables. The coefficients β_1 , β_2 , β_3 , and β_4 are the estimated parameters that measure the impact and direction of the respective explanatory variables on trade flow. The error term ε_{ij} represents the influence of other

factors not observed in the model.

3.2. Data and Sources

This study employs balanced panel data spanning from 2012 to 2022, totaling 253 observations ($11 \times 23 = 253$). According to the two-digit HS codes, the agricultural products imported by Chinese Mainland from Taiwan region are included in HS Chapter 01 to 24, excluding Chapter 02. This statistical classification is based on the research by Yang (2012) and the directory provided by the China Chamber of Commerce of Import and Export of Foodstuffs, Native Produce, and Animal By-products. Since no agricultural products under HS code Chapter 02 have ever been imported from Taiwan region by Chinese Mainland, these products are excluded from the data utilized in this research.

In this study, T_{ijt} serves as the dependent variable, representing Chinese Mainland's imports flows from Taiwan region agricultural products. The data is sourced from China Customs Statistics and is denominated in US dollars.

The primary explanatory variables of this study include:

1) GDP_{ijt} , representing the economic size of the Taiwan Cross-Strait region, calculated as the product of the Gross Domestic Products (GDPs) of Chinese Mainland and Taiwan region. We expect that a larger economic size corresponds to a higher import flows. The data is sourced from the Key Indicators Database of APEC, denoted in constant 2015 US dollars, and denominated in millions of US dollars.

2) $DGDP_{ijt}$, which is the absolute difference in per capita real income between Chinese Mainland and Taiwan region, represented by the absolute value of the difference in per capita GDP in constant US dollars. We hypothesize that a larger GDP per capita disparity between the two economies leads to a decrease in import flows. This data is also sourced from the Key Indicators Database of APEC and is denoted in constant 2015 US dollars.

3) FDI_t , the stock of direct investment from Chinese Mainland in Taiwan region. It is expected that there is a positive correlation between FDI and import flows. The data comes from the Ministry of Commerce of China, denominated in ten thousand US dollars.

4) $Exch_{ijt}$, the exchange rate between the Chinese Yuan (CNY) and the New Taiwan Dollar (TWD). It is anticipated that a depreciation of the CNY against the TWD leads to a decrease in import flows. The exchange rate data, represented as the annual average, is sourced from the International Monetary Fund (IMF) Database (Table 1).

4. Data Analysis, Conclusion and Policy Implication

4.1. Data Analysis and Results

Table 2 briefly summarizes the descriptive statistics of the dependent and independent variables before they are transformed into logarithmic form. All variables have 253 observations, as the data is balanced panel data. During the period from

Table 1. Data sources and description of variables in the specific gravity model.

	Variable	Description	Expected Sign	Source
Dependent variable	$\ln T_{ij}$	Chinese Mainland's import flows from Taiwan region agricultural products		China Customs Statistics
Explanatory variable	$\ln(GDP_{ij})$	The product of the Gross Domestic Products (GDPs) of Chinese Mainland and Taiwan region (Constant 2015 USD millions)	+	APEC Key Indicators Database
Explanatory variable	$\ln(DGDP_{ij})$	The absolute value of the difference in per capita Gross Domestic Product (GDP) between Chinese Mainland and Taiwan region (Constant 2015 USD)	-	APEC Key Indicators Database
Explanatory variable	$\ln(FDI)$	Foreign direct investment from Chinese Mainland in Taiwan region (current, ten thousand US dollars)	-	China's Ministry of Commerce
Explanatory variable	$\ln(Exch_{ij})$	Official Exchange Rate of CNY per TWD	-	IMF Database

Source: Author own work.

Table 2. Descriptive statistics.

