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中美貿易戰下臺灣航空貨運的貿易偏轉及創造效應

Trade Deflection and Creation Effects in Taiwanese Air Freight under the U.S.-China Trade War

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摘要

在中美的相互競爭及保護主義的興起下，美國藉由數次的貿易清單對於自中國進口的貨物加徵額外關稅，進而形成了中美貿易戰，同時影響著國際貿易。為了研究台灣是否因為中美貿易戰，而在自中國進口及出口至美國的航空貨運貿易中，有貿易偏轉及創造效應，本研究使用了最小平方法及固定效應之回歸模型，針對 116 個月且 38 個不同種類貨物的航空貨運貿易量及貿易值資料進行分析。除此之外，我也加入了主要貨物特定效果與時間趨勢的交互項；以及，動態效果與超前效果的虛擬變數，作為穩健性檢驗。分析後我發現，第一次貿易清單的施行，的確在由中國至台灣的航空貨運進口中造成了貿易偏轉的效應。而就貿易創造效應而言，10%額外關稅的第三清單以及第四清單中 A 部分貨物的實施，也使航空貨運的出口量及值顯著增加。由此可見，中美貿易戰在台灣自中國的航空貨運進口中，造成了貿易偏轉效應；同時，也使台灣航空貨運對美國出口量及值的增長，即發生了貿易創造效應。

關鍵詞：中美貿易戰、航空貨運、貿易偏轉、貿易創造、臺灣

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Abstract

With the rise of protectionism and competition, the U.S.-China trade war affected the international trade through several implementations of tariffs lists conducted by the U.S. The research aims to study whether the effects of trade deflection and creation take place in Taiwanese air freight trade under the trade war, in terms of volume and value. In this study, the OLS and the fixed effect models are used to investigate the panel data, covering 116 months with 38 air freight categories. For the robustness check, I estimate the specific effect of the five main categories and the category specific time trend effect of each air freight category by including interaction terms. Dynamic effect and leading effect are also considered with dummy variables. I find that trade deflection from China is observed when the first tariffs list takes effect. Also, the implementation of the third tariffs list with 10% tariffs rates and part A of the fourth tariffs list increase Taiwanese air freight export volume and value. In conclusion, the U.S.-China trade war results in a significant trade deflection effect on the imports from China to Taiwan in the beginning. On the other hand, for trade creation effect, tariffs action positively affects Taiwanese air freight exports volume and value.

Key words: U.S.-China trade war, air freight, trade deflection, trade creation, Taiwan

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Table of Contents

DOI:10.6814/NCCU202100196

List of Figures and Tables

DOI:10.6814/NCCU202100196

1. Introduction

With the rise of protectionism from the year of 2018, the Trump Administration has adopted a series of actions to impose Section 301 tariffs on goods imported from China to the U.S. The goods are subjected to 15% to 25% of additional tariff rates, affecting total import value of $450 billion. The sudden change in the United States international trade policy in the late 2018 created an opportunity to examine the impact of tariffs' implementation on trade. Nicita (2019) finds that, in the first half of 2019, the U.S. has a 25% reduction in imported goods as a result of the imposition on additional tariffs. Several researches are conducted to evaluate the impact of the U.S.-China trade war. Amiti, Redding, and Weinstein (2019) estimate an additional $12.3 billion cost of the tax revenue to the government on domestic consumers and importers, and, this additional cost could transfer from the tariffs into U.S. domestic prices. Nicita (2019) also finds that the additional tariffs rates result in a strong decline in U.S. imports from China with an indication to replace imports from other places and an 8% of absorbed cost of tariffs from the reduction of export prices.

Because of the relative change in the U.S. domestic prices, the imports from China could deflect from other exporting countries instead of China to avoid the imposition of additional tariffs. Taiwan is the top five alternative importing markets for the U.S. Under the U.S.-China trade war, Taiwan has majorly $474.76 million of export value into the U.S. for electrical equipment (HS 2-digit=85), $5.95 million for special textile (HS 2-digit=58), and $76.84 million for reticles of iron or steel (HS 2-digit=73) (Tu, Du, Lu, & Lou, 2020). The exporting goods in Taiwan are mainly high-technological or electrical products. With small gross weight and volume, these products usually have higher added-value that is exactly the ideal goods for the air transportation. In addition, due to the almost-immediate implementation after the official announcement was

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released, air transportation and air freight will have a prompt response to the additional tariffs rates. The just-in-time operation for the global value-chain heavily relies on the rapid and reliable air transportation links (Geloso Grosso & Shepherd, 2011). Therefore, the underlying impact for air freight is essential to be examined in detail for estimating the magnitude of trade deflection under the U.S-China trade war.

In the last decade, the liberalization of trade and aviation industry has made air freight an important channel for global trade to stimulate the growth of the world economy and globalization. The global freight tonnne-kilometers (tkm)[1] have grown 39% from 2008 to 2018 according to the World Bank database. Even though the cost for air freight is typically higher and acts as a limitation of air freight, in 2014, air freight still accounts for 34.6% of world trade ($6.4 trillion USD) while only constitutes 0.5% of total trade volume (International Air Transportation Association (IATA), 2018). Moreover, along with the development of e-commerce, air freight is acting as a driver of international connectivity. Aviation trade, with the prosperity of international trade, is expected to share 96% of Air e-commerce in mail tonne-kilometres (mtk)[2] in 2025 (Industry High Level Group (IHLG), 2019). Similarly, in Taiwan, the air freight trade volume in the proportion of total trade volume is also extremely little. According to an analysis conducted by the Taoyuan International Airport Corporation in 2017, with only 0.13% and 1.54% of imports and exports weight volume, their trade value account for 43.78% and 48.8% respectively (Taoyuan International Airport Corporation, 2018). Although with a low proportion of volume, the larger proportion of value shows how air freight trade is essential to a country's economic and trade development.

[1] Tonne-kilometers (tkm) is a unit of measure of freight transport which represents the transport of one tonne of goods (including packaging and tare weights of intermodal transport units) by a given transport mode (road, rail, air, sea, inland waterways, pipeline etc.) over a distance of one kilometer.
[2] Mail tonne-kilometres is obtained by multiplying the total number of tonnes of mail revenue load carried on each sector of a flight by airport-to-airport distance.

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This study aims to investigate the trade deflection and creation effects in Taiwanese air freight under the United States-China trade war. The fact that the tariffs were imposed in different phases with specific products on a single country allows this study to specifically look into imports and exports of products based on air freight category transported by air. In addition, to provide a straightforward aspect of trade value, the unit value will be used. This study uses regression analysis to estimate the effect of the trade deflection and creation on Taiwan's air freight under U.S.-China trade war. The data of air freight volume and value, in the period between April, 2010 and November, 2019, is examined for comprehensive estimation of the trade deflection and creation effects under the U.S.-China trade war. To control for the category and time, the fixed effect model is applied. With the robustness check, interaction terms of top-5 major goods and time trend for each air freight category as well as the dummy of dynamic effect are added. Additionally, also with dummy, the leading and lagged effects are examined in case the effect had happened before or after the imposition of tariffs.

In the following sections, in section 2, the paper provides a general overview of the United States-China trade war. Also, I will explain the basic concept of the trade deflection and creation effects on a theoretical basis. In section 3, the data and data sources will be described. Section 5 provides the econometric models used to estimate the effect of additional tariffs rates on trade deflection by imports and trade creation by exports. In section 6, the results will be presented to examine the direction and the magnitude of trade deflection and creation effects under the U.S.-China trade war. Lastly, section 7 concludes.

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2. Literature Review

2.1 Overview of United States-China Trade War

The U.S. and China are the leading powers in the world when it comes to economies. Since China's economic growth is soaring under globalization, the Goldman Sachs had estimated that China would surpass the U.S. in late 2020s. It leads to those trade actions, involving international trade prospects amid rising U.S. protectionism (Steinbock, 2019). The "American First" further became the catchword for protectionism rising in recent years to oppose the exports-leading trade policies by China. After the withdrawal from the Trans-Pacific Partnership (TPP) and the intention of NAFTA renegotiation, the direction had been tilted toward the country specific tariffs.

In the second half of 2018, China and the United States have been confronting a trade conflict when the Trump administration implemented tariffs lists on approximately $360 billion of U.S. imports from China. To respond to the protecting trade policy of the U.S. with retaliation, averaging tariffs of 16% has been imposed by China on $161 billion of U.S. exports (Amiti et al., 2019). These competitively retaliating tariffs policies are commonly addressed as "trade war".

Table 1, organized from the Office of the U.S. Trade Representative, shows the comprehensive time of release and implementation as well as estimated trade value from China for the four tariffs lists conducted by the Trump administration. Note that the tariffs rates of the third list were changed, and part B of the fourth list was suspended.

