Analyzing trade data between Fujian Free Trade Zone and Taiwan based on the gravity model

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Abstract. Using panel data of 19 major trading regions in Fujian from 2001 to 2017, this study employs two directional (import and export) trade gravity models to evaluate the current trade status and trade potential of Fujian. As the closer economic and trade cooperation between the two sides of the Taiwan Straits strengthens, it is of great significance to investigate how the Fujian Free Trade Zone can further promote cross-strait development. The results show that Fujian’s imports and exports to Taiwan were in an abnormal state, with imports showing “over-trading” and exports showing “under-trading”. The main reason is that Fujian presents trade subsidies in imports, while Taiwan has hidden barriers in exports. This study uses empirical results to emphasize the need for further economic integration and development between Fujian and Taiwan. In terms of population, the Fujian Free Trade Zone needs to focus on introducing talents and industrial integration at various levels. Culturally, Fujian should strengthen cross-strait cultural exchanges, reduce information asymmetry, and lower cultural barriers to promote cross-strait economic and trade development.

1. Introduction

In January 2019, a gathering to commemorate the 40th anniversary of issuing “Message to Compatriots in Taiwan” was held at the Great Hall of the People in Beijing. During this conference, President Xi emphasized the need to deepen cross-strait integration and to actively develop cross-strait economic cooperation [1]. The conference brings the cross-strait economic and trade development to a new height. In the same year, Fujian Province in its government work report also highlighted the importance of economic and social integration between Fujian and Taiwan. The report pointed out that the strategy towards Taiwan should take advantage of the Fujian Free Trade Zone (FTZ) as a platform to deepen Fujian-Taiwan integration and development.

The Fujian FTZ, formally established in April 2015, is a crucial exchange platform between Fujian and Taiwan. Its development situation has become a hot topic with changes in cross-strait relations. According to the statistics of the Fujian FTZ, 378 innovative measures were launched in 14 batches between April 2015 and April 2019. Over 20% of these measures, 81 in total, were specific for Taiwan, surpassing the ratio for other regions [2-4]. More than 2,300 Taiwanese companies have incorporated during this period, creating contracts with a total value exceeding $6.26 billion dollars.

While taking up less than one thousandth of the province’s area, Fujian FTZ has attracted more than half of Taiwanese investment in Fujian. With its unique regional economic development advantages, the Fujian FTZ has played a central role in the construction and development of Fujian-
Taiwan relation [5-6]. However, compared with other free-trade zones during the same period, the development of Fujian FTZ is slightly inadequate. Fujian Province’s total trade with Taiwan in 2017 only accounted for 5.74% of total cross-strait trading, far less than the 32.71% and 11.84% undertaken by Guangdong and Shanghai (Hu and Chen, 2019) [7-9]. The utilization and development of Fujian FTZ has become a common concern of the government, industry, and academia.

At the present, scholars have conducted in-depth research on the Fujian FTZ from multiple perspectives. They primarily focused on two aspects, qualitative research on the policy system and quantitative research on the impact factors of the FTZ’s development. In qualitative research, Wu et al. (2015) emphasized the importance of learning from the development experience of the Shanghai FTZ from a macro perspective [10-12]. The Fujian FTZ needs to combine innovation, cross-strait cooperation, and tax policies to the macro situation to form unique advantages. At the micro level, some scholars have focused on discussing the future practice and development direction for financial innovation in the Fujian FTZ (Yang, 2017). In addition, scholars have promoted the exploration of new paths and methods for cross-border e-commerce cooperation with Taiwan (Chen and Chen, 2016). In quantitative research, Zhang and Wang (2016) argued that collaborative development of the Fujian FTZ has not reached an ideal state. Similarly, Shao (2017) analyzed the main developmental factors that affect the Fujian FTZ via an integrated force mode for synergetic behavior. Qin and Xie (2016) examined various aspects through interpreting structural models. In summary, current quantitative research has emphasized on building multi-dimensional models to explore the elements that can impact and promote the development of the Fujian FTZ [13-15]. Whereas, qualitative research on the Fujian FTZ is based on its comparison of other mature FTZs, such as the Shanghai FTZ, with institutional inquiry into existing issues.