	Obs	Mean	Std. Dev.	Maximum	Minimum
T_{ij}	253	27,477,815.66	40,803,324.46	193,516,602	614
GDP_{ij}	253	7,365,646,737,086.64	2,116,097,273,804.24	11,011,386,323,111.40	4,382,398,357,478.54
$DGDP_{ij}$	253	15,318.05	940.88	17,345.67	14,464.33
FDI	253	106,933	49,597.94	167,679	13,532
$Exch_{ij}$	253	0.2162	0.0117	0.2333	0.1952

Source: Authors' compilation from EViews 13.0.

2012 to 2022, the minimum import value of agricultural products from Taiwan region to Chinese Mainland was \$¹614 (HS Chapter 14), and the maximum import value was \$193.5 million (HS Chapter 03), reflecting the varying preferences of Mainland Chinese consumers for different categories of agricultural products in Taiwan region. The cross-strait per capita income disparity ranged from a minimum of \$14,464.33 to a maximum of \$17,345.67, with a standard deviation of \$940.88, indicating a gradually widening income gap over the past 11 years. The stock of direct investment from Chinese Mainland in Taiwan region ranged from \$135.32 million to \$1.67 billion, with a mean value of \$107 million and a standard deviation of \$495.97 million, reflecting the continuous expansion of Chinese Mainland's investment in Taiwan region over the past 11 years. The exchange rate between the CNY and the TWD had a minimum value of 0.1952 and a maximum value of 0.2333, with a standard deviation of 0.0117, indicating the stability of the exchange rate between the CNY and the TWD.

Pesaran (2004) proposed a general test for cross-sectional dependence in panel

¹Note: The symbol "\$" refers to US dollars throughout the text.

data, which involves using residuals to assess cross-sectional dependence. Before conducting pooled OLS, a Panel cross-section dependence test should be performed to determine whether the sample data exhibits cross-sectional dependence or is mutually independent. Failure to conduct this test may result in biased and inconsistent regression results based on the assumed gravity equation (Irshad et al., 2018).

The results of the CD test for this study are shown in **Table 3**. The P-values for the Breusch-Pagan LM, Pesaran scaled LM, and Pesaran CD tests are all below 0.05, indicating significant cross-sectional dependence in the residuals of the gravity model. Therefore, there is interdependence among the cross-sectional units in the panel data.

Table 3. Cross-section dependence test.

Test	Statistic	Prob.
Breusch-Pagan LM	638.7060325	0.0000
Pesaran scaled LM	17.14672461	0.0000
Pesaran CD	3.528229677	0.0004

Source: Authors' compilation from EViews 13.0.

To avoid spurious regression results, this study follows the methodology of Cheng (2012) by employing the LLC test for common unit root and the PP-Fisher test for individual unit root. If both tests reject the null hypothesis of a unit root, the series is considered stationary; otherwise, it is non-stationary. The unit root results in **Table 4** show that the LLC test and PP-Fisher test *P*-values for $\ln(T_{ij})$, $\ln(GDP_{ij})$, $\ln(FDI)$, and $\ln(Exch_{ij})$ are all below 0.05, indicating stationarity. However, the results for $\ln(DGDP_{ij})$ exceed 0.05, indicating non-stationarity at the level. After first differencing, the LLC test and PP-Fisher test *P*-values for $\ln(DGDP_{ij})$ are both below 0.05, indicating stationarity in the first-difference.

Table 4. Unit root test result.

Variables	$\ln T_{ij}$	$\ln(GDP_{ij})$	$\ln(DGDP_{ij})$	$D(\ln(DGDP_{ij}))$	$\ln(FDI)$	$\ln(Exch_{ij})$
LLC test	-3.5789 (0.0002)	-18.0266 (0.0000)	1.2197 (0.8887)	-8.1316 (0.0000)	-12.5251 (0.0000)	-7.7433 (0.000)
PP-Fisher test	63.5656 (0.0439)	165.0690 (0.0000)	1.0084 (1.0000)	59.7190 (0.0843)	423.6760 (0.0000)	71.1509 (0.0101)
Stationary	stable	stable	Non-stable	stable	stable	stable

Source: Authors' compilation from EViews 13.0.

