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Global Integration and the Effects of Protectionist Measures

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Abstract

Global Integration and the Effects of Protectionist Measures

by

Anirban Sanyal

The World as a "Global Village" was first envisaged by Marshall McLuhan, a media and communication theorist, in 1964. In today's world, we live in a global economy inter-connected by trade, capital flows and technology. The unprecedented integration among economies which started since 1990 was blamed for contagion effects of the global financial crisis in 2008 (IMF, 2012). Different countries responded with various policy measures to counter the spillover impacts. While import tariffs were used as policy tool to protect domestic interests (UNCTAD, 2013), capital controls along with other macro prudential measures, were used to safeguard domestic economies from global financial uncertainties (Korinek & Sandri, 2015). My dissertation focuses on the implication of such policy measures on the inter-connectedness of economies, mainly highlighting the impact of tariffs on trade and the effect of capital control measures on international capital flows. The chapters of my dissertation are briefly described in the following section.

The first chapter of my dissertation focuses on the empirical evidence of trade diversion from the recent trade war between the US and China for India. The recent trade dispute between the United States and other trade partners resulted in higher tariffs imposed by the United States Trade Commission on other trade partners. The tariff imposition happened between 2018 and 2020. A majority of tariffs during this trade war targeted imports from China. China retaliated with similar large tariffs on significant imports from the United States. This opened

up an opportunity for other trade partners like India. In this chapter, I evaluate the trade diversion effect on India on account of the higher tariffs between US and China. The empirical analysis studies the change in trade intensity between 2019 and 2017 using detailed product level trade flows of India with the United States and China. I estimate the average change in trade intensity to India using a difference-in-difference regression. Due to the short term nature of the trade war tariffs, the average effect of trade intensity can be grossly under-estimated due to differing levels of elasticity of substitution across different product categories. Hence, I have refined the framework by introducing product level heterogeneity in the specification. For that, I have mainly considered three broad categories of product classifications namely (i) final goods vs intermediate goods (ii) homogeneous goods vs differentiated goods and (iii) highly elastic vs low elastic goods. The intermediate goods, used for final goods production, are not easily substitutable compared to final goods. Hence, one can expect that any short run effect of trade diversion is likely to increase trade intensity in final goods products, compared to intermediate goods products. Similarly, differentiated goods are hard to substituted for and are the low elastic goods. The empirical findings suggests that India benefitted from the higher tariffs on China as India's export intensity increased to the US. However, no such effect was observed in India's export to China. This finding suggests that Indian manufacturers benefitted from the higher tariffs on China due to similar or comparable comparative advantages in products targeted under US tariffs on China. However, India does not have similar comparative advantages with the US manufacturers on products targeted by China (like Soybean, agriculture products, electronics etc.). The empirical findings of average impact on imports was not statistically significant. Further, I observe significant product heterogeneity in trade diversion for India. More specifically, India's export intensity to the US increased in final products, homogeneous goods and highly elastic goods.

My second chapter analyzes changes in trade policy uncertainty and its effect on global trade flows using a structural model. The recent literature on the trade war observed that different trade partners experience varying degree of trade diversion on account of higher tariffs between US and China. During the same period of trade war, the trade policy uncertainty index scaled to historical high values due to lack of clarity on the trade war scenarios. Researchers have attributed the heterogeneity in trade diversion to the change in trade policy uncertainty. In this chapter, I assess the impact of trade policy uncertainty on global trade flows by introducing trade policy uncertainty in a multi-country Ricardian trade model. The proposed model uses multi-country multi-sector trade model proposed by Eaton & Kortum (2002) and builds in the uncertainty component. The trade policy uncertainty is drawn from two sources - first, the uncertainty around trade policy changes and second, stochastic uncertainty around the tariff sizes. The trade policy uncertainty affects the price distribution which translates to demand uncertainty. The rationale behind using these two sources of uncertainty is drawn from the experience in global protectionism like Brexit and US trade war. The policies adopted under these episodes increased uncertainty about trade environment as the trade partners were unsure about the possibility of trade policy changes and the effect of the trade policy changes on trade costs. Such uncertainties in trade policy creates challenges for trade partners due to the high adjustment cost in production planning. The trade partners make their production plans when there is lack of clarity about the future trade policy and allocates the factors of production accordingly. However, the trade policies are announced at later stage when it becomes difficult to modify the factor allocations. I introduce uncertainty in the model by adding a distribution of beliefs about future trade policy. Each partner has beliefs about the probability of a trade policy change and the possible change in tariff sizes on account of the policy change. The stochastic nature of tariff sizes and the probability of the policy change translates into the trade partners' assessment of final demand conditions which can be very different from actual tariff scenario (after trade policy is announced). I establish the effect of trade policy uncertainty using analytical derivations and quantitative calibration of the model. The analytical derivations shows that the possible heterogeneity in trade diversion is driven by the stochastic choice of trade partners about future policy. Further, it also provides the boundary conditions of different trade diversion scenarios given trade partners' belief. Later, I extend the analytical model to full scale calibration using two stage approach. The trade policy uncertainty is calibrated under different scenarios of tariff sizes and probability of policy changes. Lastly, I demonstrate that the framework can be generalized to model other scenarios where uncertainty may appear due to other externalities like lockdown imposed by China.

The third chapter looks into the heterogeneous effect of capital controls on the gross capital flows across sectors. Capital controls are macro-prudential policies adopted by different countries to safeguard their domestic interest from the volatility of capital flows. Often times these policies includes taxation on foreign investments, volume restrictions on foreign inflows, legislative steps on foreign investment etc. Generally, advanced economies invest in emerging markets in search for higher yields. However, as the domestic and global investment conditions deteriorate in the destination countries, the direction of capital flows reverses towards advanced economies and other emerging market economies. Such sudden reversal of the foreign capital flows destabilizes the domestic currency, worsens the trade balance, widens the debt burden and de-stabilizes the growth potentials of the emerging market economies. The majority of Latin American economies and South-East Asian economies faced currency crisis on account of the volatile capital flows during 1990's. In response, the International Monetary Fund prescribed capital controls as suitable macro-prudential policy measures to safeguard the emerging market economies from the volatile capital flows from advanced economies. Capital controls are used as macro-prudential policy to safeguard domestic economy from the volatility of external capital flows. The effects of capital controls are studied across many dimensions. Beyond the intended consequence of capital controls, the indirect effects of such policies are often highlighted by the investors. The survey of investors, carried out by Forbes et. al. (2016), observed that the capital control policies send a signal to the global investors about the state of domestic economy. Such signaling effect of capital control interacts with the intended effect and can lead to heterogeneous outcome on gross capital flows across different institutional sectors. The institutional sectors, namely government, banks and private corporates, have different risk profiles and the portfolio allocations across these sectors are driven by the risk profile heterogeneity. Following investors assessments about the domestic economy, one can expect that the signaling effect of capital controls can trigger heterogeneous effects on capital flows across these institutional sectors. I examine such heterogeneity in the direct and spillover effects of capital control on gross capital flows using cross-country international capital flows data across various sectors. The direct effect of capital control captures the effect of capital control on gross capital flows across these sectors. The spillover effect, on the other hand, is mainly driven by the network effect

of capital flows restrictions on capital flows among different recipient nations. In this chapter, I provide the theoretical underpinning of the possible signaling effects and then, validate the heterogeneity using sector level global capital flows data. First, I introduce the signaling effect of capital controls in a portfolio choice model with a multi-country set up to demonstrate the possible heterogeneity in the direct effect and the spillover effect on gross capital flows as one country increases capital taxation on capital inflows. I argue that the direct effect and spillover effect of capital control can be heterogeneous on capital inflows due to the signaling effect of capital controls. To validate the heterogeneity, I use quarterly capital flows data to different institutional sectors in a spatial econometric framework. The empirical findings indicate that the domestic direct effect of capital controls moderates portfolio inflows to the public sector whereas the portfolio inflows to banks and the corporate sector does not respond to the domestic capital control measures. The spillover effect of capital controls increases capital inflows to all sectors in other countries.

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Chapter 1

Impact of US-China Trade War on Indian External Trade

1.1 Introduction

Protectionist measures are commonly used to safeguard domestic producers from foreign competition. The recent trade dispute of the United States with other trade partners, EU common agricultural policy, food tariffs imposed by Argentina, Anti-dumping duties etc. are recent examples of trade protectionism. One of the common measures of trade protectionism is tariffs. Higher tariffs on any country create new opportunities for other trade partners to increase their trade volume. In this paper, I analyze the trade diversion effects on India due to higher tariffs imposed by the United States on China.

The recent tariff war between the US and China ushered in a new era of protectionism in international trade. Starting in 2018, the US increased average tariffs on imported products from China through different tranches of announcements, and ultimately, the average tariff on imported products increased from 2.6% to

20.6%.[1] According to Fajgelbaum et. al. (2020), tariffs of around 12000 products (10800 imports Ire targeted from China) increased under the US action. These protectionist measures resulted in similar retaliation from major trading partners of the United States (US) including China, European Union, Mexico, Russia and Turkey. Among these nations, China lead the retaliation by imposing tariffs of similar magnitudes on products imported from the US. The impact of trade war was felt immediately on the US and China as trade volumes plummeted significantly after the tariffs (Amiti et. al. (2020), Fajgelbaum et. al. (2020), Cavallo et. al. (2019)). Further, higher tariffs Ire found to reduce consumption growth which led to a welfare loss for the United States (Waugh, 2019). The trade war also affected export growth through supply chains (Handley et. al. (2020)). On the other hand, higher tariffs imposed by the US, reduced the profit margin of the firms in China (Wang et. al. (2020)).

Beyond the direct impact of the higher tariffs on the US and China, the tariff war was of a size that may have significant impacts globally. Comparative advantage along with changes in tariffs resulting from the trade war may lead to a meaningful substitution of commodities from other trade partners having access to targeted country's markets and not subject to the direct impacts of the trade war. Thus, the trade war may provide a positive benefit to outsiders in selling to markets directly impacted by the tariff war (Bekker & Schroeter (2020),Bolt et. al. (2019)). India, being a major common trading partner to both US and China, is an ideal case study for analyzing possible trade diversion resulting from the US-China tariff war. With this background, the paper analyses the short term impact of the US-China tariff war on India's external trade at aggregate level and across different product categories. Recently on similar topic, Khandelwal (2022) analyzed the average impact of the trade war on Indian exports using product

[1]Tariffs representing weighted average tariffs imposed at HS-8 level

level export data. The paper documents an insignificant impact of trade diversion due to the trade war tariffs between US and China. However, the paper looks at the sectoral impact of tariffs but ignores the product heterogeneity. This paper analyzes the trade diversion effect on India by factoring in heterogeneity across product groups.

Using product-level export and import data, this paper documents that the tariff war by the US and subsequent retaliation by China, impacted India's export growth significantly at the aggregate level. The effect is found to be more prominently driven by US tariffs, rather than China's retaliatory tariffs. On average, higher US tariffs on Chinese imports reduced imports from China and significantly increased imports intensity by 0.7 from India. Retaliatory tariffs levied by China, However, had an insignificant impact on trade diversion to India. This is due to the similar comparative advantages of India in the products targeted under US tariffs [2].

I evaluate heterogeneous effects in intermediate vs. final goods, homogeneous vs. differentiated goods and high vs. low elastic goods. Trade diversion is more pronounced and significant on the exports of final consumption goods and insignificant in case of intermediate goods. This is intuitive since final goods are more easily substituted whereas the intermediate goods are used in the production process, are sometimes specialized, and thereby take a longer time. I also use the differentiated and homogeneous product classification proposed by Rauch et al. (1999) to check any heterogeneity in this dimension. Exports from India to the US increased in homogeneous goods subject to US tariffs on China, and not significantly for differentiated goods. Also, I find similar effect for highly elastic products (using estimates from Broda ad Weinstein (2006)). These findings cor-

[2] US tariffs targeted wide variety of imports from China where India has comparative advantages. China tariffs targeted mainly agricultural and electronics products where India does not have comparative advantages

roborate the rigidity of replacing non-homogeneous goods (and inelastic goods) in the global value chains at least in the short run.

On the import side, I find the impact of the tariff war to be significant on the aggregate level. However, the impact of tariffs on heterogeneous product classes reveals that the import of final goods increased significantly from China, whereas imports from the US Ire unaffected. Import of homogeneous goods increased due to the tariffs, and a similar effect is observed in high elastic goods. In short, the US-China trade war increased Indian exports to the US, especially in substitutable product classes namely final goods, homogeneous goods and highly elastic goods.

This paper contributes to two strands of literature. First, the paper analyzes the effect of the US-China trade war and its implications on neutral trade partner like India, and thus, it contributes to the larger literature on the US-China trade war. Among the papers analyzing the direct effect of the trade war, Fajgelbaum et al. (2020) provides a comprehensive analysis of the trade war, identifying the anti-consumer impact of the US tariffs on China, with no reduction in China's terms of trade. Waugh (2019) analyzes the impact of the tariffs imposed due to US-China trade war on new car sales data (as proxy of consumption), he argues that the retaliatory tariffs imposed by China, caused a significant decline in the aggregate consumption. Carter & Steinbach (2020) document a significant decline in food exports by the US and a realignment of trade patterns across countries. In particular, South American countries and Europe benefit due to the reorientation of the trade flows. Analyzing the impact of retaliatory tariffs on investments, Amiti et. al. (2020) observed that the announcement of tariffs is expected to reduce the investment growth of the exposed firms by 1.9% by end of 2020. Relatedly, Handley et. al. (2020) analyze the effects of higher tariffs on exports of US firms via supply linkages. They observe that high tariffs on imported inputs and reduced the competitiveness of US exports.[3].

The paper also contributes to the trade diversion literature. Following the trade war and higher tariffs imposed by the US and China, I document a significant trade diversion toward India, a trade partner which remained neutral in the trade war. A large portion of trade diversion literature is concentrated on the trade creation and trade diversion due to North American Free Trade Agreement (NAFTA). Krueger (1999) analyzes the early impact of NAFTA on Mexico using micro level data on bilateral trade and other country specific controls, and documents that Mexico's trade with the US and Canada increased after NAFTA. Similarly, Fukao et. al. (2002) use trade data across major industry sectors at HS-2 digit level and found similar effects of NAFTA. In terms of larger, general equilibrium models, Caliendo & Parro (2012) analyze the impact of NAFTA on welfare, and estimate that the welfare of Mexico increased by 1.31% whereas welfare of the US increased by 0.08%. However Canada faced a decline of welfare around (-0.06%). Clausing (2001) analyzed the impact of tariff liberalization on trade pattern between the US and Canada. The empirical analysis observed significant trade creation happening due to the FTA with very little evidence towards trade diversion. Magee (2008) observed a significant effect on trade creation due to the FTA whereas the impact on trade diversion as found to be muted. Dai et al. (2014), However, observed significant trade diversion from non-participating countries due to the FTA. Mattoo et al. (2017) corroborated the strong trade

[3] Another strand of literature analyzes the impact of tariff using ex-post analysis across industry segments, regions and firms. Attanasio et al. (2003) identified three primary channels through which tariff reduction impacted welfare and inequality. These three channels, namely increasing return to college education, changes in relative industry wages and informality in industry, impacted the labour market widely depending upon the specialization and job types. Topalova (2010) commented that the impact of trade liberalization was more pronounced across sectors in rural areas, resulting in a sloIr decline in poverty and loIr consumption growth

diversion hypothesis due to the FTA. The impact of recent trade war has been analyzed through the aspects of trade diversion. Meinen et al. (2019) analyze the impact of US-China tariff on 30 countries using product-level observations. Using a difference-in-difference approach, they conclude that higher tariffs did not result in trade diversion significantly. Balistreri et al. (2018), Bellora & Fontagne (2019) highlighted the long term positive impact to third trading partner due US-China trade war as trade diversion to other trading partners increases. Bolt et al. (2019) proposed similar findings using a simulation-based approach. IMF (2018) expected similar effects of trade diversion to other trading partners in the short term. Bekker and Schroeter (2020) contradict the findings of trade diversion in the context of US-China trade war, and they observed significant trade diversion across trading partners using ex-post and simulation-based approaches. However, the trade diversion impact was found to be more effective after the initial waves of tariff imposition. Bekker & Schroeter (2020) also highlights that the impact of the first phase of tariff increases had limited effects on global trade due to US importers' commitment to buy Chinese products. Apart from trade diversion, the indirect effect of tariff war was found to be a drag on Japanese multilateral companies as the demand of Chinese goods reduced significantly due to US tariff (Chang et al. (2020)). Compared to the existing literature, this paper undertakes an extensive analysis of trade war impact on India by analyzing the overall impact and product heterogeneity in the trade diversion. Khandelwal (2022) analyzed the impact of the trade war on the trade diversion to India using product level. He observed an insignificant effect of the higher tariffs between US-China on the average export intensity of India. However, the paper did not considered product heterogeneity. This paper provides detailed analysis of the trade diversion across different product classifications.