The U.S. trade action lists are announced consecutively between June 2018 and August 2019. The first tariffs list (L1) specifically for China began in June, 2018, with additional 25% tariffs rates estimated for $34 billion of imports value. The second tariffs list (L2) of additional 25% tariffs rates have $16 billion of imported China goods. The third list of tariffs implementation started in September, 2018 with 10% tariffs

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(L3_10) on $200 billion of China imports. The tariffs rates were modified to 25% (L3_25) in May, 2019. The fourth list (L4) with 15% tariffs implementation took place. However, the truce was made at the G20 conference in Dec, 2018. Although the goods in part B of the fourth list will not be subjected to the tariffs, the additional 15% of tariffs with a total trade value of approximately $120 billion are imposed on the China-import goods in part A of the fourth list (L4A) effective in September, 2019. The rates of tariffs were reduced from 15% to 7.5% on Feb 14, 2020 after a Federal Register notice was issued by the United States Trade Representative (USTR).

The policy aims to encourage American people to consume and purchase American products by making imported goods much more expensive. Under the trade war, thousands of products from China are the target of the tariffs lists. In the first and second lists (L1& L2), the affected products in terms of value are mainly machineries, electronics, and transportation products. However, since the total value of these lists are subtle compared to the last two lists (L3& L4), the effect of list 1 and 2 could be expected to be smaller. For the third list (L3), even though it was imposed only for an additional 10% of tariff at the beginning, the rate was further modified to 25%, expanding the possible effect considering the value of imports. The main products affected in tariff action list 3 are: telecommunications equipment, printed circuit board (PCB) for computer, central processing Unit, home appliance and vehicle parts according to the United States International Trade Commission (USITC). The tariff list 4 mainly imposed an additional 15% tariffs on agricultural products, semiconductor, machineries, vehicles, and general products, such as clothing, shoes, and textile, with an import value of $39 billion, and the cost will transfer to consumers.

The increases in prices for domestic (U.S.) consumers and the distortion of welfare induced by the increasing cost is not the only effect raised by the imposition of the tariffs lists. Other countries could also possibly benefit from the detouring trade because

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of the increased cost induced by the tariffs lists. Those products subjected to the tariffs lists from the U.S. could avoid the imposition through the change of the origin. In Taiwan, if you want to change the origin of the product to “made in Taiwan”, it must go through substantial transformation[3] before re-exporting. In other words, the product that Taiwan has more advantage in brings more opportunity of gaining interest through the effect of trade deflection and creation. In addition, since the air liberalization and relative advantages are different across countries, the category each country may benefit from will be different as well. According to a research, Taiwan was the largest beneficiary of the trade deflection effects of United States tariffs on China, accounting for additional exports to the United States of almost US$ 4.2 billion in the first half of 2019. The increase is largely on the office machinery and communication equipment (Nicita 2019). It gives the implication that the trade war may draw benefits for different combinations of products among countries, if the products in the lists are mostly the major exporting products of Taiwan.

The fundamentally and conventionally theoretical model provides us an understanding of how imposition of tariffs affects the price of foreign goods and further decreases the demand of foreign imported goods.

2.2 The Theoretical Model of Trade Deflection and Creation

The trade deflection originally is defined as an effect by redirection of imports from a third country through a low-tariff partner member of a free-trade area (FTA) to the destination country intending to take advantage of the tax differentials between the member and non-member countries (Shibata, 1967). The redirection effect not only

[3] Substantial transformation means an increase of 35% in added-value or a complete change in 6-digits HS code, according to the Import Origins Identification Standard.

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occurs between FTA and non-FTA members, but happens when trade protectionism arises resulting in a building-up trade barrier.

Figure 1 presents the concept of trade deflection and creation effects. Using the U.S. antidumping (AD) data over the period of 1992-2001 to match with the Japanese product-level export value to third countries (EU), in this case, Bown and Crowley (2007) found a 5-7% increase in Japanese exports to non-U.S. trade partners. They mentioned four different kinds of effect as the result of increase antidumping tariff:

1) Trade destruction
2) Trade creation via import source diversion
3) Trade deflection
4) Trade depression

Here, I focus on trade deflection and creation effects. In Figure 1, country A, B and C are the U.S., China, and Taiwan, respectively. When the U.S. implemented tariffs barriers, such as the tariffs lists, China may not want to directly export their product subjected to additional tariffs rates. Therefore, China will deflect those products to other countries, such as Taiwan, to avoid the imposition of additional tariffs. The increase of the imports from China to Taiwan, is trade deflection effect. On the other hand, Taiwan has to export those products to the U.S., hence, the exports from Taiwan to the U.S. will increase. Thus, this increased effect on exports is trade creation effect. However, the data in this study has a difficulty to differentiate the trade flow with the purpose of avoiding additional tariffs from the general trade flow. As a result, it is still questionable whether trade deflection and creation effects are truly caused by the distortion of trade flow.

DOI:10.6814/NCCU202100196

In the statistical data from the Bureau of Foreign Trade of Taiwan, China is the top trade partner holding 22.68% of total trade value, 27.19% of export value and 17.47% of import value of Taiwan between April, 2010 and November, 2019. As for the U.S. in the same period, it holds the third place of trade partner to Taiwan, accounting for 11.184% of total trade value, 11.759% of export value and 10.52% of import value. Under the U.S.-China trade war, the channel for the firms to avoid the country-specific imposition for imports from China is to divert the destination for the goods to a third country thereby fleeing the additional tariffs. By diverting to another destination, the third country could be benefited by both trade deflection and creation. In this research, the focus is on Taiwan, one of the closest trade partners of China.

3. Data Sources

Table 2 shows the variable list for this study. The variables in the research are composed of air freight import (I) and export (E) weight volume, dummy for U.S.-China trade war's tariffs lists, the weighted average unit price and value, and the control variables. In the following subsections, the source and the basic information of variables are presented.

3.1 Air Freight Volume

From the Civil Aviation Administration (CAA) of Taiwan, the air freight weight volume is listed specifically for main airports in Taiwan, such as Taoyuan (TPE[4]) located in northern Taiwan and Kaohsiung International Airport (KHH) in southern Taiwan. Starting from April, 2010 to Nov, 2019, the data covers 116 monthly data

[4] The IATA airports code is used to represent the airports mentioned in this study, such as TPE for Taoyuan International airport, KHH for Kaohsiung, TSA for Songshan, and RMQ for Taichung.

DOI:10.6814/NCCU202100196

classified in 38 kinds of air freight categories. Due to the potential possibility of exogenous effect from the outbreak of pandemic the paper does not include the data after December 2019 to avoid the biased estimation.

I obtain the air freight trade volume the sum of both air ports (TPE and KHH). In the third column in Table 2, the expectation of this study is that implementation of tariffs will have a positive effect on both imports (trade deflection) and exports (trade creation), especially for those major trade categories for Taiwan, such as machines and electronics from category 23 to 27. Since the Songshan (TSA) and Taichung (RMQ) airport, the international airports in northern and central Taiwan, do not provide their air freight weight volume in separative air freight categories. Although these data are not available, the weight volume of RCSS and RCMQ only account for the total international (including entrepot trade) trade volume of around 2.5% and 0.1% respectively. Thus, the missing of these data does not bias the estimations.

Table 3 presents the descriptive statistics of all variables. Notice that the medians for the export side (trade creation) are smaller than 1. It is because a large proportion of the value in data is smaller than zero or close to zero. This also explains the significant drop of the number of observations.

Table 4 lists the air freight categories, including 38 kinds of commodity classification, i.e., metal, metal products, machinery, and electronics, etc. Nevertheless, the air freight categories are different from what we usually use in customs for tax imposition. It is used to classify the cargo for workers in the airports to precisely distinguish the commodities for the reason of applying appropriate protection during transportation. Thus, a matching of air freight category to the Harmonized System code is presented in the third column of Table 4. The matching will be further discussed in section 3.3.

DOI:10.6814/NCCU202100196

Figure 2 shows the aggregated air freight volume over time. The vertical axis shows the log-trade volume in kilogram through both airports. The horizontal axis is the corresponding month of year. The reference line indicates the starting month of the tariffs lists implementation (L1) in July, 2018. After the imposition, the trend of the air freight volume has increased, showing a potentially upward growth of the trade volume. The outliers in every year are resulted from the spring break of Chinese New Year.

3.2 Dummy Variables of the U.S. Tariff Lists

To capture the effect of the implementation of tariffs lists, the monthly policy dummy variables for each air freight category are created. Each category has a dummy representing whether this category is included in a specific tariffs list, for instance, transportations had turned into 1 for L1 dummy after July, 2018, the month of implementing the first tariff list, showing a starting point of a 25% of tariff on some of the headings included in article 86, 87, 88 and 89. Therefore, there are totally 5 dummy variables for each air freight category representing the implementation of List 1, List 2, List 3 with 10% tariffs rates, L3 with 25% tariffs rates, and part A of List 4, represented by L1, L2, L3_10, L3_25, and L4A, respectively.

3.3 Weighted Average Unit Price and Trade Value

The monthly average import and export unit prices (USD/kg) are collected from trade statistic data base in Taiwan's Bureau of Foreign Trade. This study uses the monthly average imports and exports prices reported at the customs as the proxy for the average prices for air freight prices.

