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Trade War on Taiwanese Trade**

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September 2022

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Keywords: Trade war; Tariffs; Taiwan

JEL Classification: F15; F53

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The Substitution Effect of U.S.-China Trade War on Taiwanese Trade[§]

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Abstract: Using monthly trade data from January 2018 to December 2019, we empirically examine the effects of the U.S.-China trade war on Taiwan's exports as well as imports. On the export side, the tariff hike in the U.S. against imports from China may induce Taiwan to export to the U.S., that is, the substitution effect. To investigate this hypothesis, we examine how U.S. tariffs on goods from China affect Taiwan's exports to the U.S. More directly, we also explore how China's exports to the U.S. change Taiwanese exports to the U.S. On the import side, Taiwan may increase imports of the intermediate inputs necessary to produce goods for the U.S. market, from China. Our empirical analyses confirmed the validity of these hypotheses. By contrast, we did not find a substitution effect in exports from Japan and South Korea.

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1. Introduction

The U.S.–China trade war, initiated by the U.S. government during the Trump administration in 2018, is continuing even during the COVID-19 pandemic and the Biden administration. This trade conflict was driven by various economic and political concerns such as China's chronically large trade surplus.¹ Furthermore, to promote indigenous technological capability, China adopted the *quid pro quo* policy to acquire technologies embodied in international joint ventures (Holmes et al., 2015). This "technology in exchange for market access" strategy helps China upgrade the technology ladder rapidly, especially

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¹ For more details, see, for example, Liu and Woo (2018), Swenson and Woo (2019), and Mossa et al. (2020).

related to high-speed railway technologies, 5G technologies, artificial intelligence, and others. Thus, China initiated the “Made in China 2025 (MC-25)” program in 2015, with the objective of becoming a manufacturing powerhouse and global high-technology leader (Chen et al., 2020; Liu and Woo, 2018; Swenson and Woo, 2019). This development challenges the longstanding dominant role of the U.S. in high-technology areas.

Initiating the trade war, the U.S. implemented four phases of raising tariffs on imports from China. The first phase levied an additional 25% tariff on \$34 billion imports from China on July 6, 2018. Another \$16 billion of imports were added to the list of additional tariffs on August 23, 2018, as the second phase. The third phase was an additional 10% tariff on US\$ 200 billion imports from China on September 24, 2018. This additional tariff increased to 25% on May 10, 2019. On September 1, 2019, as the fourth phase, an additional tariff of 15% was levied on other \$101 billion imports from China. This trade sanction through tariffs continued to be in effect after the induction of Joe Biden as the president of the U.S. on January 20, 2021.² In retaliation, China also imposed various tariffs on an array of products imported from the U.S., corresponding to above-mentioned phases of the tariff increase.³

The trade war between the two largest countries inevitably impacts bilateral trade between them. As reviewed in the next section, an emerging line of studies has covered this aspect as focal research. Simulation studies have shown that this trade war is worse than the zero-sum game. Both countries will experience a decrease in welfare. Nevertheless, China’s exports to and imports from the U.S. are reduced by a larger proportion than the corresponding impact on the U.S. Crucially, this trade conflict is also creating repercussions on the global trade system in the lens of global value chains (GVCs). It is relevant to other countries even if they are not directly involved in this trade war, because trade flows between the U.S. and China are diverted to their major trade partners whose sectors have comparative advantages (Carvalho et al., 2019; Guo et al., 2018). Specifically, there is a trade diversion effect or trade substitution effect in the short run.

This paper aims to investigate how the US–China trade war influences Taiwan’s exports to the U.S. Taiwan’s trade could be deeply influenced by the ongoing trade war and ensuing high-tech conflicts because it has unique economic and political relationships with China and the U.S., and it also plays a key role in China’s manufacturing supply chain. In East Asian production networks, China has played a role as a manufacturing center by exploiting its low-cost labor advantage. Chinese firms produce a variety of consumer electronics products, which are assembly produced by importing key intermediate goods

² See Bown (2021) for details on the timing and scale of the products subject to the tariff changes in the U.S.-China trade war.

³ In addition to tariff policy, U.S. also strictly regulated exports of key technology and component to China. For example, U.S. banned the usage of Huawei and ZTE equipment by the federal government in August, 2018. Such regulation must impact considerably on China’s high-tech industries. In this paper, however, we focus on the effects of tariff policy.

from their East Asian neighbors, and then exported to the global market, particularly the U.S. Thus, if the trade war reduces China's exports to the U.S., Taiwan may benefit from trade diversion by acquiring the transferred orders (substitution effect) and increasing its exports to the U.S.

One distinct feature of China's exports is that a large proportion of exports is contributed by foreign-invested enterprises (FIEs) that undertake export-platform foreign direct investment (FDI) in China, particularly processing exports.⁴ For example, FIEs contributed 44% of manufacturing exports in 2015, and also accounted for 54% of Chinese processing exports, which reached 85% for high-tech products in the 2000s (Jarreau and Poncet, 2012). In China, a large proportion of FIEs are Taiwan-owned companies, particularly in the electronics industry, and most of them, such as Foxconn, undertake processing exports.⁵ Their exports to the U.S., either direct, or as part of triangular trade that receives orders from parent firms in Taiwan, will be regarded as Chinese products and will apply the new tariff rates imposed under the trade war. In combination with the uncertainty brought about by the U.S.-China war, some Taiwan-invested FIEs, particularly high-tech firms, may accordingly shift their investments from China to Taiwan.⁶ This investment reallocation effect will facilitate Taiwanese exports.