Apart from the overall impact of trade war, the paper also analyzes the heterogeneous impact of trade war on various product categories. In that way, the paper contributes the large literature of firm and product heterogeneity. Melitz (2003) introduced firm heterogeneity in Krugman's model. Extending the framework, Arkolakis (2010) established the broader response of low tariff goods during trade liberalization through the lens of loIr marketing cost. Spearot (2012), on the other hand, extended Melitz and Ottaviano (2008) framework and observed the impact of trade liberalization significantly higher in case of high elastic goods. Feenstra and Weinstein (2010) postulated similar observations of trade liberalization on differentiated products categories. On the product level heterogeneity, Rauch (1999) identified three different types of products namely exchange traded products, referenced price products and differentiated products. In his paper, Rauch observed that the proximity and common language as two main factors for matching buyers and sellers in the differentiated goods market. Broda & Weinstein (2006) observed significant welfare implications due to product variety. They estimated the elasticity of substitution at SITC 5 classifications and observed an upward bias in price index estimate.

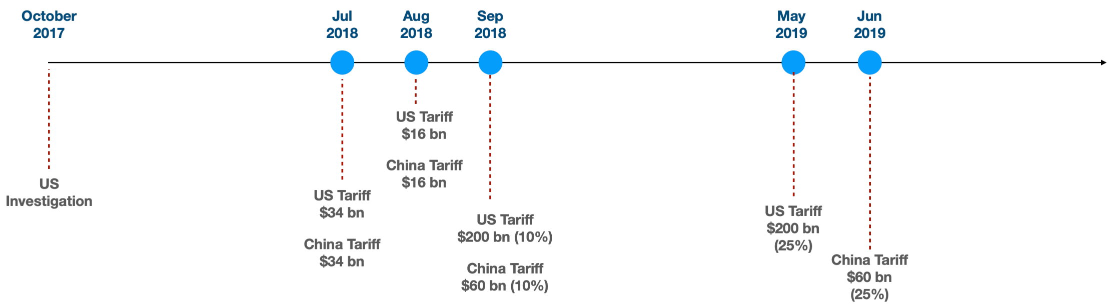
The effects of trade war on neutral trade partners like India, can happen through different channels e.g trade channel, labor market implications, price transmission etc. The trade diversion observed in this paper, indicates greater export intensity in response to higher tariffs structure. However the net impact of trade war on India remains unclear. Following Handley et. al. (2020), the impact of supply chain linkages can provide important insight about the resulting impact of export growth on import intensity. For instance, higher demand for imported inputs is likely to increase import intensity and thereby can result in higher trade deficit. One needs to perform a comprehensive analysis of supply chain linkages and resulting trade patterns due to trade diversion before drawing any conclusion on the welfare implications of trade war on neutral trade partner.

The reminder of the paper is organized as follows: A short history of US-China tariff war is illustrated in Section 2. Section 3 documents compelling facts about Indian tariff scenario during the trade war timeline. Section 4 documents data description and stylized facts. The overall impact of US-China trade war on India's trade is illustrated in Section 5. Product level heterogeneity is covered in Section 6. The paper concludes with a discussion of the findings in Section 7.

1.2 The US-China Trade War of 2018

The United States (US) imposed higher tariffs on Chinese imports using a mix of allegations, from unfair trade practice to national security grounds. Early tariffs on solar panels and washing machines Ire proposed in October and November of 2017, and implemented in January 22, 2018. Retaliatory investigations occurred almost immediately resulting in anti-dumping duties of 178.6% on sorghum imports from the US. A cascading trade war followed with the US imposing tariffs of 10% and 25% on steel and aluminum on all trading partners during March 2018. A retaliatory tariff was imposed by China up to 25% on 128 US products on April 2, 2018. The US consequently responded with 10 and 25% tariffs on Chinese imports worth $50 billion on April 3, 2018. Waves of higher tariffs Ire imposed by US and China in subsequent moves between April - September 2018. During this time, the average tariff increased from 10% to 25% on various categories of products by US and China (Source: Reuters [4]). The timeline of US-China trade war is illustrated in Figure 1.1

Figure 1.1: US-China Trade War timeline

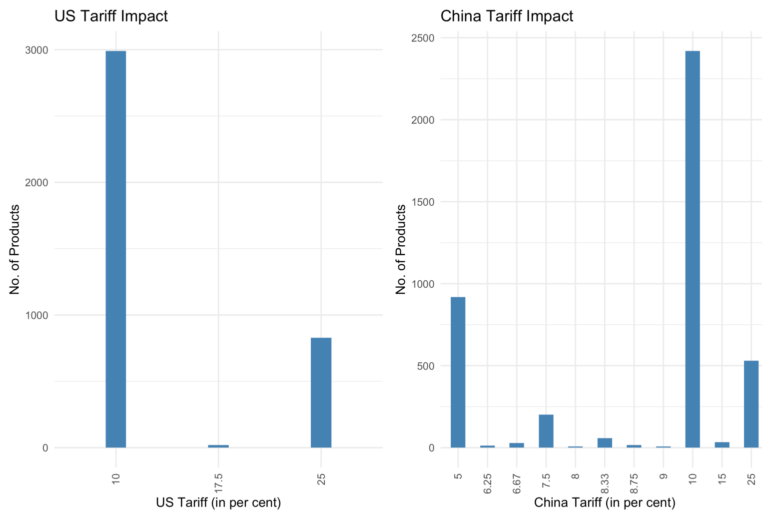


(The timelines are drawn using the tariff announcement dates of each tranches from USITC).

Before the tariff war (i.e. in 2017), China exported around 4573 different products to the US at the HS-6 digit level. The tariffs imposed by the US Ire organized in three tariff brackets, namely 10%, 17.5% and 25%. A majority of the HS6 products, targeted under the US tariff, experienced 10% tariff. China tariffs, on the other hand, Ire designed at different levels though the majority had tariffs of 10% or below (refer to Figure 1.2).

[4] Timeline: Key dates in the U.S.-China trade war `https://www.reuters.com/article/us-usa-trade-china-timeline/timeline-key-dates-in-the-u-s-china-trade-war-idUSKBN1ZE1AA`

Figure 1.2: US-China Tariff Impact on HS-6 products



(Source: Fajgelbaum et. al. (2020) and author's calculations)

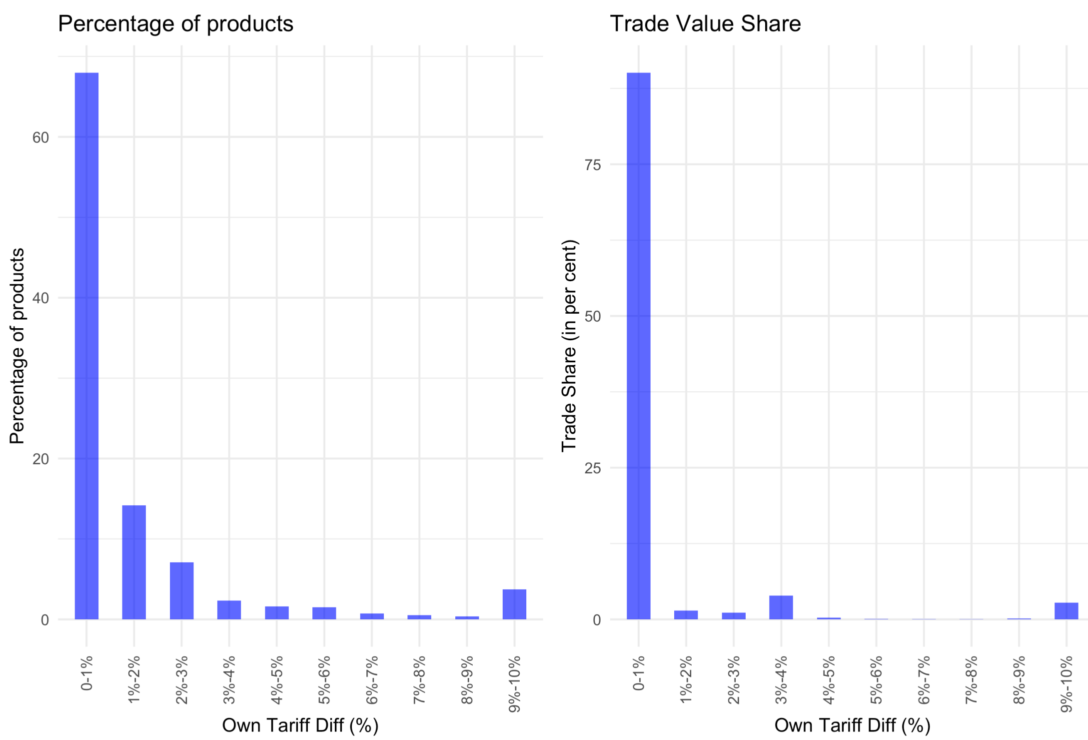
1.3 India's Tariffs

In order to analyze the impact of trade war between the US and China on India, one should also evaluate tariffs that Ire also applied by India during this same period. One of the largest changes for India was that the US government terminated India's designated position in the Generalized System of Preferences (GSP), effective June 5, 2018. GSP was designed by the US as duty free avenue for the goods coming from beneficiary countries and to promote economic development. Founded in 1974, GSP reduced US import tariffs on imported goods from 119 developing countries. India's exit from GSP, therefore, must be considered alongside any effects of the US China Trade war. [5] In order to analyze the magnitude

[5] The impact of losing GSP status was examined by Mukhopadhyay & Sharma (2020) and Chauhan (2020), which observed varying impacts losing GSP on different industry segments in India. Further they highlighted that among all sectors, there was a significant impact of higher import tariffs on sectors like organic chemicals, nuclear reactors, vehicles and parts, iron and steel, plastic and products, electrical machinery, leather, rubber and rubber products etc.

of tariff changes under GSP, the change in tariffs is calculated across products at HS-6 digit level [6] between 2019 and 2017. From the histogram of tariff difference, I observe that the maximum increase of tariffs is found to be around 10% in the post GSP period. Further majority of products traded by Indian manufacturers, are found to have no change or small change (less than 5%) in tariff levels during post the GSP period. Also in Fig. 1.3), the impact of these tariffs is appears to be largely unaffected in terms of trade value share.

Figure 1.3: Summary of trade value share and products across own tariff difference



(Source: UN Comtrade and author's calculations)

[6]Tariffs of each year are expressed as iceberg cost

1.4 Data used and Stylized facts

The primary data used in this paper is sourced from the Directorate General of Foreign Trade for Indian External Trade data. I collect the bilateral trade data at HS-6 digit and HS-8 digit levels. The HS-6 digit level information is used to map tariff details across products and countries (due to international harmonization). The data is collected at an annual frequency [7] to smooth out monthly variation in exports and imports. The data is collected at the product - destination level and it represents an unbalanced panel due to products which are exclusively traded to any particular destination, or are not traded at all. The data period for analysis is 2012-2019. [8]

The products impacted by US tariffs are defined at the HS10 digit level whereas China tariffs can be mapped at HS8 digit. The US tariffs Ire imposed in different waves over time. Further, the tariff rates Ire altered over time. Hence the effective tariff [9] is used for empirical analysis. US Tariff data is collected from USITC data Ib using the information on collected duties and dutiable value across products. The effective tariffs are calculated as a ratio of duties collected and dutiable value. Information on China's retaliatory tariff is sourced from Fajgelbaum et. al. (2020) at HS8 digit level. Average tariffs across the HS-6 digit level is used as proxy of retaliatory tariff at HS6 digit level. For the sake of simplicity, the simple average is used to estimate tariff rate at HS6 products. However the tariff estimated using this approach, does not necessarily imply the tariff shock, rather it factors in any

[7]The annual data on India's external trade corresponds to the financial year i.e. April to March for every year

[8]Financial year 2020 ends by March 2020 when the COVID impact was still in nascent stage in India. I restrict our analysis till March 2020 to avoid any overlap with COVID lockdown restrictions across countries

[9]Effective tariff refers to the tariff after rounds of tariff wave imposed by the US on China

existing tariff placed on the products. Hence the tariff shock has been estimated by removing the MFN tariff across destination countries at product level. MFN data is sourced from WTO database. India's tariff data (i.e tariffs imposed on India's exports and tariffs charged by India) are collected from WTO database to verify any change in tariff structure during US-China trade war timeline in order to assess the robustness of trade diversion findings by factoring the effect of India's exit from GSP.

In the analysis that follows, products will be further classified into product classes to understand any differential impact of tariff across product categories. These products are classified into mutually exclusive categories, namely (i) intermediate goods vs final goods (ii) differentiated goods vs homogeneous goods and (iii) high elastic goods vs low elastic goods. Intermediate goods refer to those used as inputs for manufacturing. The intermediate goods are identified based on the broad economic classification (BEC) using the mapping between HS codes and BEC code (Source: UN Stat and Comtrade) [10]. Beyond the usage of products, another aspect of trade diversion may be related to the substitutability of products. I examine the substitutability of products in two dimensions: homogeneous vs differentiated, and different elasticities of substitution. Differentiated goods classification are drawn from Rauch et al. (1999), where manufactured products have been classified into three major categories depending upon their trading patterns: (1) products traded in organized exchange (2) reference prices and (3) differentiated goods. The differentiated goods are not substituted easily due to

[10]BEC Codes Ire introduced in 1961 to classify the products into industrial supplies, food, capital equipment, consumer durables and consumer non-durables. Following revision 5, BEC codes 111 (Primary for the industry), 121 (Processed for the industry), 21 & 22 (Industrial supplies), 31 & 322 (fuel & lubricants), 41 (Capital Goods), 42 (Parts and accessories), 53 (Transport equipment) have been considered as intermediate goods (Source: Classification by Broad Economic Categories, UN)

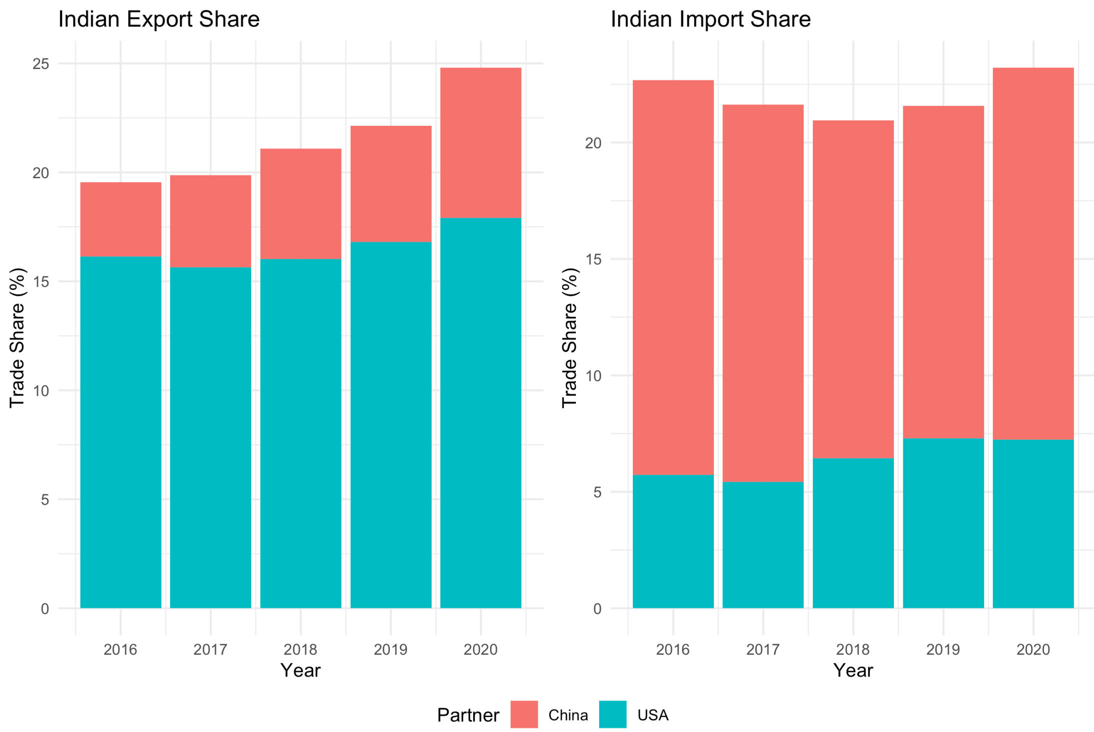
the uniqueness of these products. Traded products and reference priced products can be easily substituted (Rauch, 1999). Accordingly, any trade diversion due to the US-China trade war can be expected to be more dominantly felt across non-differentiated goods and less prevalent for differentiated goods in the short run. [11] The last product category, i.e. the elasticity of substitution, provides a different aspect of substitutability. The elasticity of substitution is sourced from Broda & Winstein (2006). Following Feenstra (1994), the elasticity of substitution has been calculated across products at SITC level for 1972-1988 and 1990-2001. The elasticity parameters used for the analysis are drawn from 1990-2001 estimates.