The multicollinearity results show that the Variance Inflation Factor (VIF) for the explanatory variables $\ln(GDP_{ij})$ and $\ln(Exch_{ij})$ exceeds 10. After removing the explanatory variable $\ln(GDP_{ij})$, the VIFs for the remaining explanatory variables in the gravity model are all **Table 5**.

Table 5. Variance inflation factor test.

Variable	VIF	VIF*
$\ln(GDP_{ij})$	49.33	
$\ln(DGDP_{ij})$	8.70	2.30
$\ln(FDI)$	15.61	1.63
$\ln(Exch_{ij})$	5.27	1.82

Source: Authors' compilation from EViews 13.0.

Therefore, the gravity model should exclude the explanatory variable $\ln(GDP_{ij})$, and the explanatory variable $\ln(DGDP_{ij})$ should be adjusted to its first-difference before performing Ordinary Least Squares (OLS) regression.

4.2. Findings and Implications

The Ordinary Least Square (OLS) regression results, as shown in **Table 6**, indicate

Table 6. Regression of OLS and GMM.

	OLS		GMM	
	Coefficient	Std. Error	Coefficient	Std. Error (White Period).
$D(\ln(DGDP_{ij}))$	3.158030	8.579828	11.46061***	1.114699
$\ln(FDI)$	-0.022630	0.413583	-1.487925***	0.125017
$\ln(Exch_{ij})$	-5.779177	4.268044	-3.487474***	0.345162
Constant	7.016418	10.22076		
$\ln(T_{ijt-1})$			0.255649***	0.041448
Number of Obs	230		161	
R ²	0.018256			
Adjusted R ²	0.005224			
Durbin-Waston Statistics	0.153679			
F-statistic	1.400824			
Prob (F-statistic)	0.243373			
J-statistics				21.59148
Prob (J-statistic)				0.305057
AR (1)				0.0000
AR (2)				0.1395

*Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.
Source: Authors' compilation from EViews 13.0.

that the coefficients of the independent variables $\ln(FDI)$, $\ln(Exch_{ij})$, and the first-difference of $\ln(DGDP_{ij})$ are not significant, and both R-Squared and Adjusted R-Squared are below 5% (0.05). This implies that the explanatory variables in the gravity model hardly explain the variations in the dependent variable. The Durbin-Watson statistic result is 0.153679, suggesting a strong positive correlation between residuals, indicating that the gravity model may suffer from omitted variable bias and that OLS regression is no longer appropriate, necessitating an adjustment in the regression method.

We take the lagged term of the dependent variable $\ln(T_{ij})$ as an explanatory variable and employ the Generalized Method of Moments (GMM) for instrumental variables regression. The regression results, as shown in **Table 6**, indicate that all explanatory variables have significant coefficients at the 1% level. Chinese Mainland's import flows from Taiwan region's agricultural products to exhibits dynamic effects and positive inertia effects, with a 1% increase in imports from the previous year promoting approximately a 0.256% increase in current year imports. In the GMM estimation, the coefficient of the one-year lagged foreign direct investment from Chinese Mainland to Taiwan region $\ln(FDI_{t-1})$ is significant and consistent with the estimation. A 1% increase in foreign direct investment from Chinese Mainland to Taiwan region leads to a decrease of about 1.49% in agricultural imports from Taiwan region. The coefficient of the exchange rate between the Chinese Yuan (CNY) and the New Taiwan Dollar (TWD) $\ln(Exch_{ij})$ is significant and aligns with expectations. A 1% depreciation of the CNY against the TWD results in approximately a 3.49% decrease in agricultural imports from Taiwan region.