DOI:10.6814/NCCU202100196

The prices are matched with the HS code[5] to link the air freight category to the tariffs lists announced in the HS code. Table 4 shows comprehensive matching between air freight categories and HS along with the code for air freight categories. For instance, the category of transportation in air freight could be matched to the chapter 86 to 89 (2-digits) in HS and toys are linked to the heading of 9501 to 9503 (4-digits). However, some of the categories, such as private baggage, diplomatic mail, and airliner cargo, and so on, cannot be matched with any HS chapter or heading because of the special characteristics of the air freight. These categories are also excluded from any tariffs list.

The prices are weighted by its proportion of volume in the category. For instance, the weighted average unit import price of transportation, including HS chapter 86 to 89, is calculated from aggregating the average unit import price for HS chapter 86, 87 and 89, then weighted by its own import volume. The same logic is applied to the goods categorized with 4-digits HS code. Moreover, the weighted average unit prices are adjusted by the quarterly Gross Domestic Production deflator to reflect the real price for the month. The GDP deflator is collected from Directorate-General of Budgets Accounting and Statistics (DGBAS) of Taiwan and converted into monthly frequency by Quadratic-Match Sum method[6]. The adjusted unit prices are then used to construct the trade value by price times quantity in order to capture the scale of the air freight trade. The value of air freight is also expected to have a positive effect as a result of the U.S.-China trade war.

The data omits the average unit price of total import and export for the air freight because the calculated average unit prices are different between 2-digits and 4-digits

[5] HS code is the Harmonized Commodity Description and Coding System developed and maintained by World Customs Organization (WCO) to standardize the traded products internationally with 2 to 6 digits code.

[6] Quadratic-Match Sum method, according to EViews, performs the same proprietary local quadratic interpolation, but the low frequency data is divided by the number of observations first.

DOI:10.6814/NCCU202100196

classification. In addition, with the absence of average unit prices for the sum of imports and exports, their derived data of sum trade value is also missing.

3.4 Control Variables

The exchange rate is an essential factor in international trade since it potentially has a negative correlation on a country's net export. This study uses the monthly real effective exchange rate (REER) of Taiwan collected from the open data in the Bank of International Settlement (BIS)[7] to control the effect from fluctuating exchange rate. The nominal effective exchange rate is the exchange rates weighted by other countries' nominal exchange rate. Thus, the REER is the nominal effective exchange rate deflated by the price or production cost index to eliminate the fluctuation of the international prices. In other words, according to the International Monetary Fund (IMF), is the real effective exchange rate (a measure of the value of a currency, in this case is New Taiwan dollar (NTD), against a weighted average of several foreign currencies) divided by a price deflator or index of costs. Therefore, at the base year, in this case is 2010, the REER is 100. When the REER is greater than 100, it implies a depreciation of NTD which is a decrease for the competitiveness in trade. While it is smaller than 100, the implication is totally the opposite. Thus, REER is expected to have a positive effect on imports side (trade deflection), while exports are in contrast.

The quarterly real GDP data for Taiwan and the United States are obtained to control for the country's economic scale over time. The quarterly real GDP data for the U.S. is from the U.S. Bureau of Economic Analysis (BEA), and the quarterly real GDP for Taiwan is from DGBAS. All the quarterly data must be converted into monthly

[7] BIS provides two kinds of measurement of REER, broad or narrow. The broad REER includes more trading countries for weighted average than the narrow one. Thus, it is collected as a control variable for this study.

DOI:10.6814/NCCU202100196

frequency via Quadratic-Match Sum in order to match with the frequency of the air freight data. The real GDP should have a positive relation to the country's imports and exports since it represents the production power and people's consumption power economically for the market.

4. Empirical Models

There are six models used in this study and they are classified into models (1) through (6). Model (1) is the classical Ordinary Least Square (OLS) model with some control variables. Models (2) is the fixed effect model that considers the product category fixed effect (38 categories) and time fixed effect (116 months).[8] Models (3) to model (6) are all extended models based on the fixed effect model (2), which consider the specific effects of five main categories (model (3)), the dynamic panel setting by adding the 1-month lagged dependent variable (model (4)), the lead 1-month independent dummy variables for the policy variables from L1 through L4A (model (5)), and the category specific time trend (model (6)), respectively.

In each model, four approaches from (a) through (d) are considered for different dependent variables. In approach (a), (b), and (c), I use the air freight trade volume of TPE, KHH, and the sum of TPE and KHH as the dependent variables, respectively. In approach (d), I use the constructed air freight trade value instead. All models with various approaches are then studied by the imports from China (denoted with I) to capture the trade deflection effect, and exports to the U.S. (denoted with E) to capture the trade creation effect. Hence in what follows, the equation numbering has three digits: the model code, the approach code, and the import/export code. For instance, model

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[8] The Hausman test shows that the fixed effect model is more appropriate for the panel data of this study than the random effect model.

DOI:10.6814/NCCU202100196

(1.a.E) stands for the OLS model considering the approach of air freight trade volume in terms of exports, and model (2.b.I) for the fixed effect model considering the approach of air freight trade value in terms of imports.

4.1 The OLS Model

As mentioned above, the OLS model considers two approaches for the imports from China (trade deflection) and the exports to the U.S. (trade creation), respectively. Hence model (1.a.I) and (1.a.E) both share the same form as follows:

(1.a.I) $$lnQA_{jt} = \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 REER_t + \beta_7 lnTWGDP_t + \varepsilon_{jt},$$

(1.a.E) $$lnQA_{jt} = \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 REER_t + \beta_7 lnUSGDP_t + \varepsilon_{jt},$$

where QA_{it} denotes the trade volume (or quantity) through the channel of both airports for air freight category j in month t (notice that "A" represents Aggregation) for the imports from China in (1.a.I) and the exports to the U.S. in (1.a.E), respectively. The independent variables $L1_{it}$, $L2_{it}$, $L3\_10_{it}$, $L3\_25_{it}$ and $L4A_{it}$ all denote the policy dummy variables for the five times of tariff rate increase in four waves. For each of them, the dummy variable equals 1 when the Trump administration implemented extra tariff rates against China for category j in month t, and equals 0 otherwise. For the control variables: $REER_t$ is the real effective exchange rate of Taiwan NTD against the USD in month t; $USGDP_t$ and $TWGDP_t$ are the monthly real GDP at time t for the U.S. and Taiwan, respectively, according to the gravity model. And, ε_{jt} is the error term.

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The OLS models for the approach of air freight trade value through both airports for air freight category j in month t for and the imports from China (trade deflection) the exports to the U.S. (trade creation), i.e., models (1.b.I) and (1.b.E), are as follows:

(1.b.I) $$lnV_{jt} = \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 REER_t + \beta_7 lnTWGDP_t + \varepsilon_{jt},$$

(1.b.E) $$lnV_{jt} = \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 REER_t + \beta_7 lnUSGDP_t + \varepsilon_{jt},$$

where V_{it} denotes the trade value through both airports for air freight category j in month t (notice that "V" represents trade value) for the imports from China (trade deflection) in (1.b.I) and exports to the U.S. (trade creation) in (1.b.E), respectively. Notice that the trade value here is calculated by multiplying the trade volume and the average unit price for category j in month t.

4.2 The Econometric Issues

In this subsection, several tests will be conducted to test the correlation, collinearity, stationary, autocorrelation and heteroskedasticity of the data.

Firstly, the correlation test on the variables shows a significantly high correlation coefficient of 0.7253 between the first list (L1) and the second list (L2). High correlation issues may result from the following problems: 1) close implementation time that there is only a month of separation. 2) almost the same combination of goods is targeted, mainly electronics, machines, and transportation. 3) the same rate of tax (25%) is imposed. 4) missing data corresponding to the time of tariffs imposition. Thus, the main independent variable of L2, will be dropped because of the smaller scale. On the other hand, the real effective exchange rate ($REER_t$) and real GDP of Taiwan and

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the U.S. ($TWGDP_t$& $USGDP_t$) are significantly correlated with correlation coefficients of 0.7712 and 0.7153 respectively. Although the result shows a high relation (close to 0.75) for these variables, in order to control the constant value and the size of the market, these three variables will still be considered. Consequently, the dummy variable of L2 will be dropped but the REER and real GDP will be included in the models.

Secondly, the study also checks for the collinearity issue for the models since it will make the estimation of coefficients and standard error to become unstable and volatile. However, the issue of collinearity is not found in the models.

Thirdly, for the reliability of the estimation, this study tests the stationary issue to check the existence of the trend in the dataset. I conduct the Fisher-type unit-root test. Because some values of the data in a certain period are missing, the multiple panels data could not meet the requirement of the augmented Dickey-Fuller unit-root test (ADF test) and Harris-Tzavalis unit-root test (HT test), where strongly balanced panel data are needed. Data with non-stationary implies that the direct estimator may cause spurious regression problems. This study then finds no existence of the non-stationary issues through the models. Therefore, the solution of using the first difference is not required.