Even after collecting trade data and other ancillary information, the broad question remains: Why is India a potential case study for analyzing the impact of the US-China tariff war? The US-China trade war impacted the trade volume of the United States and China directly through higher tariff rates. Countries like India Ire not directly impacted by tariffs , [12] but through either demand or supply chain effects may nevertheless be impacted by the tariffs. Since India's external trade share with the US and China is relatively high with both countries, this suggests that Indian firms may adjust to changes in in both countries (refer to Fig 1.4). Also, the import share of the US with China decreased drastically since 2018 and remained at a loIr level in 2020, which suggests that there is demand to meet. At least descriptively, the US import share with India increased marginally during the same time which supports trade diversion towards India (refer to Fig. 1.5).

[11] Both conservative and liberal classification of differentiated goods are used in this paper for robustness

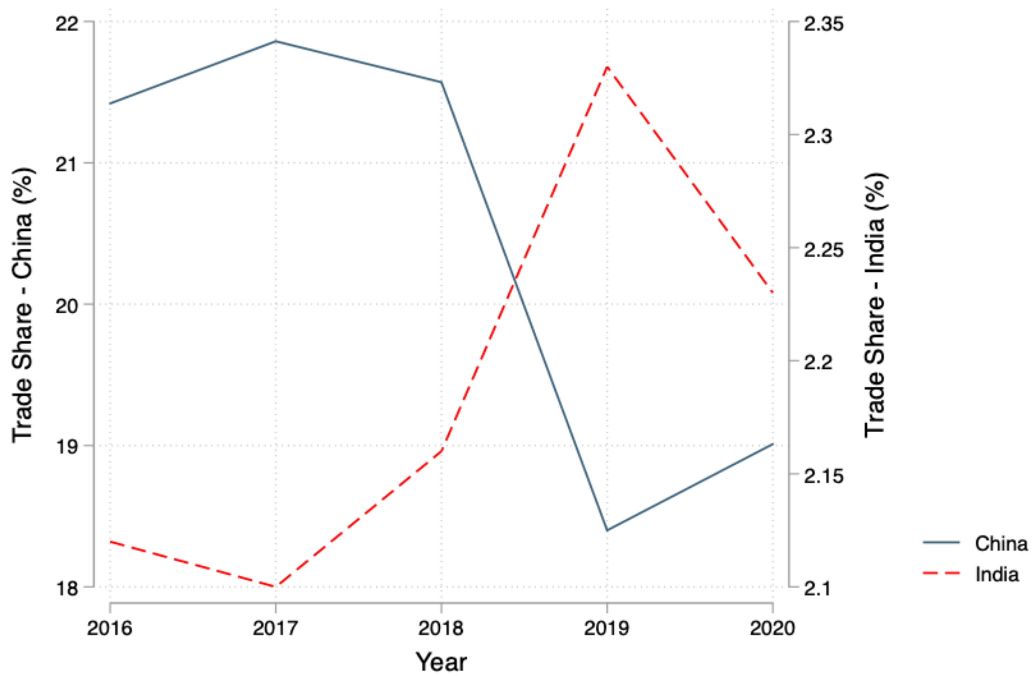
[12] except for Aluminum and Steel

Figure 1.4: India's trade share in percentage



(Source: UN Comtrade and author's calculations; The trade shares are ratio of India's trade with US (and China) with respect to India's total trade. The ratio is defined in terms of trade value)

Figure 1.5: US Import share in percentage



(Source: UN Comtrade and author's calculations; Here, I define the trade shares with respect to the total trade value of the United States.)

Apart from the market access, Indian firms are often compared with China in terms of comparative advantage. Bagaria, Santra & Kumar (2014) argued that the comparative advantage of Indian firms is estimated to be similar to that of Chinese firms across different product categories. Wei & Balasubramanyam (2015) compared the relative comparative advantages of Indian and Chinese manufacturers on capital and labor intensity. Hence, higher US tariffs on China are likely to drive off Chinese firms and may provide favorable entry condition for Indian manufacturers. Following market access and these comparative advantages, India appears to be suitable for a trade diversion case study due to higher tariffs imposed due to US-China trade war.

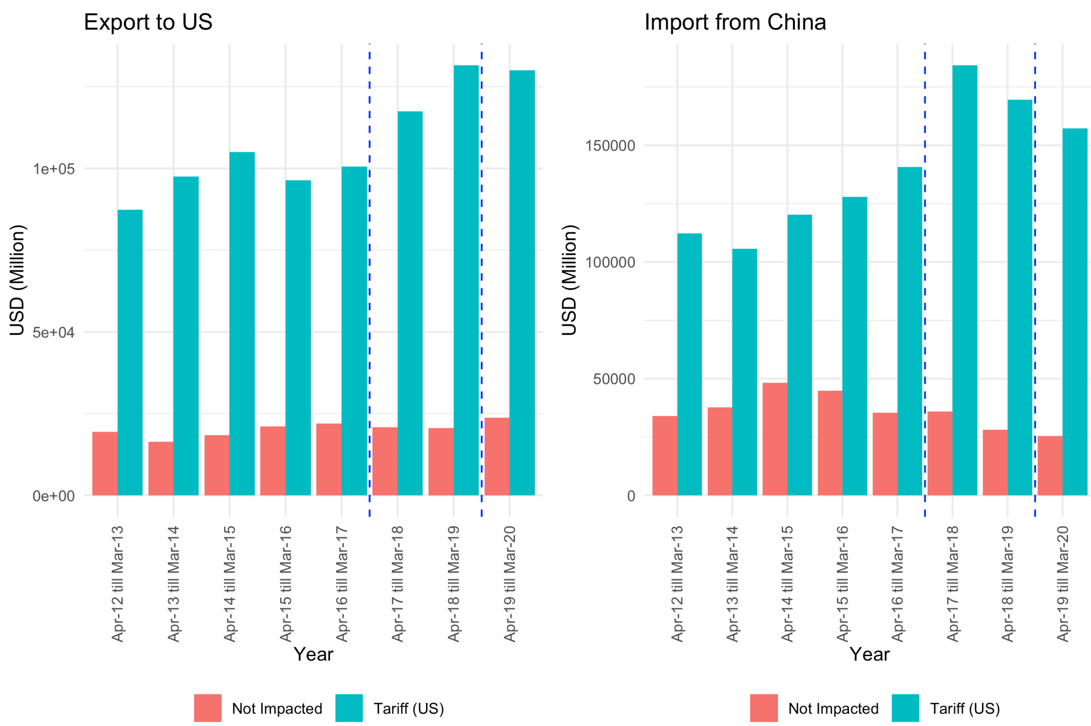
Among the targeted products at a HS-6 level, Indian export growth to the

US increased in more than 50% products, whereas 32% products experienced a decline in exports. A similar pattern is observed for products imported from China. Among 1930 products under the purview of US tariffs, import intensity [13] increased for 63% of products. On the contrary, the tariffs imposed by China are found to be less traded by Indian firms. At the HS - 6 digit level, only 283 products that are currently exported to China Ire impacted, and 341 impacted products are imported from the US.

While the above paragraph focuses mainly on the impact on the extensive margin, I measure the primary impact of US-China tariffs using trade value. The exported value of products targeted under US tariffs and those not targeted by tariffs can be traced over time. Figure 1.6 illustrates the time plot of India's exports to the US and India's exports to China. Ignoring any spillover effects from US tariffs on exports to China, the time plot demonstrates a distinctive pattern. The Indian exports of products subject to tariffs applied by the US against China increased after the imposition of these tariffs. Such differentiated pattern of export intensity indicates that Indian exporters started exporting the targeted products to the US as higher tariffs increases the price of Chinese products and thereby points towards possible trade diversion. A similar pattern is also observed for products targeted under China retaliatory tariffs. However the Indian exports of products under China's retaliatory tariffs (towards the US) started decreasing visibly since end of 2019.

[13] Measured in terms of import growth between 2019 vs 2017

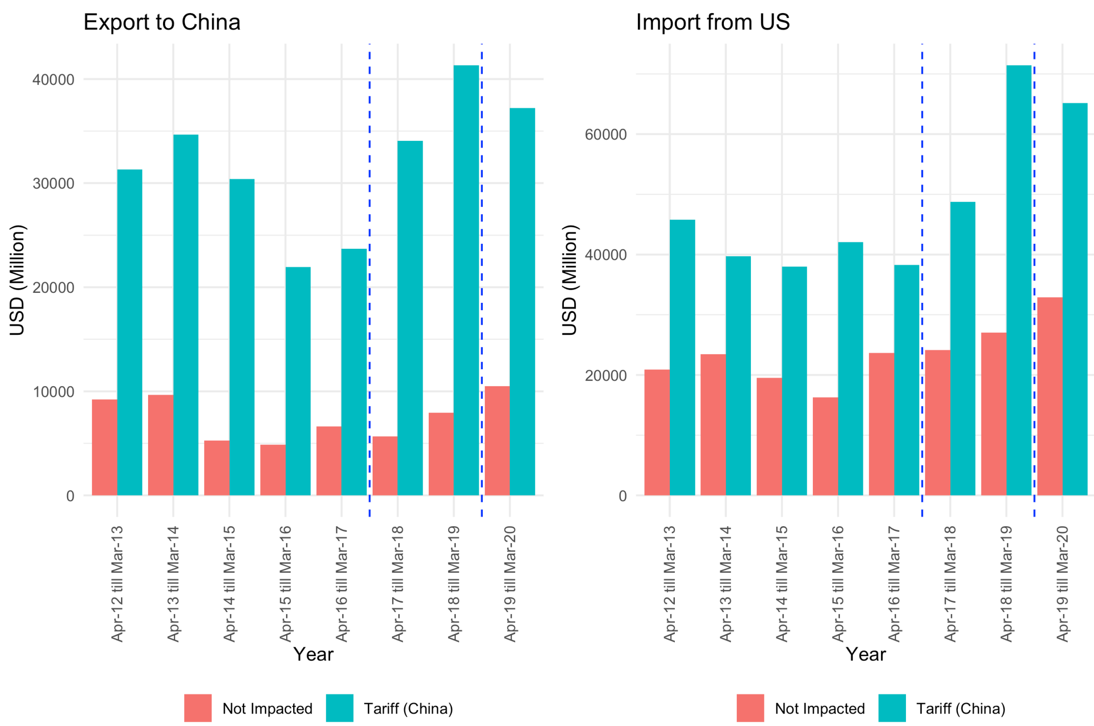
Figure 1.6: Impact of US Tariff on exports



Tariffs increased in between the two dotted lines;
(Source: UN Comtrade and author's calculation)

On the flip side, imports from the US increased sharply for products subject to higher tariff imposed by China due to the tariff war. US manufacturers increased exporting products to India following higher tariffs imposed by Chinese authorities. The left panel of Figure 1.7 illustrates a sharp increase of imports from the US for products impacted by Chinese tariffs. A similar scenario appears in case of Chinese exporters as Ill.The right panel of Figure 1.7 showcases the imported value of targeted products impacted by higher US tariffs vis-vis non-impacted products over time. Higher tariffs imposed by US authorities, forced Chinese manufacturers to redirect their trade flow to India as India's import of these products registered sharp increase during 2018 and remained at elevated level in 2019.

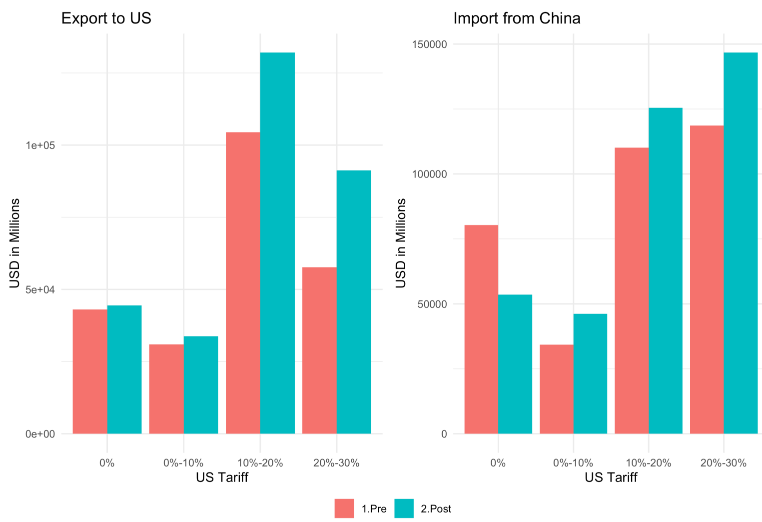
Figure 1.7: Impact of US Tariff on imports



Tariffs increased in between the two dotted lines;
(Source: UN Comtrade and author's calculation)

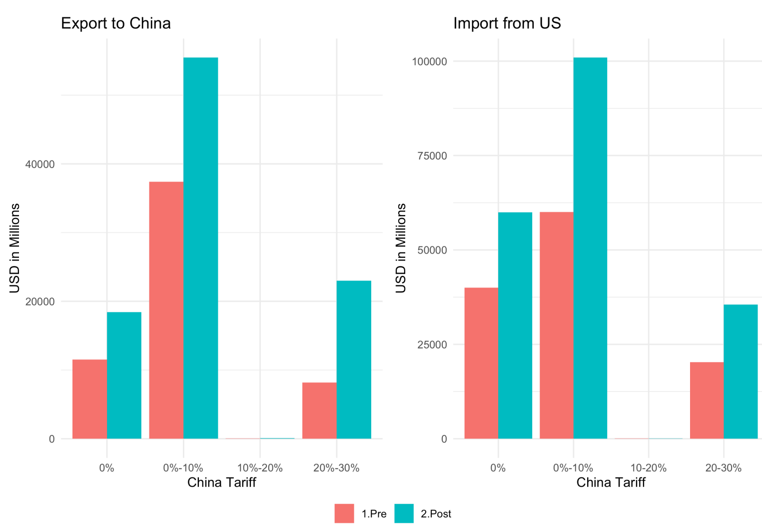
In Figure 1.8 and Figure 1.9, the total value of exports and imports is plotted for products across different tariff brackets. The period is segregated into two intervals - the 'Pre' period represents one year before tariff (i.e. FY 2017) and the Post period is one year after the tariff (FY 2020). The trade value has been aggregated across different tariff brackets for US tariffs and China tariffs separately. The left panel of Figure 1.8 represents India's exports to the US across different brackets of US tariff. The right panel represents the value of import from China across these tariff brackets. The height of the bars represents the total value of trade in millions of USD. Comparing the height of bars, I see that the exports increased during the post tariff period to the US. A similar impact was visible in the case of imports from China. These findings support the hypothesis that the trade diversion happened during post tariff period. Similar effects Ire observed for products affected by China tariff also (refer to Figure 1.9)

Figure 1.8: Impact of US Tariffs on trade value



(Source: UN Comtrade and author's calculation)

Figure 1.9: Impact of China Tariffs on trade value



(Source: UN Comtrade and author's calculation)

1.5 Overall Impact of US-China Tariffs on India's external trade

1.5.1 Empirical Framework

I use both short and long differences to examine the impact of the US-China trade war on imports and exports from India. The short difference is calculated as the difference in trade value between FY 2020 [14] and FY 2017. [15] Specifically, the short difference calculates the change in the log trade value between the financial year ending in March 2020 and financial year ending in March 2017. Similarly, the long difference is defined as the difference between FY 2020 and the average trade value of the last five years before the tariff war (i.e. April 2012 till March 2017). Both the short and long differences are calculated across HS6-country group pairs. To allow for zeros in the trade data, and to interpret as elasticities, both differences are calculated using inverse hyperbolic transformation. [16] The primary difference-in-difference specification is presented in equation 3.23,

$$\begin{aligned}\Delta Y_{ij} = \alpha_0 + \beta_i + \gamma_1^{US}\mathbf{1}_{US} + \gamma_2^{US}Duty_i + \gamma_3^{US}\mathbf{1}_{US} \times Duty_i + \gamma_4^{US}\mathbf{1}_{US} \times ReDuty_i \\ + \gamma_1^{China}\mathbf{1}_{China} + \gamma_2^{China}ReDuty_i + \gamma_3^{China}\mathbf{1}_{China} \times ReDuty_i \qquad , \\ + \gamma_4^{China}\mathbf{1}_{China} \times Duty_i + \epsilon_{ij}\end{aligned} \tag{1.1}$$

[14]FY stands for financial year i.e. April to March. FY 2020 implies April 2019 till March 2020. I follow the difference calculations using financial year rather than calendar year due to availability of Indian trade data.