In fact, prior studies are overly focused on the development of the Fujian FTZ itself. However, the Fujian FTZ, as a pioneering area for commerce and trade with Taiwan, will need to be fully utilized to further improve regional integration. In addition, it should serve as a critical conduit for future rapid development of both Fujian and Taiwan. Combined with current research deficiencies and the basis of relevant literature, this study uses the gravity model to investigate the trade situation between Fujian and Taiwan. On this basis, we quantitatively analyze the future development of the Fujian FTZ to provide constructive reference for future planning and development.

2. Literature review

Since the establishment of the Fujian Pilot FTZ, many studies have examined the FTZ’s economic impact from a qualitative perspective. For example, from a macro perspective, Wu et al. (2015) provided suggestions on the development and taxation strategy for Fujian FTZ by comparing the strategic differences between the FTZs of Shanghai and Fujian. They affirmed the results of current developments of Shanghai FTZ and emphasized that Fujian FTZ must combine its own characteristics with future reform to gradually promoted development and exchange.

In addition, scholars emphasized the need for financial reform and development for Fujian’s FTZ (Yang, 2017), the deepening of cross-strait financial cooperation under the context of existing policies (Huang and Chen, 2015), and the development of comparative advantage in cross-border e-commerce between Fujian’s FTZ and Taiwan (Chen and Chen, 2016). Lin (2015) analyzed the advantages of Fujian’s FTZ in cross-strait economic and trade development and existing problems. They proposed policy recommendations for Fujian-Taiwan economic and trade cooperation with coordinated development. Peng et al. (2015) refined the operability of coordinated development [16-17]. Taking the Fujian FTZ Xiamen Area as a research perspective, they analyzed and explored the unique advantages, construction paths, and countermeasures of the Xiamen Area, and proposed new strategies and approaches for cross-strait economic integration.

Furthermore, scholars have researched the economic impact of the Fujian FTZ through evolutionary game theory, collaborative development models, and structural models. For example, Zhang and Wang (2016) used group evolutionary game to analyze how the three areas across the Fujian FTZ can effectively cooperate. Shao (2017) analyzed the main factors that promote cooperative
development among the three areas through an integrated force model of cooperative behavior. Qin and Xie (2016), through a structural model, examined the influencing factors in the development of the Fujian FTZ, combined the relationships between factors, divided the development strategy of the Fujian FTZ into three stages, and made recommendations for future planning.

Although scholars have performed multi-angle research on the Fujian FTZ in recent years, research on Taiwan has been lacking. Including economical emphasis on the promotion of commerce development and trade construction as the core factors in internal and external competitive environments (Hu and Chen, 2019). Emphasis of the impact of Fujian’s establishment of FTZ towards Taiwan and the dynamic environment, new opportunities, and challenges on both sides (Liu et al., 2015). In terms of specific policy implementation, the docking and development strategies of finance, services, logistics, and cross-border e-commerce have become the focus of research (Zhong and Guo, 2017).

Although current qualitative analyses gradually explore the development of integration for commerce and trade between Fujian and Taiwan, quantitative analyses are needed to verify the promoting role of the Fujian FTZ. This study employs the gravity model of trade as the main quantitative method for the analysis. At present, the gravity model is used to study the effects of international trade. For examples, Qian (2019) used the gravity model to measure the growth effect of regional integration between China and other Asia-Pacific economies, and Zhou (2017) studied the economic effects of the FTZs between China and Korea. In this study, we attempt to fill the void of current quantitative analyses. We examine the current trade situation between Fujian and Taiwan, explore the potential of trade, and find the impacting factors. This study focuses on the regional economic integration between Fujian and Taiwan, supplementing the literature.