Then, Table 5 shows the result of the Wooldridge test for autoregressive correlation. Under the confidence level of 5%, the results reject the null hypothesis that there is no first order autocorrelation for the approaches of aggregated exports volume (a.E) (F = 4.813), and the export value (b.E) (F = 4.63). These two approaches have significant correlation coefficient between the dependent variables and its first-order lag variables. As a result, if the data is not detrended, the autoregressive correlation may tend to be overestimated with the obvious upward and downward trend. Therefore, for all approaches, this study uses clustered standard errors in the fixed effect models to deal with the autoregressive correlation problem.

DOI:10.6814/NCCU202100196

Lastly, this study uses Cook-Weisberg test to test the heteroskedasticity issue If the model is heteroskedastic, the variance of its errors is correlated to the independent variables. With the 5% of confidence level, the result shows the heteroskedasticity exists in four import (trade deflection) approaches from (a.I) and (b.I) and the export (trade creation) approach of the air freight export value (a.E). In order to deal with both autoregressive correlation and heteroskedasticity issues, this study applies the clustering methods in the fixed effect models to include the clustered standard errors. Noted that the inclusion of the clustered standard errors will magnify the standard errors of the estimations.

4.3 The Fixed Effect Model

As mentioned above, this study includes the product category and time fixed effects. The following equations show the baseline fixed effect models for the imports from China (trade deflection) and the exports to the U.S. In this section every model is taken into consideration in approaches (a) and (b) for both imports (trade deflection) and exports (trade creation). Taking approach (a) of the trade volume through both airports as examples, the fixed effect models (2.a.I) and (2.a.E) are given as follow:

(2.a.I) $lnQA_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \varepsilon_{jt},$

(2.a.E) $lnQA_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \varepsilon_{jt},$

where α_j denotes category fixed effect to control the nature of the 38 categories and λ_t denotes time fixed effect for every month. In this model, the category and time fixed effect will both be controlled. Since the category fixed effect and time fixed effect

DOI:10.6814/NCCU202100196

already absorb macroeconomic variation over time, the fixed effect model requires fewer control variables than in the OLS mode, hence, the real effective exchange rate (REER) of Taiwan and the country's GDP are dropped. In addition, because of the heteroskedasticity- and autocorrelation-consistent (HAC) standard errors, the clustered standard errors are included. The fixed effect model is also applied for every approach. Hence the models (2.b.I) and (2.a.E) through (2.b.E) are also considered.

For the extended fixed effect models, model (3) through (6) are based on the fixed effect model (2). Model (3) considers the specific effects on the top five main categories. Taking approach (b) of the trade value through both airports as an example, the fixed effect models with specific effects (3.b.I) and (3.b.E) are as follow:

(3.b.I) $$lnV_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 L1_{jt} \times top + \beta_7 L2_{jt} \times top + \beta_8 L3\_10_{jt} \times top + \beta_9 L3\_25_{jt} \times top + \beta_{10} L4A_{jt} \times top + \varepsilon_{jt},$$

(3.b.E) $$lnV_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 L1_{jt} \times top + \beta_7 L2_{jt} \times top + \beta_8 L3\_10_{jt} \times top + \beta_9 L3\_25_{jt} \times top + \beta_{10} L4A_{jt} \times top + \varepsilon_{jt},$$

where $L1_{jt} \times top$ through $L4A_{jt} \times top$ denote the interaction terms for the specific effects of each policy dummy variable. This study creates a main category dummy, denoted by top, for metal products, machines, electronics, transportations, and precision instruments. It determines five majorly affected categories as 1 while the others are 0. Therefore, the coefficient of the interaction terms, β_6 to β_{10}, capture the effect of tariffs barrier on the group of five main categories. On the other hand, the coefficient of tariffs policies from β_1 through β_5 represent the effects for the group of the other products.

DOI:10.6814/NCCU202100196

The fixed effect models with dynamic panel setting (model (4)) considered the first order dynamic of the dependent variable. Taking approach (a) of the aggregated trade volume as an example, the fixed effect models with dynamic effect (4.a.I) and (4.a.E) are shown below:

(4.a.I) $lnQA_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 lnQT_{jt-1} + \varepsilon_{jt},$

(4.a.E) $lnQA_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 lnQT_{jt-1} + \varepsilon_{jt},$

where QA_{jt-1} denotes the trade volume through the channel of both airports for air freight category j in the previous month $t-1$. The dynamic effect addresses how the dependent variable in the previous time period affects itself in the current time period. Noted that the dynamic term is replaced in different approaches, for instance, in approach (d), it will be V_{jt-1}. Since the result of the second lagged possess many insignificant estimations, the first lagged the dependent variables will be included.

The fixed effect model of lead and lagged effects is considered. Taking approach (b) of the trade value for both imports and exports as an example, the fixed effect models with lead and lagged effects are as follow:

(5.b.I) $lnV_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 L1_{jt-1} + \beta_7 L2_{jt-1} + \beta_8 L3\_10_{jt-1} + \beta_9 L3\_25_{jt-1} + \beta_{10} L4A_{jt-1} + \varepsilon_{jt},$

DOI:10.6814/NCCU202100196

$$(5.b.E)\quad lnV_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 L1_{jt-1} + \beta_7 L2_{jt-1} + \beta_8 L3\_10_{jt-1} + \beta_9 L3\_25_{jt-1} + \beta_{10} L4A_{jt-1} + \varepsilon_{jt},$$

where $L1_{jt-1}$ through $L4A_{jt-1}$ denote five leading policy dummies of category j for the policy dummies in the previous month $t-1$, respectively. Since the possibility of advanced responses may exist, the effect before the implementation of tariff lists should be considered. As the first list (L1) started from July, 2018, the leading policy dummies turn into 1 one month before the implementation of the tariffs lists, i.e., $L1_{jt-1}$ turns into 1 in June, 2018. The coefficients from β_6 to β_{10} show the magnitude of anticipation effect.

Lastly, taking approach (a) of the fixed effect model of the trade volume through TPE as an example, the fixed effect models with control on category specific time trend (6.a.I) and (6.a.E) are shown as follow:

$$(6.a.I)\quad lnQA_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 \theta_j \times t + \varepsilon_{jt},$$

$$(6.a.E)\quad lnQA_{jt} = \alpha_j + \lambda_t + \beta_0 + \beta_1 L1_{jt} + \beta_2 L2_{jt} + \beta_3 L3\_10_{jt} + \beta_4 L3\_25_{jt} + \beta_5 L4A_{jt} + \beta_6 \theta_j \times t + \varepsilon_{jt},$$

where $\theta_j \times t$, denotes the interaction terms between air freight category specific effect θ_j and month t. In the concept of the difference-in-differences, the time trend of the nature of a product category may affect how its volume and value varies along the time before the difference happened, in this case it is the implementation of tariffs lists. The different time trend in each air freight category will affect how each category responds

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when the tariffs list took effect. The significant coefficient indicates the difference of original slope for the category before the policy implementation.

5. The Results

5.1 The Estimation Result of the OLS Model

This subsection reports the results for the OLS model with controls (models (1.a.I) and (1.b.I) for the trade deflection effect, and models (1.a.E) and (1.b.E) for the trade creation effect). Note that these are the results without considering the issues of endogeneity and heteroskedasticity, so it is very likely that they are biased and over-estimated. To deal with the values of zero in the data, I replace those values with 1, hence, after the natural logarithm, the value will be zero instead of missing. However, due to the missing data a drop in the number of observations for both import (trade deflection) and export (trade creation) side are inevitable. In short, I find that the first list (L1) and L3_10 of policy implementation increases both air freight volume and value for both imports from China (trade deflection). On the other hand, the implementation of L1 increases the export volume and value to the U.S. (trade creation). These results are shown in Table 6.

For the imports from China (trade deflection), Table 6 shows that for import volume, the L1 implementation has a statistically significant effect in stimulating the growth of 1388% for the import volume through both airports. [9] The L3 implementation with 25% of tariffs rates (L3_25) also induces the growth for import

[9] To interpret the coefficients of the five policy dummy variables when their dependent variables are in natural logarithm, I use the formula: $\left(exp\left(\hat{c} - \frac{1}{2}\hat{V}(\hat{c})\right) - 1\right) \times 100\%$. This formula is used by Kennedy (1981) and Giles (2011) to transform estimated coefficients into the growth rates of the corresponding dependent variables.

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volume to both airports with 120.7%. For import value, I find that the first tariff lists (L1) have an effect of increase with 4865% on the import value through both airports.

For the exports to the U.S. (trade creation), Table 6 shows that for trade volume, the implementation of L1 statistically and significantly stimulates increase the export volume from both airports with 2064%. For the export value, it rises by 813% when L1 is implemented.

These results, in the first impression, look doubtfully large and might be caused by overly estimated, which may attribute to the related econometric issues of endogeneity, heteroskedasticity, autoregressive correlation, and so on. This leads us to look at the results of the fixed effect models in the following subsection.