[15]FY 2017 implies April 2016 till March 2017.

[16]Aihounton & Henningsen (2019) highlighted the sensitivity of inverse hyperbolic transformation on the units of measurement. Hence robustness checks are done using log-transformation on the trade value. The results Ire found to be robust using log-transformation. A separate appendix (*Not included in this document*) is prepared with the robustness results

where i stands for products and j stands for destinations (i.e US, China and Rest of the World). Further ΔY_{ij} is the difference in export (import) of goods, [17] β_i represents some level of product or industry fixed effects, $\mathbf{1}_{US}$ is an indicator variable with value of 1 for trade with the US [18] and 0 otherwise, $\mathbf{1}_{China}$ is an indicator variable with value of 1 for trade with China and 0 otherwise, $Duty_i$ is the tariff levied by the US against China [19] on product i, $ReDuty_i$ is the tariff levied by China against the US. Tariffs for the US and China have been transformed to iceberg costs using transformation $Duty_i = \log(1 + Tariff_i)$ and $ReDuty_i = \log(1 + ReTariff_i)$. As indicated earlier, the change in export (and import), i.e. ΔY_{ij} has been calculated as difference of import values using the inverse hyperbolic sign transformation. This is to interpret the effects as logs, but to include zeros (due to no trading in any particular year) within the analysis. β_i is the product level fixed effects for absorbing product level heterogeneity and these fixed effects are defined at HS 1-4 level with robust standard errors clustered at the same product category level.

The effects estimated by Eq. 1.1 can be represented as

$$\Delta\hat{Y}_i = \begin{cases} \hat{\alpha}_0 & \text{(Other products)} \\ \hat{\alpha}_0 + \hat{\gamma}_2^{US} \times Duty_i + \hat{\gamma}_2^{China} \times ReDuty_i & \text{(Traded with others)} \\ (\hat{\alpha}_0 + \hat{\gamma}_1^{US}) + (\hat{\gamma}_2^{US} + \hat{\gamma}_3^{US}) \times Duty_i + (\hat{\gamma}_2^{China} + \hat{\gamma}_4^{US}) \times ReDuty_i & \text{(Traded with the US)} \\ (\hat{\alpha}_0 + \hat{\gamma}_1^{China}) + (\hat{\gamma}_2^{US} + \hat{\gamma}_4^{China}) \times Duty_i + (\hat{\gamma}_2^{China} + \hat{\gamma}_3^{China}) \times ReDuty_i & \text{(Traded with China)} \end{cases} \tag{1.2}$$

In Eq. 1.2, α_0 indicates average growth of trade value and β_i represents product fixed effects at HS levels 1,2,3 and 4. The impact of the US-China Trade war tariffs are assessed through direct impact and indirect impact. Following Eq. 1.2, the direct impact of tariff (US or China) is expected to influence trade value of commodities impacted by tariff. γ_1^{US} and γ_1^{China} represent average change in growth rate of India's trade value of products traded with the US and China.

[17] I consider short difference and long difference separately in the regression

[18] i.e. export to the US or import from the US

[19] i.e. export to China or import from China

The trade value of targeted products are also likely to get impacted. The average direct impact of US tariff is estimated from estimated value of γ_2^{US} and impact of China's tariffs is estimated from γ_2^{China}. The average effect captures the overall impact of trade diversion on India's export and import to (or from) all destinations. Positive and significant estimates of γ_2^{US} in export equation, will indicate higher growth in export values due to tariffs. However the impact of US tariffs and China tariffs are expected to have additional impact when the destination country is the US or China. Such additional direct effect is estimated by $\hat{\gamma}_3^{US}$ and $\hat{\gamma}_3^{China}$[20] i.e. $\hat{\gamma}_3$ represents the difference-in-difference estimate. Hence positive and significant estimates of γ_3^{US} imply that export (or import) of products impacted by US tariffs, increased further to the US. Following trade diversion theory, tariff imposition is expected to increase imports of tariff products from common trade partner and hence positive value of γ_3^{US} and γ_3^{China} supports the hypothesis of trade diversion from countries involved in tariff war whereas positive value of γ_2^{US} and γ_2^{China} represents the average effect of trade diversion across all destination countries.

I estimate the indirect effect of US-China tariffs using additional interaction term γ_4^{US} and γ_4^{China}. The indirect effect targets any spillover impact of US tariffs and China tariffs on China and the US respectively. Such spillover effects are particularly interesting given the nature and timing of tariff imposition by the US and China on similar products over 2018. One can interpret the estimates of γ_4^{US} as effect of China tariffs on India's export (or import) with the US. Hence positive and significant value of γ_4^{US} will imply higher than average growth in India's export (or import) to the US driven by China's retaliatory tariffs. Equation 3.23 is estimated at HS-1,2,3 and 4 digit level using product fixed effect and robust

[20] $\hat{\alpha}$ represents estimated value of parameter α

standard error at HS - 1,2,3 and 4 level. Robust standard errors are used in all regressions

The estimates from difference-in-difference regression specification in eq. 1.1 are only valid under the assumption of no pre-existing trends in the trade value. To examine these pre-existing trends, a placebo test is performed using the following specification,

$$\begin{aligned}\Delta Y_{ij}^{P} &= \alpha_0 + \beta_i + \gamma_1^{US}\mathbf{1}_{US} + \gamma_2^{US} Duty_i + \gamma_3^{US}\mathbf{1}_{US} \times Duty_i + \gamma_4^{US}\mathbf{1}_{US} \times ReDuty_i \\ &+ \gamma_1^{China}\mathbf{1}_{China} + \gamma_2^{China} ReDuty_i + \gamma_3^{China}\mathbf{1}_{China} \times ReDuty_i \\ &+ \gamma_4^{China}\mathbf{1}_{China} \times Duty_i + \epsilon_{ij}\end{aligned} , \tag{1.3}$$

where, as before, subscript i stands for product and j represents trade destinations namely 'US','China' and 'Rest of the world'. ΔY_{ij}^{P} is the log difference of trade value between FY 2013 and FY 2015. β_i is the product fixed effect, designed at HS -1,2,3 and 4 digit level. The parameter of interest, in this specification, is γ_2^{US} and γ_2^{China}. A statically significant value of γ_2^{US} and γ_2^{China} imply significant impact of tariffs on Indian trade value before the tariff was introduced and thereby identifies a pre-existing trend. I estimate Equation 1.3 separately for products traded with the US, China and rest of the world. I included the regression using product fixed effects defined at HS - 1,2,3 and 4 with robust standard errors clustered at the same product category levels.

1.5.2 Empirical Findings

Impact on India's exports

The estimated coefficients are reported in Table 1.1 across different specifications. The first four columns report the estimated coefficients using short differences and the last four columns using long differences as dependent variables. Among the first four columns, the estimation methodology uses product fixed effects at HS -1,2,3 and 4 levels and robust standard errors also defined for same product clusters.

The estimates in Table 1.1 provides clear evidence that the US-China trade war led to significant trade diversion toward India. While exports to the US and China Ire generally falling over this period relative to exports to the rest of the world (rows 1 and 2), there was a significant increase in exports to the US in products that the US targeted in the trade war against China. The elasticity of Indian exports to the US due to US tariffs applied on China imports, ranges between .67 and .87, and in all cases is significant at conventional levels. In terms of Chinese retaliatory tariffs, it appears that exports to the rest of the world increased, but not to China itself.

The direct effects of US tariffs and China tariffs demonstrate a asymmetric substitution effect on Indian exports to different destinations. The average impact of US tariffs (on China) on Indian exports to all destinations, is insignificant across all specifications. This implies that the tariffs imposed by US authority on products during the US-China trade war, does not influence India's export value to other destinations. However the impact is found to be significant when the destination country is the US. This implies that the impact of higher US tariffs during US-China tariff war, boasts Indian export to the US but not to other destinations. The increase in export value to US, therefore, supports the trade diversion hypothesis, highlighting the substitution effect of US tariffs in form of short term substitution of Chinese imports by Indian imports. As higher tariffs imposed by the US, makes Chinese export costly, Indian manufacturers are able to reap the benefit of higher tariffs by increasing higher export value to the US. The substitution effect is found to be robust across all specifications. The difference-in-difference estimates, translated into differential impact across different tariff brackets, indicate an increase of 12%-16% in India's export of products under the 25% tariff bracket [21]. However the negative and significant coefficient of the intercept (i.e $\mathbf{1}_{US}$) estimates an average decline in India's export to the US, implying that the products which Ire not impacted by tariffs, faced a contraction in exports to US, compared to those impacted by tariffs [22].

On the other hand, the impact of Chinese retaliatory tariffs had a muted impact on Indian exporters. The average impact on India's exports is insignificant resulting from China's tariffs on the US. Further India's exports to China also remained unaffected by China's retaliatory tariff. Such muted impact supports the hypothesis that the substitution effect is more prominently felt between Indian and Chinese manufacturers in exports to the US. However, a similar substitution effect between US and India is muted in case of exporting to China. Such observations corroborate the hypothesis that the comparative advantage of Indian firms is comparable with Chinese manufacturing in products affected by US tariffs. Further China's retaliatory tariff targeted products where Indian manufacturers don't have any comparative advantages which resulted in muted impact

[21] Calculated based on estimated coefficient of tariffs impact to India's export to the US and tariff bracket

[22] The average negative impact on the other products (i.e. not targeted products) may be explained in terms of relative change in export share of targeted and other products. As tariffs increased the export value of targeted products, export value share of other products declined with respect to the targeted products

of China tariff on Indian exports. On the other hand, the indirect impact is found to be insignificant across all destinations (except for one specification using short difference and HS4 classification). The insignificant indirect effect of tariffs and retaliatory tariffs supports the fact that the spillover impact of the tariffs was limited in nature.

Table 1.1: DiD Estimates for tariff impact on India's exports

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
$\mathbf{1}_{US}$	-0.217***	-0.217***	-0.217***	-0.217***	-0.186**	-0.186***	-0.186***	-0.186***
	(0.063)	(0.053)	(0.049)	(0.046)	(0.073)	(0.053)	(0.049)	(0.048)
$\mathbf{1}_{China}$	-0.165*	-0.165***	-0.165***	-0.165***	-0.186**	-0.186***	-0.186***	-0.186***
	(0.080)	(0.058)	(0.061)	(0.052)	(0.072)	(0.048)	(0.044)	(0.043)
Tariff	0.263	0.248	0.222	0.110	0.069	0.035	0.025	-0.102
	(0.224)	(0.203)	(0.243)	(0.223)	(0.292)	(0.235)	(0.229)	(0.207)
Re. Tariff	0.560	0.594**	0.617**	1.042***	0.217	0.228	0.228	0.624**
	(0.424)	(0.287)	(0.270)	(0.270)	(0.555)	(0.314)	(0.301)	(0.278)
Tariff x $\mathbf{1}_{US}$	0.677*	0.677**	0.677**	0.677**	0.869*	0.869**	0.869***	0.869***
	(0.312)	(0.307)	(0.290)	(0.270)	(0.443)	(0.345)	(0.301)	(0.281)
Re. Tariff x $\mathbf{1}_{China}$	-0.644	-0.644	-0.644	-0.644	-0.293	-0.293	-0.293	-0.293
	(0.860)	(0.503)	(0.460)	(0.432)	(0.858)	(0.440)	(0.440)	(0.367)
Re. Tariff x $\mathbf{1}_{US}$	-0.229	-0.229	-0.229	-0.229	0.207	0.207	0.207	0.207
	(0.607)	(0.347)	(0.327)	(0.273)	(0.829)	(0.400)	(0.390)	(0.319)
Tariff x $\mathbf{1}_{China}$	0.135	0.135	0.135	0.135	0.216	0.216	0.216	0.216
	(0.491)	(0.397)	(0.432)	(0.372)	(0.473)	(0.370)	(0.331)	(0.281)
Observations	14,364	14,364	14,364	14,364	14,364	14,364	14,364	14,364
Number of HS	10	98	175	1,202	10	98	175	1,202
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

The left hand side variable is inverse hyperbolic sine of export value
$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
Tariff stands for the US tariffs imposed on China
Re. Tariff is the retaliatory tariffs imposed by China on the US.
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The row, highlighted in the table, highlights the change in export elasticity

Next, I examine Eq. 1.3 whether there are any pre-existing trends in the data that would bias the estimates in Table 1.1 Table 1.2 reports the estimated coefficients using different product classifications as fixed effects. The estimated impact of US tariffs and China's retaliatory tariffs are found to be insignificant on pre-existing growth in trade. The placebo results rules out possibility of pre-trends. Also, the possibility of pre-trends can be ruled out based on the robustness of elasticity estimates from short and long difference.