3. Model and data

3.1. Model

The gravity model, proposed by economist Tinbergen for international trade, is widely in the assessment of trade interactions. Subsequently, Aitken, Anderson, Krugman, Helpman, and others have frequently applied and improved upon the gravity model, maturing its utilization for studies of regional economic integration. The largest advantage of the gravity model, compared with other methods, is its ability to achieve adequate measurements without requiring the construct of many dummy variables. Compared with related literature on global integration, this study focuses on the discussion of trade relations between regional economies.

The basic equation of the trade gravity model is expressed as:

$$X_{ij} = \alpha_0 \cdot Y_i^{\alpha_1} Y_j^{\alpha_2} P_i^{\alpha_3} P_j^{\alpha_4} D_{ij}^{\alpha_5}$$

(1)

where $X_{ij}$ denotes the trade volume (import/export) from country $i$ to country $j$; $Y_i$ and $Y_j$ represent the GDPs for countries (or regions) $i$ and $j$; $P_i$ and $P_j$ denote the populations of countries (or regions) $i$ and $j$; $D_{ij}$ represents the distance between the two countries (or regions). To facilitate empirical analysis, we derive the logarithm of this model to a linear form and establish trade gravity models for import and export. The equations can be expressed as:

$$\ln l_{ij} = \beta_0 + \beta_1 \ln Y_i Y_j + \beta_2 \ln AC_i AC_j + \beta_3 \ln RD_{ij} + \beta_4 CD_{ij}$$

(2)

$$\ln o_{ij} = \gamma_0 + \gamma_1 \ln Y_i Y_j + \gamma_2 \ln AC_i AC_j + \gamma_3 \ln RD_{ij} + \gamma_4 CD_{ij}$$

(3)

where $\beta_0$-$\beta_4$ and $\gamma_0$-$\gamma_4$ are estimated coefficients of model variables. $l_{ij}$ denotes the import volume of local region (Fujian Province in this study) from other countries and regions; $o_{ij}$ represents the export volume; $AC_{i(j)}$ denotes GDP per capita, which represents a unified unit to provide comparable interpretation; $RD_{ij}$ represents the relative distance, calculated as $RD_{ij} = (GDP_i/GDP_w) \times D_{ij}$, with $GDP_w$ as the total world GDP and $D_{ij}$ as the spatial distance (Soloaga and Wintersb, 2001).
In the regression of time series, the absolute value of the spatial distance will be presented as a singular matrix, this problem can address by employing relative distance. \( CD_{ij} \) represents the cultural distance between the two location, which is a dummy variable. Based on the method in Tihanyi el al.’s (2005) study, the data is classified as 1 for data that is less than 3, which represents similar cultures; and classified as 0 for data that is more than 3, which represents dissimilar cultures.

3.2. Data description
Data in this study covers the duration starting from 2001 of China’s entry into the WTO up to 2017. A total of 19 countries and regions that have major trade exchanges with Fujian Province are selected. The data of Fujian Province’s GDP, GDP per capita, and the value of imports and exports to other countries and regions are obtained from Fujian Province’s Statistics Bureau. The GDP and per capita GDP of other countries and regions, as well as the world’s GDP over the years, are compiled from statistical offices of corresponding countries and the World Bank. Spatial distance is calculated as the direct distance from Jiangyin Port, one of the main ports in the Fujian FTZ, to the main ports of other countries or regions of economic exchange. The raw data of \( CD_{ij} \) is derived from past Hofstede statistics. The descriptive statistics of the sample are listed in Table 1.

### Table 1. Descriptive statistics of the sample.

| Variable | Mean | Std. Dev. | Maximum | Minimum |
|----------|------|-----------|---------|---------|
| \( L\ln I_{ij} \) | 10.44 | 1.38 | 13.53 | 7.30 |
| \( L\ln O_{ij} \) | 11.42 | 1.38 | 14.60 | 8.03 |
| \( L\ln Y_{ij} \) | 25.73 | 1.49 | 29.74 | 22.77 |
| \( L\ln AC_{ij} \) | 18.83 | 1.34 | 20.67 | 14.86 |
| \( L\ln RD_{ij} \) | 4.73 | 2.10 | 12.73 | 0.77 |
| \( CD_{ij} \) | 0.32 | 0.48 | 1.00 | 0.00 |