5.2 The Estimation Results of the Fixed Effect Model

This subsection shows the result of the baseline fixed effect model with the control on the product category fixed effect and time fixed effect (model (2.a.I) and (2.b.I) for trade deflection and model (2.a.E) and (2.b.E) for trade creation). Note that, in the second column of each approach in Table 6, because of increasing amounts of control variables, the results for the fixed effect models lose a big amount of statistically significant estimations. In sum, I find estimations are statistically insignificant.

For the imports from China (trade deflection), in the second column in each approach of Table 6, all results are insignificant.

For the exports to the U.S. (trade creation), with further control of the fixed effect, all results are statistically insignificant.

These results, with the additional control on category fixed effect and time fixed effect, show a large drop for the number of significant estimations. For the robustness check, this study then uses four extended fixed effects models from model (3) through

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(6) for the imports (trade deflection) and the exports (trade creation) in the following two subsections, respectively.

5.3 The Estimation Results of the Fixed Effect Model for Trade Deflection

This subsection presents the result of extended fixed effect models (models (3) through (6)) in each approach (approach (a) and (b)) for the imports (trade deflection). Table 7 presents the results of the two extended fixed effect models for each approach. In sum, the implementation of L1 increases the import volume through both airports as well as the import value. With L4A implementation, the import value for the five main categories increases in terms of model (3). However, generally, the implementation of L3_10, L3_25 and L4A decreases the import volume and value in terms of model (5) and (6). In addition, the lead of the L1 implementation significantly decreases both import volume and value in both approaches. In the following paragraphs, I will explain through the results in detail for each approach ((a) and (b)), respectively.

For aggregated import volume of both airports (approach (c)) for trade deflection, the results in Table 7 show that the implementation of L1 increases the import volume through both airports by 129.7% (with model (5)). However, with the implementation of L3_25 and L4A, the volume decreases significantly by 98.7% and 67.6%, respectively (with model (5) and (6)). As for specific effects on the top five main categories, the results are statistically insignificant. Similarly, the 1-month lagged dependent variable has a positive effect on the import volume. The leading policy dummy variable of L1 has a fall of 60.9% one month before the implementation. For the category specific time trend, significant results basically have the same direction, but the change on the significance in terms of L4A is observed.

DOI:10.6814/NCCU202100196

With respect to the import value through both airports (approach (d)) for trade deflection, a statistically significant increase of 154.7% (with model (5)) is found with the implementation of L1. In contrast, when the L3_25 is implemented, the import value decreases by 100%. In addition, the implementation of L4A significantly decreases the import value by 55.4% to 65.4% (with model (6) and (5)). For the specific effects, the implementation of L4A statistically and significantly increases the import value for the five main categories by 76.5%. The dynamic setting variable also has a positive effect on the import value. As for leading effect, the leading variable of L1 implementation has a significant fall by 66.1% for the import value. The results of specific time trends are similar to what I had in approach (c) that has a change on the significance of L4A.

In summary, when L1 is implemented, the import volume through both airports (approach (a)) and import value (approach (b)) increase with model (5)-Also, with model (5), with the implementation of L3_25, both approaches ((a) and (b)) fall. And, with L4A implementation, the volume through both airports (approach (a)) and import value (approach (b)) decrease significantly. The five main categories increase in terms of import value with the implementation of L4A. All of the 1-month lagged dependent variables have positive effects on the dependent variables. The leading policy dummy of L1 shows a statistically significant fall for both approaches. For the category specific time trend, the difference between the time trend of each top five category is subtle, but it changes the results of the L4A.

5.4 The Estimation Results of the Fixed Effect Model for Trade Creation

In this subsection, I will present the results of the extended fixed effect models (models (3) through (6)) for each approach (approach (a) and (b)) in terms of the exports (trade creation). Table 8 shows the results of the two extended fixed effect models for

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each approach. In brief, the implementation of L3_10 increases the export volume through both airports (approach (a)) and export value (approach (b)). And, with the implementation of L4A, these two approaches also increase. The specific effects for the five main categories are statistically insignificant. The export volume through both airports (approach (a)) increases significantly with the leading of L3_10 implementations.

In terms of the aggregated export volume from both airports (approach (a)) for trade creation, the implementation of L3_10 and L4A statistically and significantly increase the export volume through both airports (with model (6)). However, the specific effect of the five main categories shows insignificant results. The 1-month lagged dependent variable also has a significant positive effect on the aggregated exports volume. The leading of the implementation of L3_10 significantly increases the export volume through both airports by 105.8%. The control of the category specific time trend changes the significance of the policy dummies of L3_10 and L4A.

As for the export value from both airports (approach (b)) for trade creation, the implementation of L3_10 statistically and significantly stimulates the growth of 60.1% (with model (6)). Also, when L4A takes effect, the export value increases significantly by 1220% (with model (6)). For approach (b), the results of the specific effect of the top five main categories are all insignificant. The 1-month lagged dependent variable also has a significant positive effect on the exports value from both airports. The leading effect of the policy variables are all statistically insignificant. Similar to results in approach (b), the control of the category specific time trend also changes the significance of L3_10 and L4A.

In summary, when L3_10 is implemented, the export volume through both airports and the export value (approach (a) and (b)) increase. The implementation of L4A significantly increases the export volume through both airports and the export value

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(approach (a) and (d)). Regarding the specific effects of the five main categories, all results are statistically insignificant. Similar with the results for trade deflection, all of the 1-month lagged dependent variables have positive effects on the dependent variables for all approaches. As for the leading effect, the implementation of L3_10 significantly increases the export value (approach (b)). With respect to the category specific time trend, the control changes the significance and, in some results, the direction of estimations, hence, each category may have its own time trend effect.

5.5 Discussion of the Trade Deflection and Creation Effects

From the results of the fixed effect models for trade deflection and trade creation, I find that they are, to some extent, different from the expectation of this study. From the import side (trade deflection), lots of the results are statistically insignificant. The implementation of L1 significantly increases the import volume through both airports (5.a.I) and the export value (5.b.I). In addition, for the specific effect for the five main categories, the implementation of L4A increases the import value (3.a.I). However, many estimation results show negative effects, for instance, the implementation of L3_10 and L4A decrease the import volume through both airports and the import value with model (5) and (6), respectively. In addition, the lead of L1 implementation also decreases the imports in terms of both approaches. In sum, from the results, the U.S.-China trade war have the trade deflection effect in terms of the first tariffs list (L1) implementation, but the results of the following tariffs list implementation need further discussion due to insignificant or negative estimations.

For the exports (trade creation), the implementation of L3_10 increases the export value ((6.b.E)). With L4A implemented, the export volume through both airports and the export value ((6.a.E), (6.b.E)) also statistically and significantly increases, respectively. The lead of L3_10 implementation also increases the export volume

DOI:10.6814/NCCU202100196

through both airports. In brief, the implication of the results is that the U.S.-China trade war results in the effect of trade creation, in terms of the export volume through both airports and the export value, with L3_10 and L4A in practice. Besides, the control for the category specific time trend makes some of the estimations more significant, especially for the export side. Thus, consideration of the time trend effect is essential for further research. However, these insignificant estimations also lead to the discussion for reasonable explanations.

There are three possible reasons for the difference between expected and actual empirical results. First, because of the anticipation effect in the export side, the air freight increases as a precautionary of stocking to avoid additional tariffs, especially for L3_10 which has a comparably larger affected import value from China. Secondly, the existing trade barriers in Taiwan, such as tariffs, transportation cost, and, the rules of origin, make a detour of trade flow infeasible and costly for the dealers, so the U.S.-China trade war only result in the trade deflection effect for the first tariffs list (L1) implementation. Therefore, the trade flow might deflect through other countries to avoid the additional taxation. In addition, the determinant of identifying whether a product is from China is mainly beheld in the U.S. government so that a detour could be a pricey way without returns. Nonetheless, the trade war creates a chance for Taiwan to become an alternative source of products, hence, the trade creation happened when the first tariffs list (L1) as well as the third tariffs list with additional 10% tariffs rates (L3_10) was implemented. Thirdly, the potentially omitted variables of the effect from the reactions of other countries and changes in policies, such as the counter action from China, could also take place in the everchanging international trade relationship. Without further consideration of these factors, the empirical results could be biased.

DOI:10.6814/NCCU202100196

6. Conclusion

This study aims to investigate whether the trade deflection and creation effects exist in Taiwanese air freight under the U.S.-China trade war. In order to examine the effects, the air freight volume is included. The import and export volume are classified into 38 air freight categories over the period of April, 2010 to November, 2019 through three channels, i.e., Taoyuan International airport (TPE), Kaohsiung airport (KHH) and both airports (the aggregation of TPE and KHH). With the weighted average unit prices, the trade value is also calculated as the dependent variable. Under the U.S.-China trade war, several tariffs lists were implemented by Trump's administration, including list 1 (L1) in July, L2 in Aug, L3 with 10% tariffs in Sep during 2018, L3 modified to 25% in May and L4A in Sep during 2019. The tariffs rates ranging from 15% to 25% affect, according to the office of the U.S. Trade Representative, estimated total trade value of $550 billion from China to the U.S. Because of high correlation between the L1 and L2, the latter is dropped for an unbiased estimation. This study also controls the REER of NTD for the value of the currency and the real GDP of Taiwan and the U.S. for the scales of the economies. As for methodology, I use the OLS model (model (1)) and the fixed effect models (model (2)) as well as several extensions, including the specific effect of the five main category (model (3)), the 1-month lagged dependent variable as dynamic setting variable (model (4)), the leading variables of the policy dummies (model (5)), and the category specific time trend effect (model (6)).