Table 1.2: Placebo Effect on Export

VARIABLES	(1) placebo	(2) placebo	(3) placebo	(4) placebo
$\mathbf{1}_{US}$	0.028	0.028	0.028	0.028
	(0.016)	(0.025)	(0.023)	(0.020)
$\mathbf{1}_{China}$	0.020**	0.020	0.020	0.020
	(0.007)	(0.019)	(0.020)	(0.019)
Tariff	0.042	-0.015	-0.013	-0.061
	(0.101)	(0.105)	(0.111)	(0.124)
Re. Tariff	-0.046	-0.129	-0.156	0.170
	(0.144)	(0.177)	(0.178)	(0.208)
Tariff x $\mathbf{1}_{US}$	-0.080	-0.080	-0.080	-0.080
	(0.123)	(0.124)	(0.143)	(0.136)
Re. Tariff x $\mathbf{1}_{China}$	0.203	0.203	0.203	0.203
	(0.117)	(0.197)	(0.172)	(0.168)
Re. Tariff x $\mathbf{1}_{US}$	0.178	0.178	0.178	0.178
	(0.157)	(0.230)	(0.218)	(0.195)
Tariff x $\mathbf{1}_{China}$	-0.054	-0.054	-0.054	-0.054
	(0.098)	(0.112)	(0.126)	(0.130)
Observations	14,364	14,364	14,364	14,364
Number of HS	10	98	175	1,202
Fixed Effect	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
Tariff stands for the US tariffs imposed on China
Re. tariff is the retaliatory tariffs imposed by China on the US.
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

1.5.3 Including Impact of India's exit from GSP

India's exit from GSP countries increased tariff rate imposed by the US on Indian exports in selected sectors.[23] Accordingly, the panel regression framework is modified by incorporating the change in US tariff on India. I use the difference of tariffs between 2017 and 2019 as an additional control in the difference in difference regression to evaluate the trade diversion effect. The revised panel regression is given below

$$
\begin{aligned}
\Delta Y_i = \alpha_0 + \beta_i + \gamma_1^{US}\mathbf{1}_{US} + \gamma_2^{US} Duty_i + \gamma_3^{US}\mathbf{1}_{US} \times Duty_i + \gamma_4^{US}\mathbf{1}_{US} \times ReDuty_i \\
+ \gamma_1^{China}\mathbf{1}_{China} + \gamma_2^{China} ReDuty_i + \gamma_3^{China}\mathbf{1}_{China} \times ReDuty_i \\
+ \gamma_4^{China}\mathbf{1}_{China} \times Duty_i + \gamma_5 Tariff(GSP) \\
+ \gamma_6\mathbf{1}_{US} \times Tariff(GSP) + \mathbf{1}_{China} \times Tariff(GSP) + \epsilon_i
\end{aligned}
\tag{1.4}
$$

where $Tariff(GSP)$ is log difference of tariffs imposed by the US on Indian exported goods between 2019 and 2017. More specifically, $Tariff(own) = \log(1 + Duty_{2019}^{India}) - \log(1 + Duty_{2017}^{India})$.

The correlation between own tariffs (i.e. tariffs on India's export to US after GSP exit) is found to be insignificant with US Tariff on China and China's tariff on the US [24]. The panel regression estimates indicates significant trade diversion between India and China to the US in response to the US tariffs imposed on China. Further, a significant moderation in India's export is observed due to

[23] The tariffs increased on imports from India and some of the products were targeted by the US tariffs on China.

[24] Correlation between own tariff and US tariffs on China is 0.11 and correlation between own tariff and China's tariff on the US is 0.05

change in tariff structure due to India's exit from GSP countries. The findings further strengthens the trade diversion hypothesis and also highlights the decline in India's export due to US decision towards excluding India from GSP country group (Table 1.3).

Table 1.3: Spillovers from Trade War - Accounting for India losing GSP Status

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
$\mathbf{1}_{US}$	-0.215***	-0.215***	-0.215***	-0.215***	-0.181**	-0.181***	-0.181***	-0.181***
	(0.064)	(0.054)	(0.049)	(0.046)	(0.074)	(0.054)	(0.049)	(0.048)
$\mathbf{1}_{China}$	-0.163*	-0.163***	-0.163***	-0.163***	-0.184**	-0.184***	-0.184***	-0.184***
	(0.079)	(0.058)	(0.062)	(0.052)	(0.073)	(0.048)	(0.045)	(0.043)
Tariff	0.275	0.253	0.216	0.100	0.057	0.016	0.000	-0.129
	(0.233)	(0.206)	(0.244)	(0.224)	(0.294)	(0.241)	(0.230)	(0.207)
Re. Tariff	0.555	0.592**	0.616**	1.044***	0.210	0.224	0.225	0.624**
	(0.425)	(0.288)	(0.271)	(0.270)	(0.561)	(0.317)	(0.302)	(0.279)
Tariff x $\mathbf{1}_{US}$	0.700**	0.700**	0.700**	0.700***	0.939*	0.939***	0.939***	0.939***
	(0.304)	(0.300)	(0.289)	(0.270)	(0.427)	(0.339)	(0.300)	(0.277)
Re. Tariff x $\mathbf{1}_{China}$	-0.641	-0.641	-0.641	-0.641	-0.289	-0.289	-0.289	-0.289
	(0.866)	(0.504)	(0.460)	(0.432)	(0.865)	(0.443)	(0.441)	(0.367)
Re. Tariff x $\mathbf{1}_{US}$	-0.225	-0.225	-0.225	-0.225	0.217	0.217	0.217	0.217
	(0.614)	(0.352)	(0.330)	(0.274)	(0.843)	(0.410)	(0.397)	(0.322)
Tariff x $\mathbf{1}_{China}$	0.158	0.158	0.158	0.158	0.245	0.245	0.245	0.245
	(0.500)	(0.400)	(0.432)	(0.373)	(0.474)	(0.376)	(0.333)	(0.281)
Tariff(US GSP)	-0.702	-0.219	0.175	0.028	0.992	1.413	1.560	1.250
	(0.595)	(0.819)	(1.048)	(1.092)	(0.645)	(0.887)	(1.060)	(1.218)
$\mathbf{1}_{US}$ x Tariff(US GSP)	-1.670	-1.670	-1.670	-1.670	-4.967**	-4.967***	-4.967***	-4.967**
	(1.384)	(1.389)	(1.051)	(1.620)	(1.963)	(1.697)	(1.603)	(2.401)
$\mathbf{1}_{China}$ x Tariff(US GSP)	-1.629	-1.629	-1.629	-1.629	-2.015*	-2.015*	-2.015	-2.015
	(1.489)	(2.119)	(2.248)	(2.287)	(0.980)	(1.054)	(1.681)	(1.700)
Observations	14,364	14,364	14,364	14,364	14,364	14,364	14,364	14,364
Number of HS	10	98	175	1,202	10	98	175	1,202
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
Tariff stands for the US tariffs imposed on China
Re. tariff is the retaliatory tariffs imposed by China on the US.
Tariff (GSP) are US tariffs imposed on Indian exports after GSP.
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Following similar specification, I estimate the placebo regression using imports data from pre-trade war period. The estimated coefficients indicate no statistically significant effect of trade war tariffs on India's export prior to 2017 (refer to Table 1.4)

Table 1.4: Placebo regressions from Trade War - Accounting for India losing GSP Status

VARIABLES	(1) placebo	(2) placebo	(3) placebo	(4) placebo
$\mathbf{1}_{US}$	0.031*	0.031	0.031	0.031
	(0.016)	(0.025)	(0.024)	(0.020)
$\mathbf{1}_{China}$	0.019**	0.019	0.019	0.019
	(0.007)	(0.019)	(0.020)	(0.019)
Tariff	0.054	-0.007	-0.011	-0.069
	(0.101)	(0.104)	(0.111)	(0.124)
Re. Tariff	-0.050	-0.130	-0.156	0.171
	(0.144)	(0.177)	(0.178)	(0.208)
Tariff x $\mathbf{1}_{US}$	-0.033	-0.033	-0.033	-0.033
	(0.105)	(0.118)	(0.134)	(0.132)
Re. Tariff x $\mathbf{1}_{China}$	0.201	0.201	0.201	0.201
	(0.118)	(0.197)	(0.172)	(0.168)
Re. Tariff x $\mathbf{1}_{US}$	0.184	0.184	0.184	0.184
	(0.164)	(0.231)	(0.219)	(0.194)
Tariff x $\mathbf{1}_{China}$	-0.067	-0.067	-0.067	-0.067
	(0.098)	(0.113)	(0.127)	(0.131)
Tariff(US GSP)	-0.733*	-0.494	-0.486	0.031
	(0.364)	(0.436)	(0.471)	(0.733)
$\mathbf{1}_{US}$ x Tariff(US GSP)	-3.354***	-3.354***	-3.354***	-3.354***
	(0.337)	(0.830)	(0.972)	(1.266)
$\mathbf{1}_{China}$ x Tariff(US GSP)	0.946**	0.946	0.946	0.946
	(0.336)	(0.868)	(0.874)	(0.731)
Observations	14,364	14,364	14,364	14,364
Fixed Effect	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
Tariff stands for the US tariffs imposed on China
Re. tariff is the retaliatory tariffs imposed by China on the US.
Tariff (GSP) are US tariffs imposed on Indian exports after GSP.
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Impact on India's Imports

The impact of the US-China trade war on India's import value, represents a different scenario compared to the exports. Following Table 1.5, the direct impact of the tariffs imposed by the US during US-China tariff war, is found to have increased India's import across all destinations on average. On the other hand, the direct impact of US tariffs on India's import from China, remains insignificant implying that Indian manufacturers started importing from elsewhere (other than China) for products affected by higher US tariffs. The direct impact from tariffs imposed by China in retaliation to US tariffs, is also found to be significant on India's total import. Higher retaliatory tariff induced higher imports by India. The effect was found to be significant and robust across all product fixed effect specifications. The effect of China's tariffs is found to be more effective on India's import compared to the impact of US tariffs. Unlike the average impact, the direct impact on import intensity appears to remained unchanged for imports from US and China respectively. This observations highlights the fact the higher tariffs induces higher imports but not necessarily from US and China. So US-China trade war appears to benefit manufacturers from other destinations. The indirect effect on India's import, on the contrary, has reduced imports from the US and China. The negative and significant coefficient of the interaction terms of US Tariffs and import to US, provides a compelling insight about the decline of India's import from US manufacturers. Such decline can be tagged with the degree of uncertainty created by the US-China trade war. As the trade war introduced higher tariff barriers, the impact of uncertain trade environment reduced domestic production of US manufacturers (Fajgelbaum et. al. (2020)), resulting in a decline of exports by domestic manufacturers. Similar observations can be extended for negative and significant indirect effect of retaliatory tariff and imports from China.

Summarizing the pattern observed in the effects of tariffs imposed by the US and China during the recent trade war, I conclude that trade diversion appeared to have helped manufacturers from other destination countries as manufacturers from the US and China face uncertain trade environment. The net impact of tariffs imposed by the US and China appears to have affected exports from respective countries but other countries have benefitted from trade diversion. Further, the increase in import intensity from other destinations are found to be robust across different product level fixed effects. While the direct effect of tariffs are found to have significant impact on import intensity, the indirect effects of tariffs are found to be insignificant which confirms no significant spillover impact from either tariffs.

Table 1.5: Fixed Effect Estimate

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
$\mathbf{1}_{US}$	-0.019	-0.019	-0.019	-0.019	0.016	0.016	0.016	0.016
	(0.012)	(0.013)	(0.014)	(0.014)	(0.023)	(0.021)	(0.019)	(0.018)
$\mathbf{1}_{China}$	-0.054***	-0.054***	-0.054***	-0.054***	-0.036**	-0.036	-0.036*	-0.036**
	(0.016)	(0.017)	(0.016)	(0.015)	(0.016)	(0.022)	(0.019)	(0.018)
Tariff	0.343***	0.353***	0.338***	0.317**	0.793***	0.788***	0.800***	0.800***
	(0.100)	(0.092)	(0.103)	(0.123)	(0.112)	(0.149)	(0.140)	(0.174)
Re. Tariff	0.302	0.257	0.270	0.179	1.204***	1.210***	1.187***	1.347***
	(0.263)	(0.272)	(0.247)	(0.277)	(0.253)	(0.369)	(0.323)	(0.342)
Tariff x $\mathbf{1}_{US}$	-0.382***	-0.382***	-0.382***	-0.382***	-0.570***	-0.570***	-0.570***	-0.570***
	(0.073)	(0.120)	(0.120)	(0.124)	(0.113)	(0.156)	(0.152)	(0.149)
Re. Tariff x $\mathbf{1}_{China}$	-0.123	-0.123	-0.123	-0.123	-0.125	-0.125	-0.125	-0.125
	(0.273)	(0.347)	(0.304)	(0.330)	(0.289)	(0.399)	(0.363)	(0.361)
Re. Tariff x $\mathbf{1}_{US}$	-0.167	-0.167	-0.167	-0.167	-1.083***	-1.083***	-1.083***	-1.083***
	(0.217)	(0.332)	(0.283)	(0.285)	(0.278)	(0.356)	(0.333)	(0.314)
Tariff x $\mathbf{1}_{China}$	0.010	0.010	0.010	0.010	0.025	0.025	0.025	0.025
	(0.150)	(0.136)	(0.125)	(0.144)	(0.146)	(0.180)	(0.155)	(0.163)
Observations	17,961	17,961	17,961	17,961	17,961	17,961	17,961	17,961
Number of HS	10	98	175	1,261	10	98	175	1,261
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
Tariff stands for the US tariffs imposed on China
Re. tariff is the retaliatory tariffs imposed by China on the US.
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

However the observations from Table 1.5 is only valid subject to the assumption of no pre-existing trend from the tariffs. Hence the placebo regression is run to validate any pre-existing trend in the import patterns. The placebo regression results indicate significant impact of tariffs on the import intensity prior to trade war. However the coefficients lack robustness. The placebo results and the robustness of estimates using short and long differences rule out the concern of pre-existing trend of India's import prior to imposition of tariffs (refer to Table 1.6).

Table 1.6: Placebo Effect

VARIABLES	(1) placebo	(2) placebo	(3) placebo	(4) placebo
$\mathbf{1}_{US}$	0.020	0.020	0.020	0.020
	(0.019)	(0.015)	(0.014)	(0.013)
$\mathbf{1}_{China}$	-0.005	-0.005	-0.005	-0.005
	(0.014)	(0.015)	(0.014)	(0.013)
Tariff	0.167**	0.150	0.157	0.132
	(0.055)	(0.094)	(0.107)	(0.103)
Re. Tariff	-0.508*	-0.434*	-0.452*	-0.368*
	(0.264)	(0.222)	(0.256)	(0.215)
Tariff x $\mathbf{1}_{US}$	-0.113	-0.113	-0.113	-0.113
	(0.131)	(0.120)	(0.115)	(0.115)
Re. Tariff x $\mathbf{1}_{China}$	0.457**	0.457**	0.457*	0.457*
	(0.177)	(0.198)	(0.247)	(0.253)
Re. Tariff x $\mathbf{1}_{US}$	0.019	0.019	0.019	0.019
	(0.456)	(0.293)	(0.289)	(0.249)
Tariff x $\mathbf{1}_{China}$	-0.071	-0.071	-0.071	-0.071
	(0.058)	(0.087)	(0.107)	(0.110)
Observations	17,961	17,961	17,961	17,961
Number of HS	10	98	175	1,261
Fixed Effect	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
Tariff stands for the US tariffs imposed on China
Re. tariff is the retaliatory tariffs imposed by China on the US.
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

1.6 Heterogeneous impact of US-China Tariffs on India's external trade across product categories

1.6.1 Empirical Framework

The regression specification (represented in Eq. 1.1) assumes a uniform impact of tariffs across all product categories. However the assumption of uniform impact is restrictive in nature due to heterogeneity in the types of products. For instance, specialized intermediate goods cannot be replaced easily compared to those products which are used as final goods. Hence any Indian firm, producing intermediate goods, will not get benefits from the US China trade war whereas Indian firms producing final goods, may get benefitted due to a large market. Similarly, products which are traded on organized exchanges, can be replaced easily whereas differentiated products (Rauch et. al., 2006) cannot be replaced that easily at least in the short run. The product level heterogeneity, therefore, can drive the short run impact of US-China tariffs on Indian exports [25]. With this background, Eq. 1.1 has been modified to introduce product level heterogeneity in the specification. The impact of tariffs is also estimated by different product classifications using a similar panel regression framework by introducing product classifications and corresponding interactions. These triple difference specifications are summarized in equation 1.5

[25] Such heterogeneous impact was also observed by Bekker & Schroeter (2020) on the products targeted in phase 1 of the tariff war due to commitment of US firms to buy from Chinese firms

$$
\begin{aligned}
\Delta Y_{ij} = \alpha_0 + \beta_i + \gamma_1^{US}\mathbf{1}_{US} + \gamma_2^{US}Duty_i + \gamma_3^{US}\mathbf{1}_{US} \times Duty_i \\
+ \gamma_4^{US}\mathbf{1}_{US} \times ReDuty_i + \gamma_5^{US}\mathbf{1}_{US} \times C_i + \gamma_6^{US}Duty_i \times C_i \\
+ \gamma_7^{US}\mathbf{1}_{US} \times C_i \times Duty_i + \gamma_8^{US}\mathbf{1}_{US} \times C_i \times ReDuty_i \\
+ \gamma_1^{China}\mathbf{1}_{China} + \gamma_2^{China}ReDuty_i \\
+ \gamma_3^{China}\mathbf{1}_{China} \times ReDuty_i + \gamma_4^{China}\mathbf{1}_{China} \times Duty_i \\
+ \gamma_5^{China}\mathbf{1}_{China} \times C_i + \gamma_6^{China}ReDuty_i \times C_i \\
+ \gamma_7^{China}\mathbf{1}_{China} \times C_i \times ReDuty_i \\
+ \gamma_8^{China}\mathbf{1}_{China} \times C_i \times Duty_i + \epsilon_i
\end{aligned} \tag{1.5}
$$

where C_i is a binary variable representing classification of product i. Hence $C_i = 1$ will represent those products falling under particular product category. As indicated in earlier section, these product categories can be (i) intermediate goods or (ii) differentiated goods or (iii) low elastic goods. Additional interaction terms involving C_i have been included in the specification to assess the differential impact across product categories. These additional terms are targeted to estimate the direct and indirect impact of tariffs across destinations. Eq. 1.5 is estimated using panel fixed effect at HS -1,2,3 and 4 categories with robust standard error at these product category levels [26]. The interaction terms in the form of triple difference, complicates the interpretation of the overall effect. Hence a simplified representation of eq. 1.2 has been proposed in table 1.7 to separate out the different source of impacts over product categories. Such a representation helps to understand both direct and indirect impacts and also helps to propose testing mechanism to understand the overall impact. Table 1.7 segregates the impact

[26]Further, I check the robustness of results by incorporating the own tariff change and its interaction effects in Eq. 1.5. The estimates are found to be robust under own tariff changes

across four scenarios namely (i) other products which are not impacted by any tariffs (ii) products impacted by tariffs and are traded across all destinations (iii) products impacted by tariffs and are traded with the US and (iv) products impacted by tariffs and are traded with China. The product interaction coefficients represents differential impact of tariffs on product classes and $\hat{\alpha}$ represents the estimated value of parameter α.