We empirically examine both exports and imports in Taiwan using monthly trade data from January 2018 to December 2019. On the export side, the tariff hike in the U.S. against goods from China may induce Taiwan to export to the U.S. in place of China, that is, the substitution effect. To investigate this hypothesis, we examine the effect of U.S. tariffs on Chinese goods, on Taiwan's exports to the U.S. More directly, we also explore how China's exports to the U.S. change Taiwan's exports to the U.S., by instrumenting the former with U.S. tariffs. On the import side, on the other hand, Taiwan may import intermediate inputs necessary to produce goods exported to the U.S. from China; therefore, we examine how exporting to the U.S. changes Taiwan's imports of intermediate inputs from China. In sum, we investigate whether Taiwan increases exports to the U.S. using inputs imported from China. As reviewed in the next section, the literature on trade wars has never examined imports of inputs from China in third countries (of the triangular trade). These analyses will enhance our understanding of the whole effect of the trade war, that is, the effects in not

⁴ Benefited from the measure of tariff-free on imported intermediate goods, Chinese firms can undertake processing exports with a lower fixed cost by serving the outsourcers of international companies. Thus, low productivity firms can also enter the international markets and then contribute to China's mushroomed exports since the 2000s (Yu, 2015).

⁵ Among the scale-above enterprises (sale exceeding RMB 20 million), the number of Taiwan-invested electronics firms (CSIC 39, 40, and 41) was about 2,400, indicating that accounting for 19% of total electronics firms (12,716).

⁶ There are various policy measures implemented by the Taiwan's government since the late 2018, aiming to encourage Taiwanese companies abroad to return and invest in Taiwan. Please refer to <https://www.ndc.gov.tw>.

only the U.S. and China, but also third countries.

The remainder of this paper is organized as follows. In Section 2, the related literature is reviewed. Section 3 provides an overview of Taiwan's trade with China and the U.S. and Taiwan's outward FDI in China. After explaining our empirical framework in Section 4, we present our empirical results in Section 5. The final section contains concluding remarks and provides policy suggestions.

2. Literature Review

Two streams of literature assess the economic magnitude of the U.S.–China trade war from various perspectives. One opinion is to evaluate its impact using a computable general equilibrium (CGE) model. Ciuriak and Xiao (2018), Itakura (2020), and Li et al. (2020) simulated welfare, employment, trade, and economic growth in China and the U.S. under various tariff hike scenarios. Some studies also investigated this impact in the third (linked) economies. For instance, Fusacchia (2020) focuses on the major European Union (EU) economies. Incorporating a decomposition of trade on a value-added basis, the simulation analysis predicts that EU countries strengthen their linkages with the U.S.; EU regional integration also increases.

As China is one of the key trading partners of most members of the Association of Southeast Asian Nations (ASEAN), the 'third-country' effect of the US–China trade war is particularly relevant. While, on one hand, the potential decline in China's growth caused by the trade war may affect these economies negatively, on the other hand, they may benefit from trade diversion and investment relocation accompanied by the ongoing trade war. Focusing on the impact in four ASEAN countries (Indonesia, Malaysia, Thailand, and Vietnam), Firdaus et al. (2021) adopted the CGE model to simulate various scenarios. They found that the influence of escalating trade wars on exports, investment, and domestic sector growth varies across countries; their positive effects are relatively insignificant for Indonesia. This diminished effect might be attributed to the export structure and lack of deep integration into regional GVCs (Pangestu, 2019). Indonesia is unlikely to benefit from the trade war, as compared other ASEAN members. Aslam (2019) argues that the U.S.–China trade war is unlikely to influence U.S.–ASEAN trade and may even benefit ASEAN.

The second stream of literature attempts to evaluate the economic and trade impact by conducting regression analyses. Amiti et al. (2019) used monthly trade data to investigate the impact of tariff hikes on prices in the U.S., and found that the prices of intermediate and final goods increased substantially. A similar issue was also examined using firm-level data (Cavallo et al., 2021) and harmonized system (HS) ten-digit product-level data (Amity et al., 2020b). They consistently found that tariffs were mostly passed on to U.S. importers and consumers. Moreover, Amity et al. (2020a) found that tariff announcements of the U.S.–

China war in 2018-2019 will lower the growth rate of investment by listed U.S. companies. Handley et al. (2020) examined the impact of the 2018-2019 U.S. import tariff increases on U.S. export growth. Using firm-trade matched data to construct product-level measures of exporters' exposure to import tariff increases, they found that the most exposed products had relatively lower export growth in 2019. Based on monthly trade data, estimations by Fajgelbaum et al. (2020) echo the above findings: import and retaliatory tariffs caused large declines in U.S. imports and exports; there is a large pass-through of tariffs to duty-inclusive prices. Thus, the trade war harms the welfare of the U.S., particularly of the tradeable-sector workers.⁷

Several studies have examined these effects in Taiwan. Chow (2020) employed the CGE model to assess the impacts of the US–China trade war on the Taiwanese economy in various scenarios. As Taiwan's export commodities in the U.S. market have a high degree of overlap with those of China, Taiwan gains from exports to the U.S., benefiting from the trade diversion effect in the short term. Social welfare, exports, imports, and trade balance in Taiwan will also increase under specific tariff scenarios. The author suggests that Taiwan must map out a cosmopolitan view of its geo-strategy by diversifying its outward FDI and trade destinations. Echoing Chow's (2020) policy suggestions, Hsieh (2021) finds that Taiwan's outward FDI to China is significantly affected by lagged FDI and exports to China, thereby suggesting that lowering economic dependency on the Chinese market helps Taiwan alleviate the negative impact of the US–China trade war.