I find that the actual empirical results in this study are somewhat different from expected. For the imports (trade deflection), the implementation of the first tariffs list (L1) has a significant increase on the import volume through both airports by 129.7% and the import value by 154.7%. For the specific effect of the five main categories, the part A of the fourth tariffs list (L4A) increases the import value by 76.5% for the five

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main categories. But most of the results are insignificant. Furthermore, the implementations of L3_25 and L4A result in decrease of the import volume through both airports by 98.7% and 67.6%, as well as the import value by 100% and 55.4% to 65.4%, respectively. Besides, the leading policy dummy shows a significant decrease on both approaches for the import side when the first tariffs list (L1) is in practice.

For the exports (trade creation), with the implementation of the third tariffs list with 10% additional tariffs rates (L3_10), the export value significantly increases by 60.1%. And, when L4A takes effect, the export volume through both airports and the export value significantly increase by 61.7% and 122%, respectively. As for the specific effect of the five main categories, I find all results are insignificant. The leading policy variable of L3_10 significantly stimulates the export volume through both airports. Throughout these results, all dynamic panel settings with the 1-month lagged dependent variables have positive effects on the dependent variables. From the results above, I conclude that the U.S.-China trade war results in a statistically significant trade deflection effect of the imports from China to Taiwan with the implementation of the first tariffs list (L1). In addition, the trade creation effect is observed especially with the implementation of L3_10 and L4A, resulting in a statistically significant increase on the export volume through both airports and the export value from Taiwan to the U.S. The lead of the L3_10 implementation also induces a significant growth for the export volume through both airports. However, the results above could not explain those insignificant or even negative estimations, hence, the limitations of this study need to be discussed in the following paragraph.

The potential limitations of this study are as follows. First, inevitably, because of limitations on the data, this study is not able to separate the trade flow belonging to the trade deflection and creation effects from general trading volume. What the data presents is a mixed trade flow for all kinds of usages and goals, namely, in either trade

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deflection or creation, the trade flow of trade deflection is blended with the trade flow that regards Taiwan as a destination or a transshipment place. Therefore, without the "clear and pure" data, the change of the dependent variable may not truly reflect the effect of trade deflection and creation. The difficulty in pure data accessibility is, hence, one of the limitations for further research on international trade barriers. Secondly, the matching between the air freight category and HS code may not accurately identify the exact commodity targeted in the lists. In the tariffs lists, not all the commodities with 4-digits HS code are targeted. However, due to the limitation on classification of the air freight category, the category could only be corresponded on the level of 2-digits HS code. Hence the whole group of the category is considered as the target of the tariffs lists. Consequently, the results might possibly be biased. Lastly, as mentioned by Steinbock (2019), to expand the power of the country, more and more unilateral policies may be implemented globally. Hence, China, Taiwan or the third country may take various counter actions or responses into practice. The failure to consider the reactions of the third country or China, especially for retaliation trade policies, is a possible explanation for the inconsistent results. With the consideration of the trade barriers and responses from other trading partners, further research on the formal relationship between the effects of trade deflection and creation and the counter action to the implementation of tariffs could be a possible field to study.

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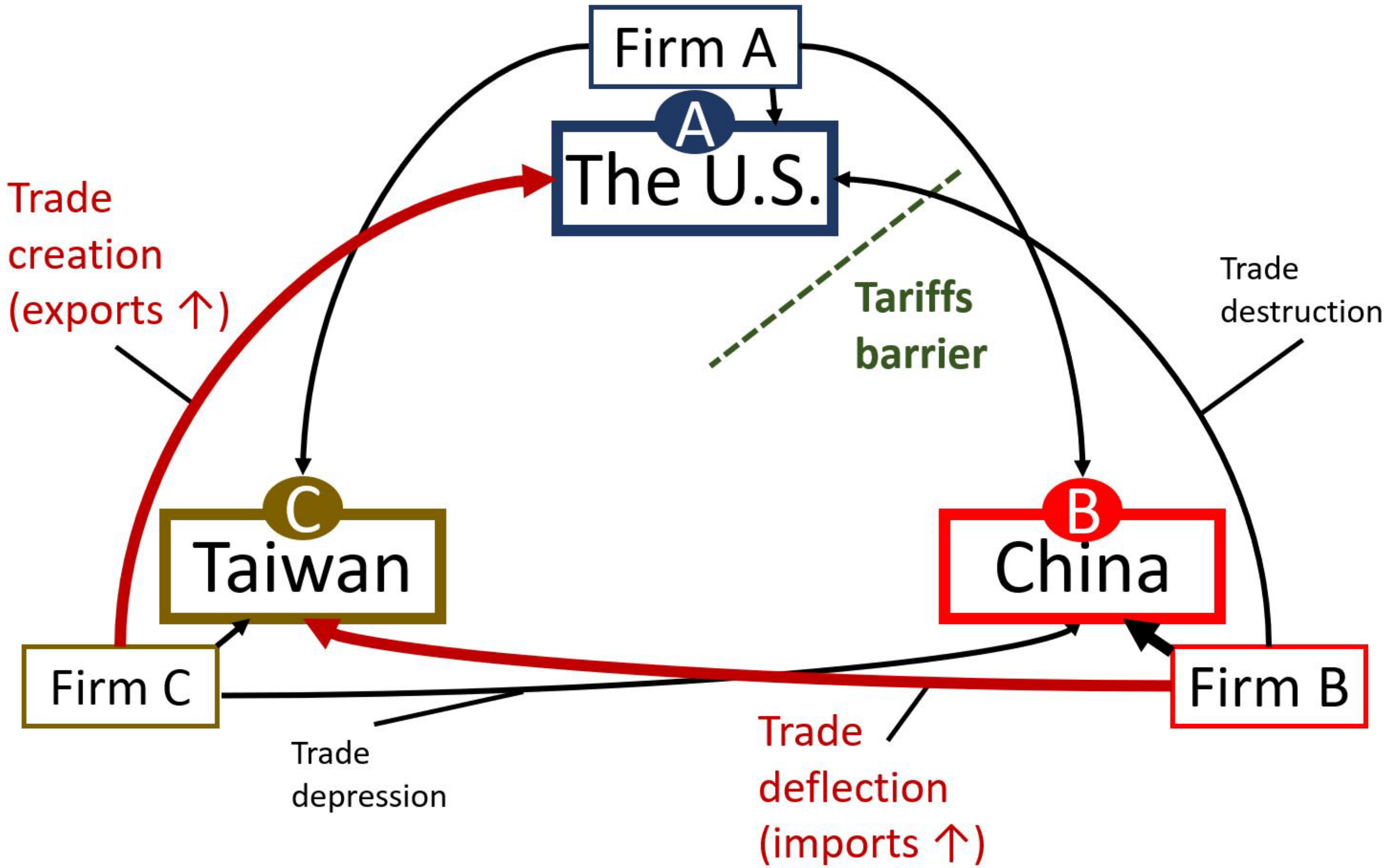

Figure 1. Dynamic Changes in the Size of Trade Flows Following an Establishment of an Antidumping Duty(illustrated by the author according to Bown and Crowley (2007))