Table 1.7: Difference of specifications over product classification

	$C_i = 1$	$C_i = 0$
Other products	$\hat{\alpha}_0$	$\hat{\alpha}_0$
Products to other destinations	$\hat{\alpha}_0 + (\hat{\gamma}_2^{US} + \hat{\gamma}_6^{US}) \times Duty_i + (\hat{\gamma}_2^{China} + \hat{\gamma}_6^{China}) \times ReDuty_i$	$\hat{\alpha}_0 + \hat{\gamma}_2^{US} \times Duty_i + \hat{\gamma}_2^{China} \times ReDuty_i$
Products to the US	$(\hat{\alpha}_0 + \hat{\gamma}_1^{US} + \hat{\gamma}_5^{US}) + (\hat{\gamma}_2^{US} + \hat{\gamma}_3^{US} + \hat{\gamma}_6^{US} + \hat{\gamma}_7^{US}) \times Duty_i + (\hat{\gamma}_2^{China} + \hat{\gamma}_4^{US} + \hat{\gamma}_8^{US}) \times ReDuty_i$	$(\hat{\alpha}_0 + \hat{\gamma}_1^{US}) + (\hat{\gamma}_2^{US} + \hat{\gamma}_3^{US}) \times Duty_i + (\hat{\gamma}_2^{China} + \hat{\gamma}_4^{US}) \times ReDuty_i$
Products to China	$(\hat{\alpha}_0 + \hat{\gamma}_1^{China} + \hat{\gamma}_5^{China}) + (\hat{\gamma}_2^{US} + \hat{\gamma}_4^{China} + \hat{\gamma}_8^{China}) \times Duty_i + (\hat{\gamma}_2^{China} + \hat{\gamma}_3^{China} + \hat{\gamma}_6^{China} + \hat{\gamma}_7^{China}) \times ReDuty_i$	$(\hat{\alpha}_0 + \hat{\gamma}_1^{China}) + (\hat{\gamma}_2^{US} + \hat{\gamma}_4^{China}) \times Duty_i + (\hat{\gamma}_2^{China} + \hat{\gamma}_3^{China}) \times ReDuty_i$

Following Table 1.7, the differential impact of tariffs on any particular product category are divided into direct impacts and indirect impacts. The direct differential impact is expressed as linear combination of different coefficients representing average impact for the product class due to tariffs and specific tariff impact due to trade destinations. For instance, specific category products traded with US has two different sources of differential impact namely $\hat{\gamma}_6^{US}$ and $\hat{\gamma}_7^{US}$. The average differential impact i.e. $\hat{\gamma}_6^{US}$, represents the average change in export (or import) across all destinations. Such average and differential effects, if found to be statistically significant, points towards average trade diversion effect due to tariffs. The other component, i.e. $\hat{\gamma}_7^{US}$, is the differential impact of tariffs on products traded with the US and hence can be termed as specific trade diversion effect on product categories. However unlike Eq. 3.23 (or eq. 1.2), the presence of average trade diversion and specific trade diversion impact complicates the overall impact of tariffs on products falling under particular product category. For instance, the average trade diversion effect can be negative for intermediate goods category whereas the specific trade diversion impact can be positive. Hence the overall impact may be positive or negative. Hence the overall impact of US tariffs and China retaliatory tariffs is examined using hypothesis testing on sum of coefficients. Similarly the indirect differential impact involves additional coefficient $\hat{\gamma}_8^{US}$ which can be positive or negative. In general, the hypothesis testing framework can be illustrated as follows

$$\begin{aligned} \Omega^C &= \{i : C_i = 1\} \text{ Products within class} \\ \Omega^N &= \{i : C_i = 0\} \text{ Products not within class} \end{aligned} \tag{1.6}$$

Direct impact on Ω^C	
Trade with the US	$H_0 : \gamma_2^{US} + \gamma_3^{US} + \gamma_6^{US} + \gamma_7^{US} = 0$
Trade with China	$H_0 : \gamma_2^{China} + \gamma_3^{China} + \gamma_6^{China} + \gamma_7^{China} = 0$
Direct impact on Ω^N	
Trade with the US	$H_0 : \gamma_2^{US} + \gamma_3^{US} = 0$
Trade with China	$H_0 : \gamma_2^{China} + \gamma_3^{China} = 0$

1.6.2 Empirical Findings

Heterogeneous impact on India's Export

The heterogeneous impact of tariffs imposed by the US and China during the recent trade war has been estimated coefficients from Equation 1.5 using different product classifications. Table 1.8 represents the estimates from regression equation using annual data from 2013-2020. However it is very difficult to evaluate the net impact of US tariffs and China's retaliatory tariffs from Table 1.8. The net effects of tariff has been analyzed using sum of coefficients, as indicated in previous section. Table 1.9 represents the net impact of trade war on India's exports on

Final goods and Input (or intermediate) goods. The net impact of US tariffs and China's tariff, calculated from 1.8, is represented in Table 1.9. The significance level of net impact, derived using standard error of estimates, is reported at 5 per cent level and statistically significant impact of the tariffs is indicated with ** in the coefficient estimates. The panel regression is separately carried out for three types of classification of products namely (i) intermediate goods vs consumption goods (ii) homogeneous goods vs differentiated goods and (iii) high elastic goods vs low elastic goods. The panel regression estimates for first classification of products (i.e. intermediate vs final goods) is presented in Table 1.8 whereas the other panel regression estimate for other classifications are represented in Annex. Only the summary table for each product classification is reported in Table 1.9, Table 1.10 and Table 1.11 respectively.

Table 1.9 provides the panel regression estimates for net effect of US tariffs and China tariffs. The estimated coefficient of final goods indicates positive and significant impact of the export of final consumption goods to US due to US tariffs. However the impact of China retaliatory tariffs does not provide any significant change in India's export of final goods to China. The export of intermediate goods (or input goods) does not register any significant change to the US and to China due to the trade war. This finding corroborates with the fact that final goods are easily replaceable where intermediate goods, used in production process, is not easily replaceable. The impact of tariffs on export of final goods is also found to be robust in nature. Finally, India's export of final goods as Ill as intermediate goods to other destinations does not change significantly due to tariffs imposed by the US and China during the trade war.

Tariffs impact on exports has also been analyzed on homogeneous goods and differentiated goods. The net effect of US tariffs and China retaliatory tariffs, represented in Table 1.10, indicates that homogeneous goods export from India increased to US due to US tariffs whereas India's export of differentiated goods did not have any significant impact due to tariffs posed by the US during trade war. The impact of China's retaliatory tariff is found to be muted on export of homogeneous goods and differentiated goods.

A similar analysis was carried out on highly elastic goods and low elastic goods. The trade elasticity estimates are drawn from Broda & Winstein (2006) at HS6 digit level. High elastic goods are those goods which have a substitution elasticity higher than median trade elasticity. Using same specification, the net effect of the tariffs on India's export revealed that export of high elastic goods increased to US due to tariffs imposed by the US where the short term impact of the low elastic products Ire found to be insignificant. No significant impact was visible in case of India's export to China for high and low elastic products.

Summarizing the panel regression estimates across different classifications of products, I can infer that the export intensity of easily replaceable products increased to the US due to the tariffs imposed by the US during US-China tariff war. Products like specialized products, low elastic products cannot be easily replaced in short run which is reflected in the estimated net effect coefficients. The impact of retaliatory tariffs imposed by the Chinese authority during the trade war, does not have any significant impact on India's export intensity. Exports to other destinations did not register any significant changes due to US-China trade war. The findings broadly corroborates with the trade diversion mechanism in short term.

Trade diversion appeared to have positive thrust due to higher export to the US and such strong positive effect underlines significant substitution happening with Chinese export being substituted by India's export to the US. The substitution effect is found to be strongly significant due to similar comparative advantage of producing targeted products by the Indian and Chinese firms. However the tariffs imposed by the Chinese Authorities are primarily agricultural commodities where India appears to have no comparative advantage, resulting in an insignificant impact.

Table 1.8: Intermediate Goods: Fixed Effect Estimate

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Class	0.048	0.055	0.049	0.109*	0.023	0.038	0.036	0.083*
	(0.048)	(0.043)	(0.051)	(0.057)	(0.041)	(0.044)	(0.047)	(0.048)
$\mathbf{1}_{US}$	-0.225**	-0.225***	-0.225***	-0.225***	-0.208**	-0.208***	-0.208***	-0.208***
	(0.080)	(0.063)	(0.065)	(0.061)	(0.088)	(0.069)	(0.067)	(0.065)
$\mathbf{1}_{China}$	-0.154*	-0.154***	-0.154***	-0.154***	-0.144*	-0.144***	-0.144***	-0.144***
	(0.078)	(0.053)	(0.057)	(0.051)	(0.073)	(0.050)	(0.046)	(0.044)
Tariff	0.121	0.075	0.026	-0.030	-0.159	-0.172	-0.194	-0.277
	(0.282)	(0.232)	(0.285)	(0.273)	(0.264)	(0.223)	(0.253)	(0.231)
Re. Tariff	0.377	0.363*	0.363	0.737***	0.119	0.166	0.150	0.520*
	(0.336)	(0.215)	(0.236)	(0.276)	(0.464)	(0.256)	(0.265)	(0.295)
Tariff x Input	0.102	0.129	0.171	-0.022	0.301**	0.259	0.277	0.122
	(0.183)	(0.208)	(0.233)	(0.258)	(0.122)	(0.171)	(0.217)	(0.222)
Re. Tariff x Input	0.291	0.318	0.365	0.303	0.050	-0.093	-0.058	-0.117
	(0.477)	(0.356)	(0.336)	(0.421)	(0.327)	(0.303)	(0.316)	(0.366)
$\mathbf{1}_{US}$ x Input	0.008	0.008	0.008	0.008	0.043	0.043	0.043	0.043
	(0.074)	(0.066)	(0.074)	(0.072)	(0.068)	(0.070)	(0.075)	(0.071)
$\mathbf{1}_{China}$ x Input	-0.030	-0.030	-0.030	-0.030	-0.139**	-0.139*	-0.139**	-0.139**
	(0.085)	(0.081)	(0.091)	(0.080)	(0.060)	(0.073)	(0.065)	(0.060)
Tariff x $\mathbf{1}_{US}$	1.123**	1.123***	1.123***	1.123***	1.463***	1.463***	1.463***	1.463***
	(0.418)	(0.347)	(0.371)	(0.359)	(0.422)	(0.374)	(0.388)	(0.364)
Re. Tariff x $\mathbf{1}_{US}$	-0.181	-0.181	-0.181	-0.181	0.230	0.230	0.230	0.230
	(0.563)	(0.326)	(0.315)	(0.264)	(0.746)	(0.357)	(0.362)	(0.303)
Re. Tariff x $\mathbf{1}_{China}$	-0.611	-0.611	-0.611	-0.611	-0.350	-0.350	-0.350	-0.350
	(0.664)	(0.406)	(0.433)	(0.382)	(0.704)	(0.376)	(0.376)	(0.334)
Tariff x $\mathbf{1}_{China}$	0.165	0.165	0.165	0.165	0.319	0.319	0.319	0.319
	(0.531)	(0.415)	(0.452)	(0.378)	(0.446)	(0.357)	(0.334)	(0.280)
$\mathbf{1}_{US}$ x Tariff x Input	-0.681	-0.681*	-0.681*	-0.681*	-0.958**	-0.958**	-0.958**	-0.958***
	(0.380)	(0.376)	(0.385)	(0.360)	(0.339)	(0.370)	(0.378)	(0.355)
$\mathbf{1}_{China}$ x Re. Tariff x Input	0.022	0.022	0.022	0.022	0.701	0.701	0.701	0.701
	(1.450)	(1.104)	(0.950)	(0.903)	(0.617)	(0.600)	(0.656)	(0.614)
Observations	14,364	14,364	14,364	14,364	14,364	14,364	14,364	14,364
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destimation is China.
$Tariff$ stands for the US tariffs imposed on China
$Retariff$ is the retaliatory tariffs imposed by China on the US.
$Input$ is a dummy variable for intermediary goods
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Following Table 1.8, the effect of the tariffs (US tariffs on China and Chinese tariffs on US) are evaluated to assess the total heterogeneous effect on different product categories.

Table 1.9: Fixed Effect Estimate: Intermediate Goods and Final Goods

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Export of Final Goods - US	1.051**	0.920**	0.868**	0.867**	1.112**	1.065**	1.035**	1.005**
Export of Final Goods - China	-0.010	0.351	0.391	0.447	-0.156	0.029	0.064	0.131
Export of Input Goods - US	-0.447	-0.334	-0.287	-0.515	-0.518**	-0.538	-0.508	-0.690
Export of Input Goods - China	0.343	0.114	0.056	0.334	-0.164**	-0.201	-0.275	-0.153
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

Refer to Table 1.8 for details
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.10: Fixed Effect Estimate: Differentiated Good and Homogeneous Good

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Export of Homogenous Goods - US	0.767**	0.739**	0.711**	0.571**	0.842**	0.757**	0.751**	0.578**
Export of Homogenous Goods - China	0.376	0.740	0.729	1.066**	-0.229	0.073	0.048	0.268
Export of Diff Goods - US	-0.144	-0.125	-0.130	-0.145	-0.216	-0.116	-0.139	-0.035
Export of Diff Goods - China	-0.257	-0.484	-0.502	-0.607	-0.324	-0.627	-0.628	-0.623
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

Refer to Table 1.9 for details
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.11: Fixed Effect Estimate: High vs Low Elasticity

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Export of High Elastic Goods - US	0.544**	0.498**	0.358	0.672**	0.551**	0.549**	0.449**	0.799**
Export of High Elastic Goods - China	-1.066	-0.671	-0.531	-0.716	-0.968	-0.777	-0.702	-1.082
Export of Low Elastic Goods - US	0.306	0.297	0.425	-0.017	0.321	0.266	0.367	-0.112
Export of Low Elastic Goods - China	1.377*	1.197	1.046	1.582**	.688	.656	.564	1.209**
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

Refer to Table 1.10 in appendix for details
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Impact on India's Import

The detailed panel regression results are reported in Annex 1.8 for reference. The net effects, calculated using sum of coefficients, are reported in the summary table. The heterogeneous impact of tariffs is analyzed across three different classifications of products. Table 1.12, Table 1.13 and Table 1.14 reports the net effects of US tariffs and China tariffs for each type of classifications.