In this growing body of literature, we conduct regression analyses to investigate the effects of the trade war on Taiwan's exports and imports. Although Chow (2020) conducted simulation analyses of the substitution effect, we examine this effect using observed trade data. In addition, we investigate how this substitution effect changes Taiwan's imports of intermediate inputs from China. In terms of examining Taiwan's trade with China, Hayakawa et al. (2022) is another related study that explores how U.S. imports of 'output' from China change the latter's imports of 'inputs' from Taiwan (Japan and South Korea). The study found that a decrease in China's exports of 'output' or end-products to the U.S. results in a reduction in Taiwan's exports of 'inputs' to China. In sum, while Hayakawa et al. (2022) examined Taiwan's exports to China, we investigate Taiwan's imports from China. In this sense, these two studies are complementary.

⁷ There are some other studies on the effects of the trade war. For example, Mao and Görg (2020) consider the indirect impact of the U.S.-China trade war on cumulative tariffs paid by third countries. Combining data from input-output relationships, imports, and tariffs to calculate the cumulative tariffs, they find that the tariff hikes, particularly those on Chinese imports in the U.S., increase cumulative tariffs for other countries. The relatively close trade partners of U.S. are heavily impacted, namely the EU, Canada, and Mexico. In addition, Blanchard et al. (2019) and Egger and Zhu (2020), examined the effects of the trade war on political sentiments and stock market prices, respectively. Chor and Li (2021) showed a negative effect of US tariffs on night-time luminosity in China, while Cui and Li (2021) found a negative effect on Chinese new firm entry rates.

3. Taiwan's Trade and Investment

This section provides an overview of Taiwan's trade and FDI. Taiwan experienced persistent and spectacular export-led economic growth in the late-1970s – the mid-1980s, mainly from exporting to the U.S. Due to geopolitical considerations, the U.S. provided technological and economic aid, thereby considerably helping Taiwan to achieve the so-called “economic miracle.” In the late 1980s, Taiwan's business environment was marked by substantial shocks such as increased production costs (e.g., labor or land), stringent environmental protection, and large currency appreciation. Thus, Taiwanese companies began to undertake outward FDI to seek lower production costs, while a disproportionately large share of investment concentrated on China because of the advantages of geographic, cultural, and ethnic proximities.

Another wave of mushroomed outward FDI to China began in 2002, when Taiwan's government lifted the restriction of electronics firms' outward FDI to China. With a rise in global production fragmentation, an increasing number of Taiwanese electronics firms have relocated their production lines to China to access the upstream and downstream supply chains.⁸ This development further facilitates intra-industry trade, wherein Taiwan exports intermediate goods to China for processing, manufacturing, and exports. We can view such a surge in Taiwan's manufacturing FDI to China in Figure 1⁹, which shows an increase from US\$ 6,807 million in 2003 to US\$ 10,305 million in 2011. However, along with the increased wage level and strict enforcement of the Labor Contract Law in China in 2011, which requires the employer to provide for employees' social insurance (about 30% – 35% of wage) (Yang, 2021), Taiwanese firms have reduced investments in China since 2012. In particular, the investment was found to have declined sharply since 2019, probably attributable to the indirect effect of the U.S.-China trade war (Hsieh, 2020). Correspondingly, the high concentration of outward manufacturing FDI to China declined from a peak of more than 90% to 37% in 2020.

=== Figure 1 ===

Next, we provide an overview of the trade in Taiwan. Since this study is interested in Taiwan's exports to the U.S. and imports from China during the trade war period, we focus on these trade flows.¹⁰ Figure 2 shows the monthly changes in these trade values, in addition to the simple average of U.S. tariffs against goods from China. First, U.S. tariffs on goods from China have risen gradually. In particular, relatively large increases can be found

⁸ See Yang et al. (2010) for the development of Taiwan's outward FDI to China.

⁹ We obtain the FDI data from Statistics on Overseas Chinese & Foreign Investment, Outward Investment, Mainland Investment, Ministry of Economic Affairs, Taiwan.

¹⁰ We obtain the trade data from the Global Trade Atlas maintained by the IHS Markit.

in the third quarter of 2018 and the second quarter of 2019. Second, China’s exports to the U.S. have decreased since the fourth quarter of 2018; they fell by about 30% between January 2018 and March 2019. Third, we observe a gradual increase in Taiwan’s exports to the U.S. during the study period. Their levels at the end of 2019 rose to 30% higher levels than those in January 2018. Finally, Taiwan’s imports from China were stable, except in February 2019. These remained at a level similar to that in January 2018 during the study period.