The study initially hypothesized a negative significant relationship between the explanatory variable $\ln(DGDP_{ij})$ and import flows, predicting that a widening per capita income gap between Chinese Mainland and Taiwan region would reduce agricultural imports from Taiwan region. However, in the GMM estimation, the coefficient of the two-year lagged first-difference of the Cross-Strait per capita real income disparity $(D\ln(DGDP_{ij}, -2))$ is significantly positive, indicating that a 1% increase in the growth rate of the per capita GDP disparity between Chinese Mainland and Taiwan region leads to approximately an 11.46% increase in agricultural imports from Taiwan region. This result suggests that although the income gap between Chinese Mainland and Taiwan region is widening, this change has not reduced the demand for Taiwan region agricultural products in Chinese Mainland. On the contrary, other economic factors might be contributing to an increase in import volume. Since the explanatory variable $\ln(GDP_{ij})$ was excluded due to a VIF greater than 10, which originally was expected to have a significant positive relationship with import volume, we have reason to believe that the expansion of economic size contributes to the increase in agricultural imports from Taiwan region to Chinese Mainland.

Based on the regression results, we derive the following gravity model for this study:

$$\ln(T_{ijt}) = 0.255649 * \ln(T_{ijt-1}) + 11.46061 * D(\ln DGD P_{ijt}) - 1.487925 * \ln(FDI_t) - 3.487474 \ln(Exch_{ijt}) + \varepsilon_{ij} \quad (6)$$

Based on the above research findings, we propose the following policy recommendations for consideration by the authorities on both sides of the Taiwan Strait:

1) Chinese Mainland and Taiwan region signed the Cross-Strait Currency Clearing Cooperation Memorandum in 2010, establishing a currency clearing mechanism between the Chinese Yuan (CNY) and the New Taiwan Dollar (TWD). However, to date, cross-border settlement in local currencies across the Taiwan Strait has not been realized. While a clearing mechanism exists, a settlement mechanism has not yet been established, and electronic wallet payments do not facilitate transactions in local currencies. Our study indicates that exchange rate stability facilitates Chinese Mainland's agricultural imports from Taiwan region. The financial authorities of the two economies should sign a local currency settlement agreement and actively assist financial institutions in establishing settlement accounts and electronic wallet payment channels for CNY and TWD to facilitate transactions for importers, exporters, and individuals.

2) The study shows a significant negative relationship between Chinese Mainland's direct investment in Taiwan region and the import volume of agricultural products from Taiwan region. This could be due to trade policy restrictions imposed by the authorities in Taiwan region, as well as production shifts and import substitution effects. To increase the export of agricultural products in Taiwan region to Chinese Mainland, agricultural authorities across the Taiwan Strait should negotiate and sign cooperation agreements in the field of agricultural investment, supporting agricultural technology and sustainable development projects. Additionally, authorities in Taiwan region need to optimize policies regarding Chinese Mainland's FDI in Taiwan region, such as relaxing market entry restrictions, particularly in the agricultural and food processing sectors, to promote Cross-Strait agricultural trade growth.

3) We also recommend establishing a Cross-Strait agricultural trade information platform to share real-time market demand, price fluctuations, and seasonal changes. This will help farmers and agricultural exporters in Taiwan region better plan production and exports, reducing risks associated with market uncertainties in Chinese Mainland. Although this study does not include political stability factors such as the "1992 Consensus" as a variable, it is important to acknowledge that the "One-China principle" plays a crucial role in Cross-Strait institutional consultations. Therefore, when the authorities across the Taiwan Strait negotiate and sign cooperation agreements, adherence to the "One-China principle" is essential.