India's import intensity appears to remain unchanged across product classification when traded with the US and China. The import of final goods increased using long difference - in - difference. A similar pattern is observed in case of homogeneous goods and elastic goods also. However the robustness of estimates cannot be ensured as the impact changes sign across different product fixed effects. Also the difference-in-difference estimates using short difference show insignificant impact of tariffs. This corroborates with the fact that India's import from the US and China did not show any significant impact due to US-China tariff war. However the impact was found to be significant for imports from other destinations.

Table 1.12: Fixed Effect Estimate: Intermediate and Final Goods

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Import of Final Goods - US	-0.071	-0.136	-0.156	-0.215	0.027	-0.084	-0.094	-0.107
Import of Final Goods - China	-0.107	0.151	0.129	-0.031	0.759**	1.120*	1.028**	1.064**
Import of Input Goods - US	-0.119	-0.054	-0.039	0.078	-0.040	0.012	0.015	0.051
Import of Input Goods - China	-0.131	-0.288	-0.297	-0.232	-0.628	-0.868	-0.805	-0.914

Refer to Table 1.18 in appendix for details
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.13: Fixed Effect Estimate: Differentiated and Homogeneous Good

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Import of Homogenous Goods - US	-0.180	-0.180	-0.175	-0.122	0.058	0.016	0.021	0.037
Import of Homogenous Goods - China	-0.151	-0.004	-0.032	-0.229	0.427	0.699*	0.677*	0.644*
Import of Diff Goods - US	0.130	0.069	0.023	-0.118	0.050	0.024	0.042	0.082
Import of Diff Goods - China	0.079	0.071	0.046	0.192	-0.025	-0.191	-0.233	-0.132

Refer to Table 1.19 in appendix for details
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.14: Fixed Effect Estimate: High Elastic and Low Elastic Goods

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Import of High Elastic Goods - US	0.158	0.225	0.269	0.190	0.471	0.536*	0.603*	0.205
Import of High Elastic Goods - China	-0.137	-0.051	-0.100	-0.482	0.450	0.564*	0.477	0.232
Import of Low Elastic Goods - US	-0.314	-0.421	-0.476	-0.398	-0.405	-0.541	-0.599	-0.153
Import of Low Elastic Goods - China	-0.009	0.051	0.074	0.316	0.035	0.143	0.195	0.476

Refer to Table **??** in appendix for details
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

1.7 Concluding Remarks

The tariff war introduced a new era of protectionism in international trade. Higher tariff imposed by US was retaliated with high tariff barriers by China and other large trading partners on US Export. In this context, the paper looks at the implication of tariff war on neutral trading partner like India. Using product level data, the paper evaluates the impact of tariffs imposed by the US and retaliatory tariffs imposed by China on overall exports and imports from India. Further the paper introduces product classifications across different dimensions, to understand any product level heterogeneity in tariff impact.

Using product level export and import data at HS-6 digit level, the paper documents a asymmetric impact of the tariffs imposed by the US and the retaliatory tariff imposed by China on aggregate trade of India. The export data showcases strong substitution of Chinese exports for Indian exports to the US. The impact of US tariffs appears to be the major driver behind the influx of exports to the US. The retaliatory tariffs, imposed by China, appears to have insignificant impact on India's export. The indirect impact of tariffs is insignificant on Indian exports. The substitution effect from US tariffs highlights that Indian firms exhibit similar comparative advantage of producing tariff impacted products.

Unlike export impact, the impact of US tariffs and retaliatory tariffs by China are mainly contributed towards higher import value from other destinations. Such positive and significant impact on India's export to the US and India's import from other destinations follows trade diversion mechanism where neutral trade partner benefits from trade war due to diversion of trade from countries involved in trade war.

Further, the impact of US-China trade war has significant impact on easily replaceable products in short term. The paper uses three different classifications of products to assess the heterogeneity in impact of US tariffs and China's retaliatory tariffs. India's final goods export increased to the US due to trade war whereas the export of intermediate goods do not show similar effect from tariffs. Similar result follows using other product classifications namely homogeneous vs differentiated goods classification and highly elastic vs low elastic goods. In both the cases, export intensity increased for products which can be easily substituted. The effect of trade war appears to be similar in case of imports also. However unlike the exports, the import intensity appears to have increased for easily substituted products from other destinations.

Finally, the impact of tariffs imposed by the US and China influenced the unit value of exports. Tariffs imposed by the US improved the pricing poIr of Indian firms whereas the impact of China's retaliatory tariffs is found to have muted impact on export price. The quantity impact remains insignificant in case of Indian exports. On the other hand, the tariff appears to have significant impact on quantity of imports by Indian firms and households. The price burden from imports remained at same level as higher tariffs does not influence the unit value of imports.

1.8 Appendix

1.8.1 Heterogeneous impact on exports of different product categories

Table 1.15: Differentiated Goods: Fixed Effect Estimate

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Diff (C)	0.562	0.745	0.778	0.938*	0.091	0.282	0.318	0.220
	(0.564)	(0.585)	(0.540)	(0.504)	(0.336)	(0.469)	(0.434)	(0.436)
$\mathbf{1}_{US}$	-0.765	-0.765	-0.765	-0.765	-1.203	-1.203**	-1.203**	-1.203**
	(0.658)	(0.603)	(0.577)	(0.534)	(0.670)	(0.563)	(0.549)	(0.537)
$\mathbf{1}_{China}$	-0.476	-0.476	-0.476	-0.476	-0.309	-0.309	-0.309	-0.309
	(0.562)	(1.143)	(0.896)	(0.783)	(0.599)	(0.884)	(0.706)	(0.604)
Tariff	0.316	0.287	0.259	0.119	0.153	0.069	0.063	-0.110
	(0.208)	(0.214)	(0.246)	(0.240)	(0.256)	(0.238)	(0.230)	(0.222)
Re. Tariff	0.209	0.573	0.562	0.900*	-0.172	0.131	0.105	0.326
	(0.558)	(0.558)	(0.491)	(0.474)	(0.362)	(0.451)	(0.424)	(0.400)
Tariff x Diff (C)	-0.194	-0.176	-0.180	-0.195	-0.109	-0.009	-0.032	0.073
	(0.208)	(0.190)	(0.226)	(0.233)	(0.140)	(0.143)	(0.187)	(0.215)
Re. Tariff x Diff (C)	-0.278	-0.505	-0.523	-0.628	0.042	-0.260	-0.262	-0.256
	(0.528)	(0.532)	(0.469)	(0.441)	(0.373)	(0.432)	(0.377)	(0.381)
$\mathbf{1}_{US}$ x Diff (C)	-0.016	-0.016	-0.016	-0.016	0.191	0.191	0.191	0.191
	(0.248)	(0.310)	(0.366)	(0.349)	(0.240)	(0.343)	(0.362)	(0.362)
$\mathbf{1}_{China}$ x Diff (C)	-0.173	-0.173	-0.173	-0.173	0.367	0.367	0.367	0.367
	(0.963)	(1.303)	(1.162)	(1.009)	(0.714)	(0.966)	(0.828)	(0.693)
Tariff x $\mathbf{1}_{US}$	0.452	0.452	0.452	0.452*	0.688	0.688*	0.688**	0.688**
	(0.287)	(0.302)	(0.281)	(0.273)	(0.437)	(0.369)	(0.300)	(0.280)
Re. Tariff x $\mathbf{1}_{US}$	0.082	0.082	0.082	0.082	0.302	0.302	0.302	0.302
	(0.457)	(0.470)	(0.429)	(0.417)	(0.387)	(0.416)	(0.435)	(0.425)
Re. Tariff x $\mathbf{1}_{China}$	0.166	0.166	0.166	0.166	-0.058	-0.058	-0.058	-0.058
	(0.687)	(1.209)	(0.987)	(0.805)	(0.569)	(0.933)	(0.751)	(0.630)
Tariff x $\mathbf{1}_{China}$	0.167	0.167	0.167	0.167	0.185	0.185	0.185	0.185
	(0.376)	(0.367)	(0.405)	(0.356)	(0.370)	(0.324)	(0.292)	(0.263)
$\mathbf{1}_{US}$ x Tariff x Diff (C)	0.050	0.050	0.050	0.050	-0.107	-0.107	-0.107	-0.107
	(0.201)	(0.258)	(0.306)	(0.295)	(0.187)	(0.292)	(0.307)	(0.306)
$\mathbf{1}_{China}$ x Re. Tariff x Diff (C)	0.021	0.021	0.021	0.021	-0.367	-0.367	-0.367	-0.367
	(0.930)	(1.246)	(1.099)	(0.954)	(0.675)	(0.920)	(0.781)	(0.650)
Observations	14,364	14,364	14,364	14,364	14,364	14,364	14,364	14,364
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
$Tariff$ stands for the US tariffs imposed on China
$Retariff$ is the retaliatory tariffs imposed by China on the US.
$Input$ is a dummy variable for intermediary goods
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.16: Elastic Goods: Fixed Effect Estimate

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
high_elas	-0.310	-0.136	-0.113	-0.185	0.369	0.460	0.449	0.296
	(0.704)	(0.640)	(0.628)	(0.741)	(0.384)	(0.516)	(0.529)	(0.688)
$\mathbf{1}_{US}$	-0.244	-0.244	-0.244	-0.244	-0.398	-0.398	-0.398	-0.398
	(0.816)	(0.735)	(0.755)	(0.659)	(0.530)	(0.534)	(0.616)	(0.592)
$\mathbf{1}_{China}$	0.657	0.657	0.657	0.657	0.420	0.420	0.420	0.420
	(1.227)	(1.109)	(1.053)	(1.148)	(1.190)	(0.902)	(0.880)	(0.867)
Tariff	0.467	0.420	0.280	0.594	0.530	0.528	0.428	0.778*
	(0.401)	(0.381)	(0.435)	(0.438)	(0.378)	(0.321)	(0.388)	(0.454)
Re. Tariff	-0.494	-0.099	0.041	-0.144	-0.411	-0.220	-0.145	-0.525
	(0.654)	(0.515)	(0.500)	(0.718)	(0.475)	(0.473)	(0.504)	(0.670)
Tariff x Elasticity (L)	-0.164	-0.173	-0.045	-0.486	-0.432	-0.487*	-0.387	-0.865**
	(0.362)	(0.347)	(0.414)	(0.413)	(0.294)	(0.291)	(0.384)	(0.433)
Re. Tariff x Elasticity (L)	0.659	0.479	0.328	0.864	0.266	0.234	0.142	0.788
	(0.480)	(0.437)	(0.441)	(0.687)	(0.327)	(0.392)	(0.447)	(0.641)
$\mathbf{1}_{US}$ x Elasticity (L)	-0.711	-0.711	-0.711	-0.711	-1.011*	-1.011**	-1.011*	-1.011**
	(0.605)	(0.599)	(0.639)	(0.549)	(0.471)	(0.469)	(0.531)	(0.478)
$\mathbf{1}_{China}$ x Elasticity (L)	-0.981	-0.981	-0.981	-0.981	-0.640	-0.640	-0.640	-0.640
	(1.156)	(1.260)	(1.149)	(1.247)	(1.000)	(1.006)	(0.961)	(0.913)
Tariff x $\mathbf{1}_{US}$	0.078	0.078	0.078	0.078	0.021	0.021	0.021	0.021
	(0.556)	(0.539)	(0.561)	(0.457)	(0.391)	(0.374)	(0.418)	(0.376)
Re. Tariff x $\mathbf{1}_{US}$	0.169	0.169	0.169	0.169	0.424	0.424	0.424	0.424
	(0.420)	(0.471)	(0.430)	(0.423)	(0.360)	(0.417)	(0.441)	(0.435)
Re. Tariff x $\mathbf{1}_{China}$	-0.572	-0.572	-0.572	-0.572	-0.557	-0.557	-0.557	-0.557
	(1.050)	(1.009)	(1.000)	(1.108)	(0.944)	(0.835)	(0.840)	(0.828)
Tariff x $\mathbf{1}_{China}$	-0.020	-0.020	-0.020	-0.020	0.159	0.159	0.159	0.159
	(0.368)	(0.353)	(0.401)	(0.335)	(0.378)	(0.327)	(0.288)	(0.251)
$\mathbf{1}_{US}$ x Tariff x Elasticity (L)	0.470	0.470	0.470	0.470	0.754	0.754*	0.754	0.754*
	(0.523)	(0.518)	(0.563)	(0.475)	(0.432)	(0.407)	(0.466)	(0.407)
$\mathbf{1}_{China}$ x Re. Tariff x Elasticity (L)	0.717	0.717	0.717	0.717	0.422	0.422	0.422	0.422
	(1.075)	(1.175)	(1.074)	(1.177)	(0.913)	(0.918)	(0.874)	(0.852)
Observations	14,364	14,364	14,364	14,364	14,364	14,364	14,364	14,364
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destimation is China.
$Tariff$ stands for the US tariffs imposed on China
$Retariff$ is the retaliatory tariffs imposed by China on the US.
$Input$ is a dummy variable for intermediary goods
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

1.8.2 Heterogeneous impact on imports of different product categories

Table 1.17: Intermediate Goods: Fixed Effect Estimate

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Diff (C)	0.562	0.745	0.778	0.938*	0.091	0.282	0.318	0.220
	(0.564)	(0.585)	(0.540)	(0.504)	(0.336)	(0.469)	(0.434)	(0.436)
$\mathbf{1}_{US}$	-0.765	-0.765	-0.765	-0.765	-1.203	-1.203**	-1.203**	-1.203**
	(0.658)	(0.603)	(0.577)	(0.534)	(0.670)	(0.563)	(0.549)	(0.537)
$\mathbf{1}_{China}$	-0.476	-0.476	-0.476	-0.476	-0.309	-0.309	-0.309	-0.309
	(0.562)	(1.143)	(0.896)	(0.783)	(0.599)	(0.884)	(0.706)	(0.604)
Tariff	0.316	0.287	0.259	0.119	0.153	0.069	0.063	-0.110
	(0.208)	(0.214)	(0.246)	(0.240)	(0.256)	(0.238)	(0.230)	(0.222)
Re. Tariff	0.209	0.573	0.562	0.900*	-0.172	0.131	0.105	0.326
	(0.558)	(0.558)	(0.491)	(0.474)	(0.362)	(0.451)	(0.424)	(0.400)
Tariff x Diff (C)	-0.194	-0.176	-0.180	-0.195	-0.109	-0.009	-0.032	0.073
	(0.208)	(0.190)	(0.226)	(0.233)	(0.140)	(0.143)	(0.187)	(0.215)
Re. Tariff x Diff (C)	-0.278	-0.505	-0.523	-0.628	0.042	-0.260	-0.262	-0.256
	(0.528)	(0.532)	(0.469)	(0.441)	(0.373)	(0.432)	(0.377)	(0.381)
$\mathbf{1}_{US}$ x Diff (C)	-0.016	-0.016	-0.016	-0.016	0.191	0.191	0.191	0.191
	(0.248)	(0.310)	(0.366)	(0.349)	(0.240)	(0.343)	(0.362)	(0.362)
$\mathbf{1}_{China}$ x Diff (C)	-0.173	-0.173	-0.173	-0.173	0.367	0.367	0.367	0.367
	(0.963)	(1.303)	(1.162)	(1.009)	(0.714)	(0.966)	(0.828)	(0.693)
Tariff x $\mathbf{1}_{US}$	0.452	0.452	0.452	0.452*	0.688	0.688*	0.688**	0.688**
	(0.287)	(0.302)	(0.281)	(0.273)	(0.437)	(0.369)	(0.300)	(0.280)
Re. Tariff x $\mathbf{1}_{US}$	0.082	0.082	0.082	0.082	0.302	0.302	0.302	0.302
	(0.457)	(0.470)	(0.429)	(0.417)	(0.387)	(0.416)	(0.435)	(0.425)
Re. Tariff x $\mathbf{1}_{China}$	0.166	0.166	0.166	0.166	-0.058	-0.058	-0.058	-0.058
	(0.687)	(1.209)	(0.987)	(0.805)	(0.569)	(0.933)	(0.751)	(0.630)
Tariff x $\mathbf{1}_{China}$	0.167	0.167	0.167	0.167	0.185	0.185	0.185	0.185
	(0.376)	(0.367)	(0.405)	(0.356)	(0.370)	(0.324)	(0.292)	(0.263)
$\mathbf{1}_{US}$ x Tariff x Diff (C)	0.050	0.050	0.050	0.050	-0.107	-0.107	-0.107	-0.107
	(0.201)	(0.258)	(0.306)	(0.295)	(0.187)	(0.292)	(0.307)	(0.306)
$\mathbf{1}_{China}$ x Re. Tariff x Diff (C)	0.021	0.021	0.021	0.021	-0.367	-0.367	-0.367	-0.367
	(0.930)	(1.246)	(1.099)	(0.954)	(0.675)	(0.920)	(0.781)	(0.650)
Observations	14,364	14,364	14,364	14,364	14,364	14,364	14,364	14,364
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
$Tariff$ stands for the US tariffs imposed on China
$Retariff$ is the retaliatory tariffs imposed by China on the US.
$Input$ is a dummy variable for intermediary goods
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.18: Differentiated Goods: Fixed Effect Estimate