=== Figure 2 ===

Finally, we provide an overview of Taiwan’s trade in terms of industry. Table 1 shows the annual trade values by industry, that is, the two-digit HS codes. We only showed the top-10 industries in terms of their value in 2017. The general (84) and electronic (85) machinery industries are two important industries regarding Taiwan’s exports to the U.S., and its imports from China. These two industries experienced a gradual increase in both exports to the U.S. and imports from China. In particular, the increase in exports of HS-84 products to the U.S. was outstanding, registering a 90% growth rate between 2017 and 2019. These increases in exports to the U.S. and imports from China might be driven by the rise in U.S. tariffs on goods from China.

=== Table 1 ===

4. Empirical Framework

This section explains our empirical framework for investigating the effects of the trade war on Taiwanese trade. Focusing on the period from January 2018 to December 2019, we examine the monthly trade and tariffs.

First, we examine the substitution effect of China’s exports to the U.S. As found in previous studies, the tariff hike in the U.S. against goods from China contributed to reducing China’s exports to the U.S. Such a decrease may induce other countries, apart from China, to export to the U.S. To examine this hypothesis for Taiwan, we regress the following equation:

$$X_{pt} = \exp\{\alpha \times \ln(1 + \text{Tariff}_{pt}) + \delta_p + \delta_t\} \times \epsilon_{pt} \quad (1)$$

The dependent variable (X_{pt}) is Taiwan’s exports of product p to the U.S. at time t . Product p is defined at an eight-digit level of the U.S. HS classification. Our main independent variable is Tariff_{pt} , which applies U.S. tariffs to product p from China at time t . We expect the coefficient for this tariff variable (α) to be positive. Taiwan is expected to increase exports

to the U.S., of those products on which tariffs were imposed, that is, the substitution effect.

We also introduce product fixed effects (δ_p) and time fixed effects (δ_t). The former ‘fixed effect’ will control for U.S. tariffs on goods from Taiwan because these tariffs differ by product but do not change much over time. Similarly, this type of fixed effect may control for the potential size of product-level demand in the U.S. and productivity/international competitiveness in Taiwan. Furthermore, product fixed effects control for exporters’ export trends in the pre-war period. As shown in Table 1, for example, Taiwan mainly exports products categorized as HS 84 and HS 85 to the U.S. The latter fixed effects will control for the change in factor prices (e.g., land prices or wages) over time in Taiwan. ϵ_{pt} is a disturbance term. This equation is estimated using the Poisson pseudo-maximum likelihood (PPML) method. For comparison purposes, we also estimate this equation for other neighboring countries’ exports to the U.S., that is, Japan’s and South Korea’s exports.

Next, we investigate the substitution effect of China’s exports to the U.S. In the specification above, we examine the relationship between U.S. tariffs on goods from China, which are expected to negatively affect China’s exports to the U.S. In the second specification, we directly examine the relationship between China and Taiwan’s exports to the U.S. Specifically, in equation (1), we replace U.S. tariffs on goods from China with China’s exports to the U.S. as follows:

$$\ln X_{pt} = \beta \times \ln(1 + CN \text{ exports to } US_{pt}) + \delta_p + \delta_t + \epsilon_{ft} \quad (2)$$

We expect a negative coefficient, which implies that the decrease in China’s exports to the U.S. increases Taiwan’s exports to the U.S. In this specification, there is an endogeneity concern that unobservable factors affect both countries’ exports to the U.S., such as demand shocks in the U.S. Thus, we estimate this equation using the instrumental variable (IV) method.¹¹ We use $\ln(1 + \text{Tariff}_{pt})$ as the instrument. Naturally, U.S. tariffs on China affect China’s exports to the U.S. Although we directly examine the effect of these tariffs on Taiwan’s exports to the U.S. in equation (1), such an effect should be sourced originally from competition with China’s exports to the U.S. Thus, in equation (2), we examine how the decline in China’s exports to the U.S., triggered by the rise in U.S. tariffs, changes Taiwan’s exports to the U.S..

Finally, we explore how the increase in Taiwan’s exports to the U.S. changed Taiwan’s imports from China. To avoid the negative effect of the trade war, Taiwanese firms may switch from exporting from China to exporting from Taiwan to the U.S. market. Nevertheless, they may need to import the necessary inputs from China to produce goods for the U.S. market. To test this hypothesis, we estimated the following equation:

¹¹ Due to the use of the IV method, we drop observations with zero-valued trade.

$$\ln M_{pt} = \gamma \times \ln(1 + TW \text{ exports to } US_{it}) + \delta_p + \delta_t + \epsilon_{ft} \quad (3)$$

M_{pt} is Taiwan's imports of input p from China at time t . Input p is defined at the ten-digit level of Taiwan's HS. Our main variable, $TW \text{ exports to } US_{it}$, is explained below. Similar to equations (1) and (2), we introduce product and time fixed effects. The former contributes to controlling for various time-invariant product characteristics such as the distribution of firm productivity in China. This type of fixed effect also controls for Taiwan's tariffs on goods from China because these tariffs differ by product, but do not change during our study period. The latter type of fixed effect mainly controls for factor prices (e.g., wages) in China.