According to the results in Table 1, the descriptive statistics of \( L\ln I_{ij} \) and \( L\ln O_{ij} \) are highly consistent, indicating that the development of Fujian Province in recent years, in terms of import and export growth, has been relatively consistent. The variables \( L\ln Y_{ij} \) and \( L\ln AC_{ij} \) are multiplicative, thus showing higher mean values; however, the standard deviation shows that neither of these variables exhibit extremes and the data is consistent. The variable \( L\ln RD_{ij} \) exhibited lower mean with extreme cases of the highest standard deviation and lower minimum value, which can be explained by Hong Kong’s inclusion in the 19 countries and regions. Hong Kong’s relative distance is small (680km) and its GDP is relatively small compared to the world. The mean value of variable \( CD_{ij} \) is 0.32, indicating that in the selected region, 6 countries or regions are similar to the Chinese culture.

4. Empirical analysis and suggestions

4.1. Empirical analysis
We estimate the import and export trade with gravity models in Eq. (2) and Eq. (3). The results are reported in Tables 2 and 3. As the two models have highly consistent significance and coefficient values, the two models are explained together in the following analysis. First, all variables in the two models passed the \( t \)-test at the level of 1%, indicating that the four variables selected in this study are statistically representative. Moreover, the \( F \)-statistics of the two models are significant, with fitness of 64% and 71%, representing strong explanatory power.

Second, we analyze the main explanatory variables, the \( L\ln Y_{ij} \) coefficients of import and export trade gravity models in Eq. (2) and Eq. (3) are 0.88, consistent with other related trade gravity models. In economic terms, when the product of GDP growth rates of the two regions increases by 1%, Fujian’s import and export volume will increase by 0.88%. This shows that economic development can significantly increase the level of bilateral trade. The estimated coefficients of \( L\ln AC_{ij} \) are negative in both models, which mean that under static GDP, population increase will have a positive
effect on the degree of bilateral trade. The estimated coefficients of $\ln RD_{ij}$ are negative in both models, indicating that farther distance is related to weaker degree of trade exchanges, and vice versa. Furthermore, the estimated coefficients of $CD_{ij}$ in the two models show that similar cultures can significantly promote trade exchanges. Last, the constant variable is significant at the 1% level, which show that there may be other undetected variables.

**Table 2.** Estimated results of the gravity model for import.

| Variable | Coefficient | $t$-statistic | $p$-value |
|----------|-------------|---------------|-----------|
| Constant | -5.67867    | -5.848        | <0.001    |
| $\ln Y_iY_j$ | 0.88772 | 20.591 | <0.001 |
| $\ln AC_iAC_j$ | -0.35544 | -6.699 | <0.001 |
| $\ln RD_{ij}$ | -0.07803 | 10.088 | 0.0033 |
| $CD_{ij}$ | 1.26141 | -2.730 | <0.001 |
| $R$-squared | 0.64880 |  |  |
| Adjusted $R$-squared | 0.6444 |  |  |
| $F$-statistic | 147.300 | $p$-value ($F$-statistic) | <0.001 |

**Table 3.** Estimated results of the gravity model for export.

| Variable | Coefficient | $t$-Statistic | $p$-value |
|----------|-------------|---------------|-----------|
| Constant | -7.74522    | -9.063        | <0.001    |
| $\ln Y_iY_j$ | 0.88035 | 23.204 | <0.001 |
| $\ln AC_iAC_j$ | -0.16843 | -3.607 | <0.001 |
| $\ln RD_{ij}$ | -0.14648 | -5.824 | <0.001 |
| $CD_{ij}$ | 1.40743 | 12.970 | <0.001 |
| $R$-squared | 0.73920 | Adjusted $R$-squared | 0.7166 |
| $F$-statistic | 205.200 | $p$-value ($F$-statistic) | <0.001 |

Because the gravity model is derived from the physical model, scholars are interested in analyzing distance, resulting in many extensions of this factor. This phenomenon can be found in current research and application of the gravity model. Currently, “distance” is commonly divided into spatial distance, economical distance, technical distance, cultural distance, and political distance. This study focuses on spatial and cultural distances. Luo et al. (2014) have found that the technical and economical distances are opposites to trade volume, which provides a certain basis for negative estimated coefficients of the constant term.