4.3. Conclusion, Limitation and Suggestions for Future Research

In our study, we analyzed the determinants of Chinese Mainland's agricultural imports from Taiwan region using data collected from 2012 to 2022 with a gravity

model. The regression results were obtained using both the OLS estimator and the GMM estimator. Based on the GMM estimation, we found that Chinese Mainland's agricultural imports from Taiwan region exhibit a positive inertial relationship with the previous year's imports. It indicates that the previous year's imports from Taiwan region help increase the following year's imports. Additionally, the widening gap in per capita real income between the two economies is significantly positively related to import volume, indicating that an increase in the growth rate of the income gap between Chinese Mainland and Taiwan region promotes higher agricultural imports from Taiwan region. This intriguing phenomenon aligns with the H-O theory, which posits that differences in factor endowments drive greater international trade flows. The expansion of the income gap reflects a growing divergence in factor endowments between the two regions of the Taiwan Cross-Strait, which in turn fosters increased agricultural trade across the Strait.

The paper analysis reveals a significant negative relationship between Foreign Direct Investment (FDI) from Chinese Mainland into Taiwan region and agricultural import volumes from Taiwan region, indicating that increased direct investment by Chinese Mainland in Taiwan region may lead to production shifts or substitution effects, thereby reducing the demand for agricultural imports from Taiwan region. This finding is consistent with Mundell's theory that FDI can substitute for some aspects of international trade flows.

Furthermore, the depreciation of the Chinese Yuan (CNY) against the New Taiwan Dollar (TWD) is associated with a decrease in agricultural imports from Taiwan region, highlighting the suppressive effect of exchange rate volatility on trade. In this context, adopting a local currency settlement mechanism between the two economies could mitigate exchange rate risks, stabilize trade conditions, and ultimately promote agricultural trade. Therefore, it is advisable for the Cross-Strait authorities to pursue the establishment of a CNY-TWD Cross-border settlement framework to enhance trade flows.

This study has certain limitations, as it does not address the export of agricultural products from Chinese Mainland to Taiwan region. Additionally, the potential impacts of the Economic Cooperation Framework Agreement (ECFA) and cross-strait political stability on agricultural trade were not considered. Future research should explore these aspects in greater depth to provide a more comprehensive understanding of the dynamics of agricultural trade between the two economies of the Taiwan Strait.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Chinese Mainland's Imports from Agricultural Products in Taiwan region in 2012-2022 (Unit: US Dollars).