Our main variable, $TW \text{ exports to } US_{it}$, is defined at the industry level. Industry i is the one to which input p belongs. Specifically, it is constructed as follows:

$$TW \text{ exports to } US_{it} \equiv \sum_j (a_{ij} \times Z_{jt})$$

a_{ij} represents the value of industry i 's input to produce one dollar of industry j . Z_{jt} is the exports of industry j from Taiwan to the U.S. at time t . Thus, $a_{ij} \times Z_{jt}$ shows the input value of industry i required to produce exports of industry j from Taiwan to the U.S. Since we aggregate this value over industry j , this variable indicates the value of inputs required by industry i to produce the total exports from Taiwan to the U.S. at time t . In other words, it represents the input demand for industry i at time t , for Taiwanese exports to the U.S. Naturally, as their demand increases, so do Taiwan's imports of inputs from China.

This empirical framework is again concerned with endogeneity bias. While our main independent variable represents the demand for inputs in Taiwan, the dependent variable is the supply of inputs from China to Taiwan. Thus, this supply-demand nexus yields a simultaneity issue in our estimates. To address this endogeneity bias, we employ the IV method. Similar to the framework in equation (2), we use U.S. tariffs on China as an instrument.

$$IV_{it} \equiv \ln \left[1 + \sum_j \left(\left\{ \frac{a_{ij}}{\sum_i a_{ij}} \right\} \times Tariff_{jt} \right) \right]$$

$Tariff_{jt}$ denotes U.S. tariffs for products in industry j from China at time t . Unlike export values in the independent variable, we should not aggregate tariff rates over industries. Therefore, we take a weighted average of such tariffs using the share of inputs from industries i to j out of the total inputs in industry j . As examined in equation (1), the rise of U.S. tariffs on goods from China may increase Taiwan's exports to the U.S. and, thus, the demand for inputs in Taiwan. However, these tariffs are not directly associated with Taiwan's imports from China.

Our data sources are as follows: Data on trade values (i.e., X_{pt} , M_{pt} , $CN \text{ exports to } US_{pt}$, and Z_{jt}) are obtained from the Global Trade Atlas (IHS Markit). The weight parameter (a_{ij}) is computed using the input-output (IO) table for 487 industries in

Taiwan in 2016.¹² Thus, the industries in Equation (3) correspond to the industry classification in the IO table. The data on U.S. tariffs are drawn from the World Integrated Trade Solution, replication files of Fajgelbaum et al. (2020), and Notices of Modification by the Office of the United States Trade Representative. When we estimate Equation (3), we need industry-level tariffs. For this computation, we take a simple average of tariff-line level tariffs at an HS six-digit level, and then a weighted average of the six-digit level tariffs at an IO classification, using Taiwan’s exports to the U.S. in 2017 as a weight.

5. Empirical Results

This section presents our estimation results. In all estimations, the standard errors are clustered by product. The upper panel (i) of Table 2 shows the PPML estimation results of Equation (1) for all products. As mentioned previously, China is a manufacturing center in East Asian production networks. Thus, we first present the possible export substitution effect of the U.S.–China trade war on Taiwan, Japan, and South Korea. Column “TWN” shows the results for Taiwan’s exports to the U.S. The coefficient of tariffs is significantly positive, although its significance level is 10%. This result implies that Taiwan significantly increased the exports of those products to the U.S. for which the latter raised tariffs against China. Specifically, a 1 percentage-point rise in tariffs against goods from China increases Taiwan’s exports to the U.S. by 0.6%. Columns “JPN” and “KOR” indicate the results for Japan’s and South Korea’s exports and show insignificant results. Thus, we observe the substitution effect only in Taiwan’s exports and not in Japan’s or South Korea’s exports. These results are unchanged even if we restrict the study products only to Taiwan’s main export products, as represented in HS 84 and HS 85, in the lower panel (ii). In Taiwan, the absolute magnitude of the coefficient increases slightly compared to the results for all products.¹³

== Table 2 ==

Table 3 shows the IV estimation results for Equation (2). The upper panel (i) shows the results for all products. The test statistics for under-identification (Kleibergen-Paap rk *LM* statistic) and weak identification (Kleibergen-Paap rk Wald *F* statistic) show reasonably high values. The high value in the under-identification test indicates that the rank condition is satisfied and that the equations are identified, whereas the high value in the weak identification test suggests that our IV estimates are unlikely to suffer from bias due to weak instruments. Consistent with the results in Table 2, we find a significant outcome only in

¹² <https://eng.stat.gov.tw/ct.asp?xItem=44871&ctNode=1650>

¹³ Another estimation uses one-month lagged tariffs and shows similar results though the magnitude of coefficients declines slightly.

Taiwan's exports. The coefficient for China's exports to the U.S. is estimated to be significantly negative for Taiwan's exports. Specifically, a 1% decline in China's exports of a product to the U.S. increases Taiwan's exports to the U.S. by 0.13%. By contrast, China's exports to the U.S. are not significantly associated with those from Japan and South Korea. Similar results were obtained when focusing on the products in HS 84 and HS 85, as shown in lower panel (ii).

=== Table 3 ===

This contrasting result among Taiwan, Japan, and South Korea may be attributed to the characteristics of their manufacturing bases in China. As shown in Figure 1, an overwhelming proportion of Taiwan's outward manufacturing FDI is concentrated in China. Many Taiwanese firms had formed FDI clusters in China, particularly electronics clusters, including many electronics suppliers. Within this clustering, they benefited from network effects (Chen and Chen, 1998). Furthermore, they indirectly exported a large proportion of their products to the U.S. market from their affiliates in China. After the outbreak of the trade war, however, they may respond to this conflict quickly by relocating production lines for exports to the U.S. market back to the home country, i.e., Taiwan. This relocation will naturally increase exports from Taiwan to the U.S.