The analysis results allow for a more accurate understanding of the communications methods of commerce between the Fujian FTZ and Taiwan. Next, we use the established gravity models for import and export to calculate the trade potential ratios between the two locations, and further understand the status of trade. The estimated trade potential ratios, shown in Table 4, are obtained by dividing the theoretical trade value by the actual trade value, where 1 represents a critical point. When the trade potential ratio is greater than 1, it represents untapped potential. The larger the value, the greater the potential, and vice versa. The results in Table 4 show that Fujian’s import potential ratio with Taiwan is 0.35, which is far less than 1, indicating that Fujian’s import from Taiwan is in an “over-trading” state, and it is close to an extreme state. However, Fujian’s export potential ratio with Taiwan is far greater than 1, reaching 1.58, indicating that Fujian’s export to Taiwan is in a serious “under-trading” state.
| Item ($1 million dollars)            | Theoretical value | Actual value | Trade potential ratio |
|------------------------------------|-------------------|--------------|-----------------------|
| Fujian’s imports from Taiwan       | 2477.27           | 7093.38      | 0.34924               |
| Fujian’s exports to Taiwan         | 7629.35           | 4834.02      | 1.57826               |

Both “over-trading” and “under-trading”, to an extent, represent the distortion of market economy, and surprisingly, the exports and imports of the same region can show completely opposite conditions. The main causes of this phenomenon are attributed to the differences of economic policies on both sides. The core reason for the distortion of imports is caused by a series of preferential policies of Fujian towards Taiwan. The Fujian FTZ has emphasized that it is a pioneering and experimental position for cross-strait exchanges. It highlights the introduction and subsidies of Taiwanese materials, and the establishment of a good platform for the development of Taiwanese businessmen. In 2018 alone, 66 policies were passed that benefitted Taiwanese, encouraging Taiwan businessmen to invest and greatly boosting Fujian’s import development towards Taiwan.

By contrast, the reasons for such an apparent “under-trading” in Fujian’s exports to Taiwan can be observed in Figures 1 and 2 (unit: million dollars). Figure 1 shows that the import and export throughput between the two regions is significantly different. In 2017, the ratio of Fujian’s external exports to Taiwan’s external imports was 40.5%, and this is under the condition where the distance between the two places was less than 200 km. Hence, could the strong directional characteristics of a single region be the cause for the staggered imports and exports phenomenon between the two regions?

![Figure 1. Fujian’s exports and Taiwan’s imports during 2003-2017.](image1)

![Figure 2. Taiwan’s wood, animal, and plant product imports during 2003-2017.](image2)
these industries are considered as dominant industries in Fujian Province. By exploring the essence of this phenomenon, we find that it is caused by barriers, including tariffs and a series of hidden political and procedural barriers. In addition, some historical reasons can attribute to Fujian’s “under-trading” of exports to Taiwan. Apparently, such a distorted state of bilateral trade is not conducive to the long-term and orderly economic development of the two regions.

4.2. Suggestions

Only when the trade factors between the two regions is understood can targeted recommendations be made. Based on the above empirical results, this study provides suggestions on the variables of population and culture. First, in terms of population, as the results show, the growth is an important factor in promoting bilateral trade. It can be further broken down into direct and indirect population growth. A direct increase in population is simply an attraction towards the outside world. At the present, major cities in China have begun to compete for talent. In the new round of competition, urban agglomerations such as Beijing-Tianjin-Hebei, Chengdu-Chongqing, and Shenzhen-Hong Kong have emerged, and are more attractive to talent. It will be ever more difficult for a single province to fight alone. The general trend will drive the integration of Fujian and Taiwan. Although the systems of the two regions are different and may form trade barriers, they will also have unmatched advantages over other regions.