HS Code	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
01 - LA	1433462.00	996200.00	1423794.00	1444148.00	1394585.00	739263.00	358873.00	2391543.00	316210.00	173729.00	103528.00
03 - FCMA	93246932.00	130680324.00	159924199.00	193516602.00	118894100.00	48568412.00	102197002.00	8020992.00	66980059.00	180445849.00	90940940.00
04 - DPBE	8166037.00	9410067.00	8297327.00	7795946.00	8032411.00	2044298.00	2231679.00	4940635.00	3975314.00	8471688.00	5663323.00
05 - POAO	25030212.00	28477564.00	26786809.00	21893783.00	24548396.00	31661655.00	7597694.00	89376853.00	36390617.00	64427904.00	67533551.00
06 - LTAO	8563080.00	7946455.00	4049893.00	2994852.00	2413042.00	4091159.00	3858893.00	3824431.00	971288.00	653655.00	405442.00
07 - EVCR	1816708.00	1399329.00	2045147.00	2878822.00	2073581.00	181933.00	277323.00	522352.00	162378.00	122831.00	332373.00
08 - EFPN	28972651.00	48035514.00	55547699.00	101721097.00	104964189.00	92137644.00	118465348.00	154611796.00	129008001.00	85797643.00	1631111.00
09 - CTMS	11951447.00	15048573.00	14007305.00	26718468.00	29173841.00	35414834.00	43770891.00	41560040.00	34710120.00	28063052.00	17919938.00
10 - CEREALS	1328393.00	1134848.00	1837000.00	845675.00	509565.00	267007.00	11847414.00	17541492.00	38360423.00	28122658.00	7682960.00
11 - PSMIS	899586.00	756296.00	495733.00	1752446.00	740076.00	135598.00	74806.00	40067.00	17958.00	44282.00	22756.00
12 - OSOF	3125269.00	1943628.00	2502599.00	3804204.00	3772716.00	2474036.00	3035532.00	2915351.00	2848799.00	2173170.00	4851117.00
13 - LGRV	2079856.00	728398.00	2204815.00	2177457.00	2704604.00	2602541.00	1751689.00	2305203.00	1913987.00	1365304.00	1743005.00
14 - VPM	2626645.00	2685885.00	2123020.00	1222632.00	1037488.00	542145.00	614.00	12160.00	10259.00	153050.00	46961.00
15 - AVFO	23748444.00	21521590.00	12132266.00	8232687.00	6422997.00	2685257.00	2895634.00	2781480.00	4298533.00	6888421.00	5849509.00
16 - PMFC	4892363.00	4531431.00	5048915.00	7848359.00	9456087.00	5313118.00	5294953.00	5879193.00	4049936.00	4157713.00	2765898.00
17 - SSC	10515354.00	14308200.00	15430465.00	29241921.00	21640143.00	10417244.00	12780613.00	13300093.00	16420120.00	25099270.00	12194261.00
18 - CCP	1341271.00	1624880.00	1409251.00	2195966.00	2566354.00	1006660.00	1965612.00	1321091.00	923477.00	1049209.00	335980.00
19 - PCFSM	60123476.00	84569113.00	93598658.00	132860235.00	119064250.00	64372322.00	79433850.00	83815234.00	68268353.00	71022316.00	43118149.00
20 - PVFN	6324998.00	8624831.00	12137333.00	17334753.00	15483923.00	14134357.00	19166383.00	18916149.00	11018861.00	14487989.00	7045106.00
21 - MEP	65446968.00	78680050.00	88071746.00	119383398.00	130950243.00	94196339.00	12500468.00	125522612.00	132853833.00	132963157.00	100795693.00
22 - BSV	61844098.00	69070339.00	63688057.00	109699509.00	103358492.00	32352863.00	85762766.00	111328892.00	95360173.00	91085676.00	69564404.00
23 - RWFI	14583840.00	8632553.00	7409397.00	1057693.00	10107416.00	9147748.00	9146101.00	6301207.00	6690806.00	7980351.00	5559441.00
24 - TOBACCO	1778857.00	2522784.00	14283762.00	20208958.00	25691231.00	2961193.00	3061573.00	2980366.00	2832124.00	2944649.00	2891822.00
Total	439839947.00	543328852.00	594455190.00	826349611.00	742999730.00	457447627.00	708035711.00	774358232.00	658381629.00	757693566.00	448997268.00

01 - LA = Live animals; animal products. 03 - FCMA = Fish and crustaceans, molluscs and other aquatic invertebrates. 04 - DPBE = Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included. 05 - POAO = Products of animal origin, not elsewhere specified or included. 06 - LTAO = Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage. 07 - EVCR = Edible vegetables and certain roots and tubers. 08 - EFPN = Edible fruit and nuts; peel of citrus fruit or melons. 09 - CTMS = Coffee, tea, maté and spices. 10 - CEREALS = Cereals. 11 - PSMIS = Products of the milling industry; malt; starches; inulin; wheat gluten. 12 - OSOF = Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder. 13 - LGRV = Lac; gums, resins and other vegetable saps and extracts. 14 - VPM = Vegetable plaiting materials; vegetable products not elsewhere specified or included. 15 - AVFO = Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes. 16 - PMFC = Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates. 17 - SSC = Sugars and sugar confectionery. 18 - CCP = Cocoa and cocoa preparations. 19 - PCFSM = Preparations of cereals, flour, starch or milk; pastrycooks' products. 20 - PVFN = Preparations of vegetables, fruit, nuts or other parts of plants. 21 - MEP = Miscellaneous edible preparations. 22 - BSV = Beverages, spirits and vinegar. 23 - RWFI = Residues and waste from the food industries; prepared animal fodder. 24 - TOBACCO = Tobacco and manufactured tobacco substitutes.