In contrast, for Japanese and South Korean firms, both China and their respective home countries may not be the main production base for the U.S. market. For example, according to the Basic Survey on Overseas Business Activities for 2018 (Japan), the primary sales market of Japanese affiliates in electric machinery industries in China is the domestic market, that is, China. It accounts for 49% of the total sales. Japan has the second largest market, accounting for 36% of the total. The share of sales in the North American market is only 1%. Japanese affiliates in North America sell their products locally (88%). Similarly, South Korean electronics companies have established their export bases in Vietnam. This difference yields contrasting results.

Next, we estimate Equation (3) for only Taiwan. The results are presented in Table 4. For comparison purposes, we estimate this equation using the OLS, IV, and PPML methods. All the coefficients are estimated to be positive. Although the OLS result shows an insignificant coefficient, the coefficients are significantly positive for both the IV and PPML methods. These results indicate that the rise in Taiwan's exports of goods to the U.S. increases their imports of inputs used to produce those goods, from China. However, the magnitude of the coefficient in the IV method seems too large. This value is greater than one, implying that imports of inputs rise more than the demand of inputs for exports to the U.S. market. Theoretically, this magnitude is possible if the trade war induces Taiwanese firms to supply their products from Taiwan to, not only the U.S., but also other countries, including Taiwan. In addition, the larger coefficient in IV than in OLS is not consistent with

our expectation of simultaneous bias, which will overestimate the OLS estimate due to the positive correlation between the dependent and independent variables. Nevertheless, the magnitude of the coefficient in the PPML method seems more reasonable, indicating that a 1% increase in Taiwan's exports to the U.S. increases Taiwan's imports of inputs from China by 0.3%. The large difference in the number of study observations between OLS/IV and PPML suggests the existence of many zero-value observations. Thus, incorporating zero-valued observations may matter more than addressing the endogeneity bias.

=== Table 4 ===

Finally, we conduct a robustness check on the estimation of equation (3). This equation examines the effect of imports of inputs. However, we include all products, including finished products, in the estimation above. Therefore, as a robustness check, we estimate equation (3) only for the imports of intermediate goods. Specifically, we define products categorized into 112, 122, 51, 61, 62, and 63 in the broad economic categories as finished goods. We then restrict the study products to non-finished goods. The results are presented in Table 5. The coefficient is insignificant in the IV method, but significantly positive in both the OLS and PPML methods. In the PPML result, the absolute magnitude of the coefficient increases slightly compared with that in Table 4. A 1% increase in Taiwan's exports to the U.S. increases Taiwan's imports of inputs from China by 0.5%. As found in our analysis of Taiwan's exports to the U.S., some Taiwanese firms seemed to relocate production lines to the home country. However, to produce goods for the U.S. market in Taiwan, they needed to import parts and components from their network established in China. As a result, we witness an increase in Taiwan's imports of inputs from China along with the ongoing US-China trade war.

=== Table 5 ===

6. Concluding Remarks

This study empirically investigated how the U.S.–China trade war influenced Taiwan's trade with the U.S. and China. We examined both Taiwan's exports and imports, using monthly trade data from January 2018 to December 2019. The results indicate ripple effects on Taiwan's trade from the U.S.–China trade war. On the export side, we found that the tariff hike in the U.S. against goods from China increased Taiwan's exports to the U.S.; that is, some of China's exports to the U.S. were replaced by Taiwan's exports. In contrast, we did not find such a substitution effect in Japan and South Korea's exports to the U.S. On the import side, we found that Taiwan increased imports from China, especially those of

intermediate inputs necessary to produce goods exported to the U.S. Robustness checks obtained similar findings. These results imply that Taiwan increased exports to the U.S., using inputs imported from China. Taiwan's manufacturing FDI concentrated on China and mainly undertook export-platform FDI or produced intermediate goods to supply to exporters in China. The demand shock caused by the US–China trade conflict on China's exports thus generated a substitution effect in which Taiwan's affiliates reallocated the production of final goods to Taiwan, and the sales of intermediate goods from China to Taiwan.

Our findings have the following policy implications. Taiwan's economic growth relies heavily on exports from domestic firms and export-platform FDI in developing countries. Unexpected shocks in international trade are inevitable, such as the US–China trade war, COVID-19, and others. Taiwan's trade pattern of exporting high-quality products from Taiwan and standard (labor-intensive) products from export-platform FDI in developing countries has contributed in coping with both positive and negative shocks. To further enhance the resilience or flexibility of Taiwanese firms' exports, they should diversify their outward FDI destinations to various countries.