The indirect population increase is achieved mainly through the increase of population quality and the employment rate. From the perspective of increasing population quality, current policies attract Taiwan’s outstanding talents to Fujian. In fact, Figure 3 shows that Taiwan’s current high-end talents are still growing, but the proportion of bachelors is in constant decline. Quality higher education is a scarce resource; therefore, in addition to encouraging outstanding Taiwanese talents to come to the mainland, it is also possible to gradually connect outstanding high school students in Fujian with Taiwan in future development to improve population quality.

![Figure 3. Full time equivalent in Taiwan during 2003-2016.](image1)

![Figure 4. Structure of labor-intensive exports in Taiwan during 2003-2017.](image2)
From the perspective of improving the employment rate, Figure 4 shows that Taiwan’s current exports are concentrated in the middle- and high-level labor-intensive industries. At present, in the Fujian Province, the level of industrialization varies in different geographical regions. The level of industrialization is slightly lower in the hinterland areas of the Fujian Province, which is suitable for medium labor-intensive industries. In coastal cities, its higher industrialization can further promote innovative industries. In terms of industrial cooperation, Fujian is necessary integrate with Taiwan in a targeted manner according to its characteristics of distance, economy, and industrialization level in different regions.

In terms of culture, Fujian has emphasized the five advantages with its development towards Taiwan, that is, geographical similarity, blood relationship, cultural relationship, commercial connection, and legal relationship. However, the calculation of cultural distance shows that the current cultural distance between Mainland China and Taiwan was higher than expected, roughly 1.2 between Mainland China and Taiwan, whereas 0.3 for Hong Kong and 0.78 for Vietnam. The cultural distance between Mainland China and Taiwan is close to the cultural distance between Mainland China and Indonesia. Although a single method and data may not be convincing, it deserves attention.

Normally, in the exchanges between Fujian and Taiwan, the two regions are treated as having the same culture, but this approach may cause obstacles. Therefore, it is particularly important to further strengthen cultural exchanges between the two regions, especially of Taiwan’s knowledge of the mainland’s current economy and system. In addition to travel, academic, and non-governmental exchanges between the two regions, focus should be placed on exporting soft power, such as film, television, animation, or games, to Taiwan. Effective cultural output can quickly improve mutual understanding of the two regions.

5. Conclusions
This study starts with the weaknesses of current studies on commerce and trade between Fujian and Taiwan, emphasizes the data as a framework to explore the current actual trade situation, and provides corresponding suggestions. In terms of research methods, this study employs the trade gravity model to conduct the empirical analysis on the current trade situation between Fujian and Taiwan. The results show that the current state of trade between the two regions is in an unconventional state of economy. The subsidies on the Fujian side are the main causes for “over-trading”, and hidden barriers in Taiwan caused its “under-trading”. Both states hinder long-term and effective development. To break away from the existing stalemate, the Fujian FTZ needs to implement targeted policies.

Based on the empirical analysis results, this study emphasizes the need to focus on talent and culture and to promote gradual integration of the economies of Fujian and Taiwan. In terms of talent training, it is important to attract Taiwan’s highly educated population, whereas Fujian can export young students in the opposite direction. In terms of employment, attention needs to be paid to the geographical, economic, and industrial characteristics of different markets to achieve a higher level of integration with Taiwan’s industries. As for culture, this study finds a large cultural gap between the two regions that was previously undiscovered, which should be confirmed with future empirical analysis. This reminds us not to ignore the possible differences that could exist. It is important to further promote cross-strait cultural exchanges.

This study, to an extent, enhances Fujian’s current understanding of the trade status with Taiwan. We employ the gravity model for regional economic integration; however, there are still some shortcomings. The concept of “distance” in the gravity model has been gradually transformed from the concrete to the abstract. This study focused on spatial and cultural distances. Future studies can conduct more detailed analysis of varying conceptual distances between Fujian and Taiwan.

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