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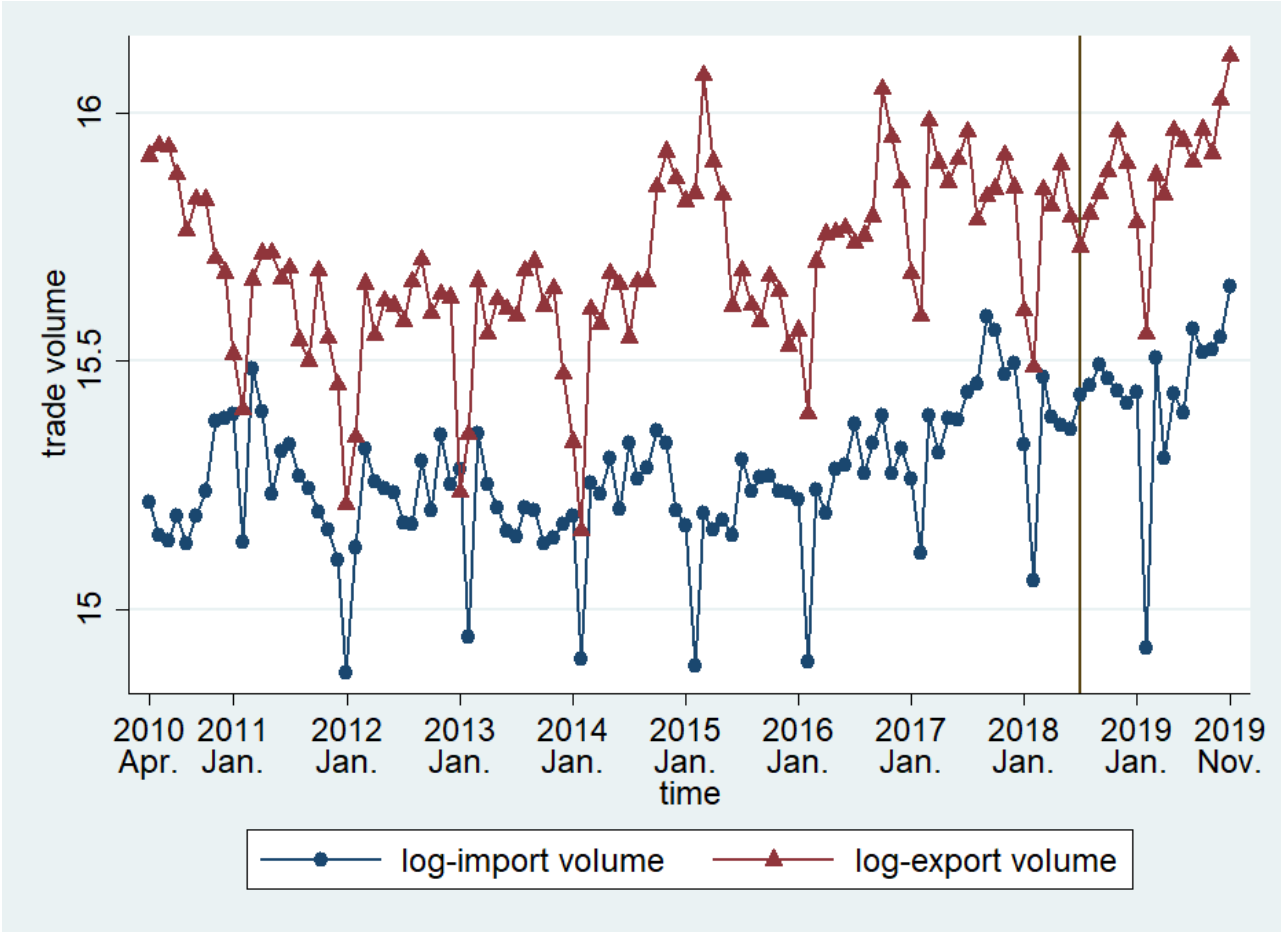

Figure 2. The Trend of Aggregated Air Freight Volume over Time

Note: Y-axis is logged air freight volume (kg) through both airports. And X-axis is month, i.e., 2010 Apr. is April, 2010.

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Table 1. The Implementation of Tariffs Lists (organized from the Office of the United States Trade Representative)

	Value of U.S. Imports	Date of Notice of Action Released	Date of Implementation	Rate of Tariffs
List 1	$34 bn	June 6, 18	July 6,18	25%
List 2	$16 bn	August 16, 2018	August 23, 2018	25%
List 3	$200 bn	September 21, 2018 May 9, 2019	September 24, 2018 May 10, 2019	10% Modified to 25%
List 4	$300 bn	August 20, 2019	September 1, 2019	15%

DOI:10.6814/NCCU202100196

Table 2. The List of Variables

Variables	Notations	Expected signs	Description
Trade volume	QT_{jt} QK_{jt} QA_{jt}		Dependent variable. Imports or exports volume of China or the U.S. for air freight category j in month t including TPE (T), KHH (K) and their aggregation (A). (Unit: kg)
Trade value	V_{jt}		Dependent variable. Value of trade of air freight category j in month t. (Unit: US$)
List 1*	$L1_{jt}$	+	Dummy variable. It shows whether the air freight category j is subjected to the tariffs list 1 in month t.
List 2*	$L2_{jt}$	+	Dummy variable. It shows whether the air freight category j is subjected to the tariffs list 2 in month t.
List 3_10*	$L3\_10_{jt}$	+	Dummy variable. It shows whether the air freight category j is subjected to the tariffs list 3 with 10% tariff rates in month t.
List 3_25*	$L3\_25_{jt}$	+	Dummy variable. It shows whether the air freight category j is subjected to the tariffs list 3 with 25% tariff rates in month t.
List 4A*	$L4A_{jt}$	+	Dummy variable. It shows whether the air freight category j is subjected to the part A of tariffs list 4 in month t.
Real effective exchange rate	$REER_t$	+(Imports) -(Exports)	Real effective exchange rate of Taiwan in month t.
GDP	$TWGDP_{it}$ $USGDP_{it}$	+	Country i (Taiwan or the U.S.)'s gross domestic product in month t. (Unit: US$1 billion)

**Notes*: The expected signs of the main independent dummy variables ($L1_{jt}$, $L2_{jt}$, $L3\_10_{jt}$, $L3\_25_{jt}$ and $L4A_{jt}$) for average unit price may be ambiguous since the effect of implementation of tariffs list on the price is unclear.

DOI:10.6814/NCCU202100196

Table 3. Descriptive Statistics

Variables	Notations	Mean		Median		Standard Deviation		Observations	
		Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Trade volume	QT_{jt}	219081.3	349090.9	8959.5	0	778374.1	1352304	4408	4408
	QK_{jt}	11195.1	8478.5	0	0	42938.6	34220.76	4408	4408
	QA_{jt}	230276.4	357569.4	9552	1	818831.4	1384078	4408	4408
Trade value	V_{jt}	1740889	7886238	36052.2	.9141421	6314744	7886238	3709	3520
List 1	$L1_{jt}$	.0269964		0		.1620911		4408	
List 2	$L2_{jt}$	.0326679		0		.177786		4408	
List 3_10	$L3\_10_{jt}$	.0490018		0		.2158963		4408	
List 3_25	$L3\_25_{jt}$	.0428766		0		.2026018		4408	
List 4A	$L4A_{jt}$	.0197368		0		.1391103		4408	
Real effective exchange rate	$REER_t$	102.2103		101.3		2.921844		4408	
GDP	$TWGDP_{it}$	44.80823		44.40108		4.325221		4408	
	$USGDP_{it}$	6000.513		5984.151		660.4428		4408	

DOI:10.6814/NCCU202100196

Table 4. Air Freight Categories Matching

Code	Air Freight Category	HS code	Relevant Tariffs Lists			
1	Total	All	N/A			
2	Agricultural Products	06、07、08、09、10、11、12、13、14、15			L3	L4
3	Forest Products	44、45			L3	L4
4	Poultry& Livestock	01、02、04、0501、0502、0503、0504、0505、0506、0509、0510、0511			L3	L4
5	Aquatic Products	03、0508			L3	
6	Hunting Products	0507				L4
7	Energy Mineral	27		L2	L3	L4
8	Ore	26			L3	L4
9	Non-Metal Ore Products	25			L3	
10	Rough Gemstone	7101、7102、7103、7104、7105、7116、7117			L3	L4
11	Processed Food	16、17、18、19、20、21、23			L3	L4
12	Beverage& Tobacco	22、24			L3	L4
13	Textiles	50、51、52、53、54、55、56、57、58、59、60、63			L3	L4
14	Textile's Accessories	61、62、64、65			L3	L4
15	Hides& Leather	41、42、43			L3	L4
16	Bamboo& Plaiting Materials	46			L3	
17	Paper& Printing Materials	47、48、49			L3	L4
18	Chemical Materials	28	L1		L3	L4
19	Chemical Products	29、30、31、32、33、34、35、36、37、38		L2	L3	L4
20	Plastic& Rubber	39、40	L1	L2	L3	L4
21	Non-Metal Mineral Products	68、69、70		L2	L3	L4

DOI:10.6814/NCCU202100196

Table 4. Air Freight Categories Matching (cont.)

Code	Air Freight Category	HS code	Relevant Tariffs Lists			
22	Base Metals	7106~15、7108、72、73、74、75、76、77、78、79、80、81		L2	L3	L4
23	Metal Products	82、83			L3	L4
24	Machines	84	L1	L2	L3	L4
25	Electronics	85	L1	L2	L3	L4
26	Transportations	86、87、88、89	L1	L2	L3	L4
27	Precision Instruments	90、91、92	L1	L2	L3	L4
28	Others	94、96、66、67			L3	L4
29	Arts& Antiques	97				L4
30	Special Goods					
31	Baggage					
32	Diplomatic Mails					
33	Jewelry& Valuables					
34	Toys	9501-9503				
35	Educational Equipment	9608-9612				L4
36	Sports Equipment	9504-9508				L4
37	Airliners Cargo					
38	Military Supplies	93				L4

DOI:10.6814/NCCU202100196

Table 5. The Results of the Wooldridge Test

Approach	(a)	(b)	(c)	(d)	(e)
Trade Deflection	3.579	9.084***	3.333*	0.119	1.405
(Exports)	(0.07)	(0.01)	(0.08)	(0.73)	(0.24)
Trade Creation	1.684	0.006	4.881**	0.035	4.630**
(Imports)	(0.21)	(0.94)	(0.04)	(0.85)	(0.04)

Note: P-values is presented in parentheses. ***, **, and * denote the statistical significance at 1, 5, and 10% levels, respectively.