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Table 1. Overview of Taiwan's Trade (Million USD)

HS2	Export to the US (USD)				HS2	Import from China (USD)			
	2017	2018	2019	Growth (%)		2017	2018	2019	Growth (%)
85	14,056	14,153	16,050	14	85	22,187	24,308	28,192	27
84	8,177	9,809	15,514	90	84	7,757	8,449	9,224	19
73	2,636	3,049	2,988	13	72	2,044	1,665	1,019	-50
87	2,605	2,796	2,962	14	38	1,512	1,289	949	-37
39	1,956	1,986	2,092	7	90	1,470	1,611	1,710	16
90	1,321	1,575	1,902	44	29	1,321	1,487	1,452	10
94	1,155	1,124	1,290	12	39	1,295	1,526	1,581	22
98	1,056	1,280	1,191	13	74	1,093	1,089	1,005	-8
95	991	1,060	1,255	27	98	999	1,052	1,208	21
72	975	793	559	-43	87	919	963	1,063	16

Source: Global Trade Atlas

Note: "Growth" indicates the growth rate from 2017 to 2019.

Table 2. Regressions of Exports to the U.S. on US Tariffs on China's Goods

Exporter	TWN	JPN	KOR
(i) All products			
ln (1 + Tariff)	0.594*	-0.24	0.268
	[0.335]	[0.181]	[0.316]
Number of observations	166,583	201,276	164,945
Pseudo R-squared	0.8780	0.8180	0.8390
(ii) HS 84 & HS 85			
ln (1 + Tariff)	0.756*	0.161	0.409
	[0.446]	[0.255]	[0.600]
Number of observations	40,861	44,878	37,765
Pseudo R-squared	0.8990	0.7720	0.7960

Notes: This table reports the estimation results obtained using the PPML method. ***, **, and * indicates the 1%, 5%, and 10% levels of statistical significance, respectively. Standard errors reported in parentheses are those clustered by product. All products are included in panel (i), whereas panel (ii) includes only products categorized as HS 84 and HS 85.

Table 3. Regressions of Exports to the U.S. on China's Exports to the US

Exporter	TWN	JPN	KOR
(i) All products			
ln (1 + CN exports to US)	-0.125*** [0.039]	0.032 [0.036]	0.017 [0.038]
Underidentification test	290.3	177.5	259.9
Weak identification test	342.0	190.2	300.0
Number of observations	106,810	134,826	99,825
(ii) HS 84 & HS 85			
ln (1 + CN exports to US)	-0.177*** [0.065]	-0.024 [0.068]	0.06 [0.083]
Underidentification test	130.3	109.2	95.4
Weak identification test	181.6	134.5	120.3
Number of observations	32,027	37,171	27,911

Notes: This table reports the estimation results obtained using the IV method. ***, **, and * indicates the 1%, 5%, and 10% levels of statistical significance, respectively. Standard errors reported in parentheses are those clustered by product. The under-identification test and weak identification test show the Kleibergen-Paap rk *LM* statistic and Kleibergen-Paap rk Wald *F* statistic, respectively. All products are included in panel (i), whereas panel (ii) includes only products categorized as HS 84 and HS 85.

Table 4. Regressions of Imports from China on Exports to the U.S.

Method	OLS	IV	PPML
ln (1 + TW exports to US)	0.028 [0.032]	1.502* [0.780]	0.308*** [0.109]
Underidentification test		30.4	
Weak identification test		32.2	
Number of observations	119,910	119,658	180,672
(Pseudo) R-squared	0.8290		0.9650

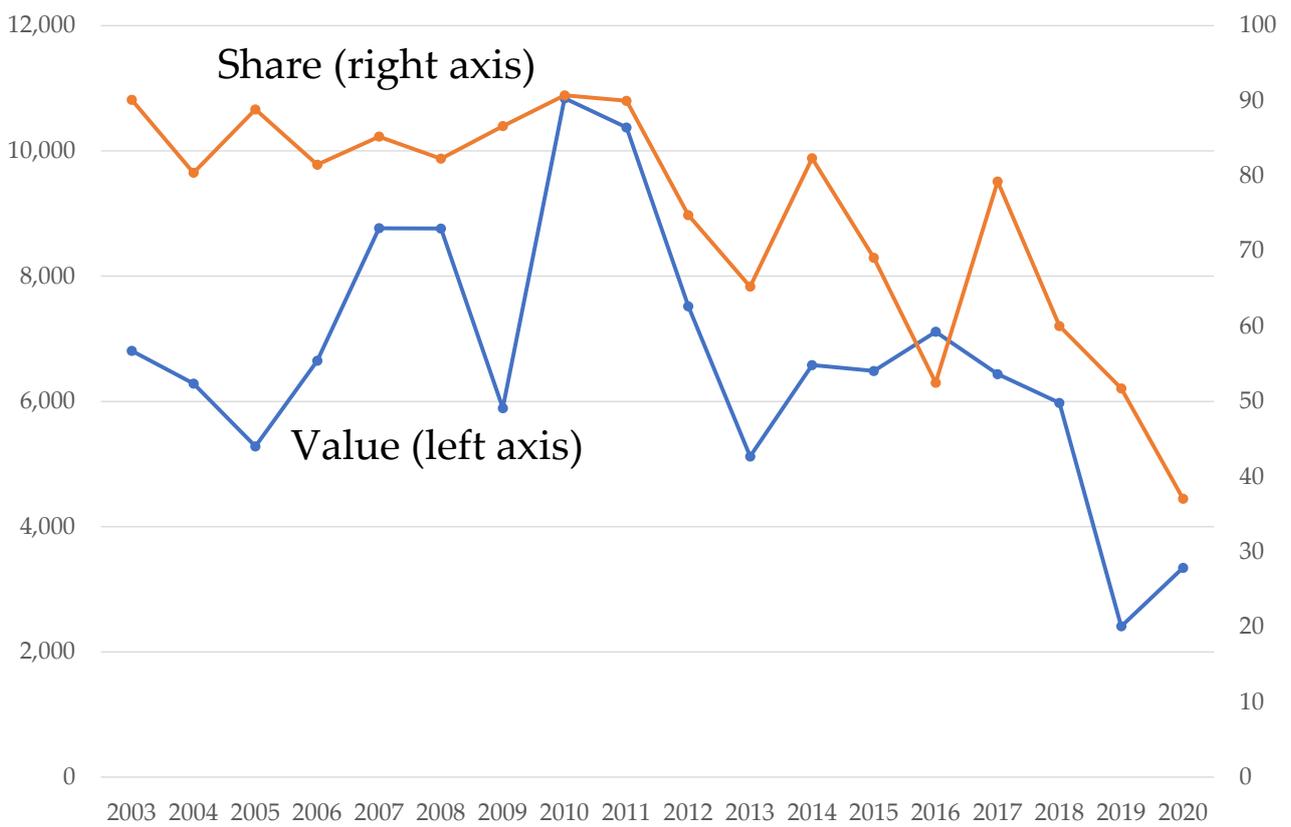
Notes: This table reports the estimation results using OLS, IV, and PPML methods. ***, **, and * indicates the 1%, 5%, and 10% levels of statistical significance, respectively. Standard errors reported in parentheses are those clustered by product. The under-identification test and weak-identification test show the Kleibergen-Paap rk *LM* statistic and Kleibergen-Paap rk Wald *F* statistic, respectively.

Table 5. Regressions of Imports from China on Exports to the U.S.: Intermediate Goods

Method	OLS	IV	PPML
ln (1 + TW exports to US)	0.094** [0.048]	-0.771 [0.615]	0.467** [0.203]
Underidentification test		52.7	
Weak identification test		52.1	
Number of observations	73,475	73,306	115,200
(Pseudo) R-squared	0.8260		0.9660

Notes: This table reports the estimation results using OLS, IV, and PPML methods. ***, **, and * indicates the 1%, 5%, and 10% levels of statistical significance, respectively. Standard errors reported in parentheses are those clustered by product. This is restricted to intermediate goods. The under-identification test and weak-identification test show the Kleibergen-Paap rk *LM* statistic and Kleibergen-Paap rk Wald *F* statistic, respectively.

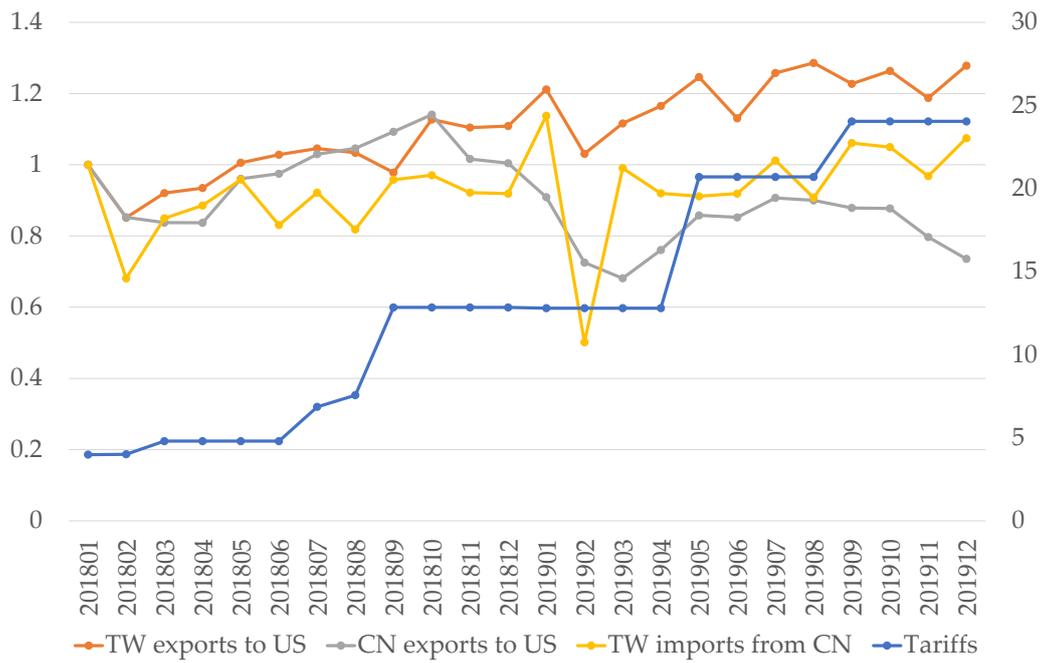
Figure 1 FDI Values to China and Their Share in Total FDI Values (Million USD, %)



Source: Statistics on overseas Chinese and foreign investment, outward investment, mainland investment, Ministry of Economic Affairs, Taiwan.

Note: The statistics in outward FDI contain only manufacturing investments.

Figure 2. Monthly Changes of Trade (Left axis) and Tariffs (Right axis, %)



Source: Global Trade Atlas and WITS

Notes: "Tariffs" refer to the average US tariffs on China's goods. Exports were normalized such that the value in January 2018 became one.