DOI:10.6814/NCCU202100196

Table 6. The Results of the OLS and Baseline Fixed Effect Mode

Side	Imports				Exports			
Approach	(a)		(b)		(a)		(b)	
Model	1	2	1	2	1	2	1	2
$L1_{jt}$	2.78***	-0.14	4.03***	-0.14	3.21***	-0.09	2.41***	-0.23
	(0.40)	(0.30)	(0.50)	(0.34)	(0.52)	(0.30)	(0.63)	(0.50)
$L3\_10_{jt}$	0.37	-1.21	-0.08	-1.45	0.46	0.15	0.57	-0.07
	(0.31)	(1.15)	(0.36)	(1.48)	(0.41)	(0.32)	(0.48)	(0.47)
$L3\_25_{jt}$	0.86**	-1.59	0.25	-2.11	0.24	-0.19	0.28	-0.31
	(0.37)	(1.31)	(0.44)	(1.51)	(0.50)	(0.26)	(0.58)	(0.39)
$L4A_{jt}$	-0.71	-0.08	-0.57	-0.50	-0.30	0.20	0.09	0.38
	(0.51)	(0.66)	(0.60)	(0.65)	(0.65)	(0.32)	(0.78)	(0.45)
$REER_t$	0.05		0.04		0.01		0.01	
	(0.03)		(0.04)		(0.04)		(0.05)	
$TWGDP_t$	-1.74		-0.35					
	(1.11)		(1.31)					
$USGDP_t$					-3.05**		-3.45**	
					(1.23)		(1.45)	
Constant	10.38***	8.32***	6.34*	8.97***	29.54***	4.03***	34.04***	4.54***
	(2.86)	(0.38)	(3.37)	(0.48)	(8.39)	(0.25)	(9.93)	(0.31)
Observation	3712	3712	3593	3593	3712	3712	3404	3404
R-sq	0.021	0.057	0.023	0.058	0.014	0.054	0.007	0.060
Cat. Dummy		Yes		Yes		Yes		Yes
Month dummy		Yes		Yes		Yes		Yes

Note: Clustered standard errors are presented in parentheses. ***, **, and * denote the statistical significance at 1, 5, and 10% levels, respectively.

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Table 7. The Results of the Import Side Fixed Effect Models

Approach	(a)				(b)			
Model	3	4	5	6	3	4	5	6
$L1_{jt}$	0.08	-0.08	0.90**	-0.01	0.04	-0.08	1.05**	0.20
	(0.35)	(0.21)	(0.37)	(0.34)	(0.45)	(0.26)	(0.48)	(0.41)
$L3\_10_{jt}$	-1.21	-0.76	-1.12	-0.47	-1.44	-0.80	-1.94	-0.67
	(1.15)	(0.71)	(0.91)	(1.06)	(1.49)	(1.07)	(1.53)	(1.47)
$L3\_25_{jt}$	-1.60	-1.07	-3.33**	-0.78	-2.14	-1.60	-5.60**	-1.25
	(1.31)	(0.78)	(1.42)	(1.16)	(1.52)	(0.99)	(2.69)	(1.49)
$L4A_{jt}$	-0.11	-0.19	0.03	-1.02**	-0.58	-0.51	-0.95**	-0.78***
	(0.67)	(0.41)	(0.65)	(0.46)	(0.66)	(0.47)	(0.47)	(0.23)
L1×Top5	-0.42				-0.60			
	(0.38)				(0.48)			
L2×Top5	-0.24				0.11			
	(0.32)				(0.40)			
L3_10×Top5	0.29				0.16			
	(0.36)				(0.50)			
L3_25×Top5	0.22				0.15			
	(0.37)				(0.52)			
L4A×Top5	0.31				0.61**			
	(0.25)				(0.29)			

Note: Clustered standard errors are presented in parentheses. ***, **, and * denote the statistical significance at 1, 5, and 10% levels, respectively.

DOI:10.6814/NCCU202100196

Table 7. The Results of the Import Side Fixed Effect Models (cont.)

Approach	(a)				(b)			
Model	3	4	5	6	3	4	5	6
L1.DV		0.35***				0.28***		
		(0.07)				(0.07)		
Lead L1			-0.90***				-1.02***	
			(0.28)				(0.35)	
Lead L2			-0.21				-0.28	
			(0.37)				(0.46)	
Lead L3_10			-0.29				0.13	
			(1.62)				(2.40)	
Lead L3_25			1.54				3.26	
			(2.33)				(3.60)	
Lead L4A			0.25				0.62	
			(0.49)				(0.73)	
Cat.23×Month				-0.02***				-0.03***
				(0.00)				(0.00)
Cat.24×Month				-0.04***				-0.05***
				(0.00)				(0.00)
Cat.25×Month				-0.03***				-0.04***
				(0.00)				(0.00)
Cat.26×Month				-0.04***				-0.04***
				(0.00)				(0.00)
Cat.27×Month				-0.04***				-0.05***
				(0.00)				(0.00)
Constant	8.32***	5.49***	8.32***	24.86***	8.97***	6.36***	8.97***	28.58***
	(0.38)	(0.58)	(0.38)	(3.01)	(0.48)	(0.56)	(0.48)	(3.95)
Observation	3712	3680	3680	3712	3593	3559	3562	3593
R-sq	0.058	0.173	0.060	0.229	0.058	0.132	0.062	0.169
Cat. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Clustered standard errors are presented in parentheses. ***, **, and * denote the statistical significance at 1, 5, and 10% levels, respectively.

DOI:10.6814/NCCU202100196

Table 8. The Results of the Export Side Fixed Effect Models

Approach	(a)				(b)			
Model	3	4	5	6	3	4	5	6
$L1_{jt}$	-0.12	-0.06	0.28	0.15	-0.13	-0.18	0.65	0.34
	(0.38)	(0.26)	(0.81)	(0.43)	(0.58)	(0.43)	(1.04)	(0.59)
$L3\_10_{jt}$	0.19	0.10	-0.58	0.53**	-0.04	-0.10	-0.97	0.51*
	(0.32)	(0.27)	(0.42)	(0.22)	(0.48)	(0.40)	(0.59)	(0.28)
$L3\_25_{jt}$	-0.18	-0.15	-0.41	0.26	-0.26	-0.25	-0.68	0.42
	(0.26)	(0.22)	(0.56)	(0.23)	(0.40)	(0.35)	(0.77)	(0.32)
$L4A_{jt}$	0.21	0.18	-0.35	0.52*	0.45	0.34	-0.36	0.89**
	(0.33)	(0.27)	(0.40)	(0.28)	(0.48)	(0.38)	(0.50)	(0.43)
L1×Top5	1.16				1.64			
	(1.60)				(2.21)			
L2×Top5	-0.24				-0.48			
	(0.68)				(0.88)			
L3_10×Top5	-1.10				-1.50			
	(1.51)				(2.26)			
L3_25×Top5	-0.91				-1.48			
	(1.59)				(2.45)			
L4A×Top5	-0.05				-0.22			
	(0.23)				(0.36)			

Note: Clustered standard errors are presented in parentheses. ***, **, and * denote the statistical significance at 1, 5, and 10% levels, respectively.

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Table 8. The Results of the Export Side Fixed Effect Models (cont.)

Approach	(a)				(b)			
Model	3	4	5	6	3	4	5	6
L1.DV		0.17***				0.17***		
		(0.04)				(0.04)		
Lead L1			-0.49				-0.94	
			(0.79)				(1.07)	
Lead L2			0.14				0.10	
			(0.33)				(0.39)	
Lead L3_10			0.81*				0.98	
			(0.42)				(0.62)	
Lead L3_25			0.13				0.25	
			(0.50)				(0.68)	
Lead L4A			0.32				0.46	
			(0.36)				(0.49)	
Cat.23×Month				-0.02***				-0.02***
				(0.00)				(0.00)
Cat.24×Month				-0.00*				-0.01*
				(0.07)				(0.06)
Cat.25×Month				-0.02***				-0.02***
				(0.00)				(0.00)
Cat.26×Month				-0.05***				-0.07***
				(0.00)				(0.00)
Cat.27×Month				-0.02***				-0.04***
				(0.00)				(0.00)
Constant	4.03***	3.60***	4.03***	17.45***	4.54***	4.20***	4.54***	22.61***
	(0.25)	(0.32)	(0.25)	(0.69)	(0.31)	(0.40)	(0.31)	(1.00)
Observation	3712	3680	3680	3712	3404	3342	3375	3404
R-sq	0.054	0.081	0.055	0.097	0.062	0.087	0.061	0.103
Cat. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Clustered standard errors are presented in parentheses. ***, **, and * denote the statistical significance at 1, 5, and 10% levels, respectively.

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