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
Diff (C)	0.074**	0.071*	0.080**	0.078**	0.135**	0.139***	0.136***	0.184***
	(0.029)	(0.039)	(0.033)	(0.032)	(0.044)	(0.045)	(0.045)	(0.048)
$\mathbf{1}_{US}$	-0.019	-0.019	-0.019	-0.019	0.015	0.015	0.015	0.015
	(0.017)	(0.015)	(0.015)	(0.014)	(0.025)	(0.024)	(0.022)	(0.020)
$\mathbf{1}_{China}$	-0.025	-0.025*	-0.025*	-0.025*	-0.012	-0.012	-0.012	-0.012
	(0.018)	(0.014)	(0.013)	(0.014)	(0.022)	(0.021)	(0.019)	(0.019)
Tariff	0.256*	0.257**	0.261**	0.315**	0.731***	0.688***	0.694***	0.710***
	(0.135)	(0.112)	(0.112)	(0.144)	(0.174)	(0.158)	(0.144)	(0.187)
Re. Tariff	0.406**	0.554**	0.526**	0.328	1.230***	1.502***	1.480***	1.447***
	(0.154)	(0.223)	(0.224)	(0.302)	(0.337)	(0.289)	(0.316)	(0.372)
Tariff x Diff (C)	-0.005	-0.066	-0.112	-0.252	-0.063	-0.089	-0.070	-0.195
	(0.194)	(0.140)	(0.150)	(0.178)	(0.200)	(0.210)	(0.202)	(0.256)
Re. Tariff x Diff (C)	-0.413*	-0.421	-0.446	-0.301	-0.913**	-1.079***	-1.121***	-1.020**
	(0.192)	(0.261)	(0.272)	(0.315)	(0.328)	(0.282)	(0.327)	(0.396)
$\mathbf{1}_{US}$ x Diff (C)	-0.073	-0.073	-0.073	-0.073*	-0.086	-0.086*	-0.086*	-0.086*
	(0.055)	(0.044)	(0.045)	(0.042)	(0.066)	(0.050)	(0.049)	(0.046)
$\mathbf{1}_{China}$ x Diff (C)	-0.095**	-0.095*	-0.095**	-0.095**	-0.057	-0.057	-0.057	-0.057
	(0.034)	(0.049)	(0.045)	(0.039)	(0.045)	(0.059)	(0.047)	(0.042)
Tariff x $\mathbf{1}_{US}$	-0.436***	-0.436***	-0.436***	-0.436***	-0.672***	-0.672***	-0.672***	-0.672***
	(0.072)	(0.135)	(0.131)	(0.140)	(0.139)	(0.158)	(0.148)	(0.160)
Re. Tariff x $\mathbf{1}_{US}$	0.329**	0.329	0.329	0.329	-0.195	-0.195	-0.195	-0.195
	(0.118)	(0.234)	(0.235)	(0.264)	(0.223)	(0.266)	(0.255)	(0.286)
Re. Tariff x $\mathbf{1}_{China}$	-0.557	-0.557	-0.557	-0.557	-0.803	-0.803**	-0.803***	-0.803**
	(0.389)	(0.351)	(0.339)	(0.339)	(0.446)	(0.341)	(0.297)	(0.333)
Tariff x $\mathbf{1}_{China}$	0.200	0.200	0.200	0.200	0.139	0.139	0.139	0.139
	(0.147)	(0.125)	(0.138)	(0.141)	(0.132)	(0.173)	(0.166)	(0.161)
$\mathbf{1}_{US}$ x Tariff x Diff (C)	0.135	0.135	0.135	0.135	0.113	0.113	0.113	0.113
	(0.216)	(0.178)	(0.209)	(0.224)	(0.279)	(0.240)	(0.252)	(0.253)
$\mathbf{1}_{China}$ x Re. Tariff x Diff (C)	0.492	0.492	0.492	0.492	0.888	0.888	0.888*	0.888*
	(0.437)	(0.555)	(0.523)	(0.475)	(0.511)	(0.599)	(0.533)	(0.506)
Observations	17,961	17,961	17,961	17,961	17,961	17,961	17,961	17,961
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destimation is China.
$Tariff$ stands for the US tariffs imposed on China
$Retariff$ is the retaliatory tariffs imposed by China on the US.
$Input$ is a dummy variable for intermediary goods
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.19: Elastic Goods: Fixed Effect Estimate

VARIABLES	(1) Short	(2) Short	(3) Short	(4) Short	(5) Long	(6) Long	(7) Long	(8) Long
high_elas	-0.011	-0.005	-0.001	-0.024	-0.075	-0.064	-0.064	-0.104***
	(0.021)	(0.026)	(0.032)	(0.036)	(0.044)	(0.047)	(0.046)	(0.035)
$\mathbf{1}_{US}$	-0.052	-0.052	-0.052	-0.052	-0.084***	-0.084*	-0.084*	-0.084
	(0.041)	(0.038)	(0.039)	(0.048)	(0.023)	(0.049)	(0.047)	(0.059)
$\mathbf{1}_{China}$	-0.039	-0.039	-0.039	-0.039	-0.070	-0.070	-0.070	-0.070
	(0.032)	(0.030)	(0.038)	(0.040)	(0.039)	(0.049)	(0.046)	(0.048)
Tariff	0.345***	0.412**	0.456**	0.378	0.488	0.553*	0.620**	0.222
	(0.094)	(0.172)	(0.227)	(0.383)	(0.351)	(0.318)	(0.270)	(0.344)
Re. Tariff	-0.180	-0.094	-0.143	-0.524	0.263	0.377	0.290	0.044
	(0.316)	(0.418)	(0.416)	(0.505)	(0.302)	(0.494)	(0.545)	(0.587)
Tariff x Elasticity (L)	-0.008	-0.114	-0.169	-0.091	0.371	0.235	0.177	0.624*
	(0.130)	(0.173)	(0.219)	(0.381)	(0.370)	(0.317)	(0.268)	(0.353)
Re. Tariff x Elasticity (L)	0.522	0.583	0.606	0.847*	0.770	0.878	0.930*	1.211**
	(0.387)	(0.446)	(0.417)	(0.494)	(0.440)	(0.550)	(0.533)	(0.591)
$\mathbf{1}_{US}$ x Elasticity (L)	0.022	0.022	0.022	0.022	0.090**	0.090*	0.090*	0.090
	(0.035)	(0.038)	(0.040)	(0.049)	(0.034)	(0.051)	(0.048)	(0.061)
$\mathbf{1}_{China}$ x Elasticity (L)	-0.003	-0.003	-0.003	-0.003	0.050	0.050	0.050	0.050
	(0.039)	(0.034)	(0.041)	(0.041)	(0.043)	(0.052)	(0.047)	(0.049)
Tariff x $\mathbf{1}_{US}$	-0.187	-0.187	-0.187	-0.187	-0.017	-0.017	-0.017	-0.017
	(0.269)	(0.237)	(0.243)	(0.301)	(0.206)	(0.297)	(0.310)	(0.350)
Re. Tariff x $\mathbf{1}_{US}$	0.255*	0.255	0.255	0.255	-0.288	-0.288	-0.288	-0.288
	(0.120)	(0.218)	(0.223)	(0.254)	(0.242)	(0.255)	(0.246)	(0.276)
Re. Tariff x $\mathbf{1}_{China}$	0.043	0.043	0.043	0.043	0.187	0.187	0.187	0.187
	(0.563)	(0.600)	(0.519)	(0.497)	(0.780)	(0.759)	(0.589)	(0.562)
Tariff x $\mathbf{1}_{China}$	0.087	0.087	0.087	0.087	0.110	0.110	0.110	0.110
	(0.139)	(0.125)	(0.127)	(0.137)	(0.145)	(0.167)	(0.150)	(0.158)
$\mathbf{1}_{US}$ x Tariff x Elasticity (L)	-0.307	-0.307	-0.307	-0.307	-0.777**	-0.777***	-0.777**	-0.777**
	(0.249)	(0.218)	(0.226)	(0.296)	(0.246)	(0.285)	(0.304)	(0.348)
$\mathbf{1}_{China}$ x Re. Tariff x Elasticity (L)	-0.532	-0.532	-0.532	-0.532	-0.735	-0.735	-0.735	-0.735
	(0.617)	(0.641)	(0.544)	(0.529)	(0.848)	(0.801)	(0.622)	(0.600)
Observations	17,961	17,961	17,961	17,961	17,961	17,961	17,961	17,961
Fixed Effect	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4
Cluster SE	HS1	HS2	HS3	HS4	HS1	HS2	HS3	HS4

$\mathbf{1}_{US}$ takes value of 1 if the product is exported to the US.
$\mathbf{1}_{China}$ is the dummy variable when export destination is China.
$Tariff$ stands for the US tariffs imposed on China
$Retariff$ is the retaliatory tariffs imposed by China on the US.
$Input$ is a dummy variable for intermediary goods
Robust standard errors are reported in the parenthesis.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 2

Caught in the Crossfire: How Trade Policy Uncertainty Impacts Global Trade

2.1 Introduction

Trade policy uncertainty has become a major concern for global trade in the wake of recent economic policy changes like Brexit, trade protectionism measures, China's lockdowns etc. For example, US Trade policy uncertainty index, developed by Bloom et. al. (2016) and Caldara et. al. (2018) rose to its highest level in 2017 as the protectionist measures were discussed. Similar patterns were observed in China, United Kingdom and European Union. This paper introduces trade policy uncertainty in neo-classical multi-country trade models to provide a structural understanding of the uncertainty effect on global trade flows.

Changes in trade policies impacts trade partners in different ways. Generally, higher tariffs moderates trade intensity among trade partners. However, these policy changes introduce uncertainty among trade partners. The effect of uncertainty complicates firms' decision making process. The unavailability of future policy information at the time of planning, triggers uncertainty in the firms' forward looking allocations and thereby, modulates firms' optimal choice. The effect of TPU affects the global trade partners via trade linkages. The trade protectionist measures adopted by the United States, elevated trade policy uncertainty for the trade partners due to lack of clarity in terms of possible tariff sizes and duration of those policies. These trade policies targeted many trade partners, though the majority of these tariffs were targeted towards China. Higher tariffs increased price level of products coming from those targeted countries and thereby, created an opportunity of trade diversion for other trade partners. However, empirical evidence suggests that the effect of those high tariffs moderated global trade and there was no clear winner from the trade war (Fajgelbaum et. al. (2022)). Also, different trade partners experienced different level of trade intensity in those targeted products (Sanyal (2020); Choi & Nguyen (2021)). The direct effect of higher tariffs moderated consumption demand and increased domestic price level in the United States (Waugh (2019); Fajgelbaum et. al. (2020)). The effect on higher tariffs also affected US consumer through global value chain due to higher tariffs on intermediate goods (Bellora and Fontagne (2020)). The impact of trade war also affected export growth of the US through supply chains due to higher trade tariffs (Handley et. al. (2020)). On the other hand, higher tariffs imposed by the US, marginalized the profit margin of the firms in China (Wang et. al. (2020)). Apart from the direct effect of tariffs, the uncertainty reduced trade volume between China and US (Ongan & Gocer, 2020; Yan & Xiao, 2022; Benguria et. al., 2022). Similar effects were observed during the Brexit vote in 2016. Lack of clarity and widespread speculations about future policies increased uncertainty during Brexit. These uncertainty slowed investment momentum and affected productivity (BoE, 2019) and reduced trade volume by 16-20% between EU and UK (Kren & Lawless (2022)). The recent lockdown in China also imparted similar effects on export intensity and global value chain (Nie, 2022).

From the theoretical point of view, multi-country trade models are used to derive the direct effect of tariffs on different trade partners. Changes in the tariff sizes changes the iceberg trade costs and thereby, impacts the price distribution at the originating country. However, these models do not account for the policy uncertainty. This paper provides a generalization of the trade policy uncertainty in multi-country trade models to address the effect of uncertainty on global trade flows and re-allocations. The model uses the multi-country trade set up under perfect competition following Eaton & Kortum (2002) and introduces trade policy uncertainty from two sources - probability of trade policy changes and possible tariff sizes. The firms make their production plans at the beginning of the period when the trade policies are not yet declared. The uncertainty in trade policy affects the trade intensity as the price distribution in the originating country becomes uncertain. The policy uncertainty, thereby, translates to lower than potential trade intensity among trade partners. The proposed model starts with trade policy changes between two countries i.e. higher tariff is proposed by one country on another. Using the probability of trade policy changes and the possible size effect of tariffs, the model provides an analytical derivation of the effect of TPU on global trade and domestic prices. The model is then extended to a generalized scenario where policy uncertainty affects trade cost on all trade partners. Such generalization can be related to China's recent lockdown. Using this generalized set up, the comparative statics of TPU parameters shows similar effect on all trade partners. Later, the quantitative model is calibrated using different scenarios of tariffs sizes and probability of policy changes to demonstrate the effect of TPU.

The paper contributes to two strand of the literature. The first strand addresses trade integration in multi-country multi-sector Ricardian models (Caliendo and Parro 2010; Shikher 2011; Costinot, Donaldson, and Komunjer 2012). Dekle et. al. (2007, 2008) used similar framework to explain the impact of trade balances on factort costs and welfare. Eaton, Kortum, Neiman and Romalis (2011) extended the model framework to explain the role of trade in global recession. Giovanni et. al. (2014) used similar framework to address the welfare implication of trade partners in the wake of China's trade integration and technological changes. Costinot & Rodriguez-Clare (2014) provided survey of findings of global inter-connectedness and sectoral heterogeneity. Similar model set up was used for explaining equity home bias (Hu, 2022), spatial risk sharing (Arora et. al., 2022). This paper provides a generalization of the Eaton and Kortum (EK) framework (2002) with uncertainty in the trade cost. The paper also contributes to the growing literature of trade policy uncertainty. Some of the notable papers in this context are Handley & Limao (2018, 2022), Steinberg (2015, 2018) and Caldara et. al. (2018). Compared to these papers, my paper addresses the trade policy uncertainty in multi-country and multi-sector set up and analyzes the impact of the uncertainty on trade flows and global re-allocations.

The remaining of the paper is organized as follows - Section 2 provides the model details with analytical derivations, Section 3 details the calibration approach, Section 4 summarizes the findings of the model simulations followed by concluding remarks in Section 5.

2.2 Model

2.2.1 Set up

The model uses Ricardian trade model set up with multiple countries and multiple sectors following Eaton & Kortum (2002). There are N countries (for simplicity, I assume that country 1 is United States and Country 2 is China). There are J traded sectors and one non-traded sector in each country. The production process happen in two stages. In the first stage, each country produces intermediate goods using labor, capital and other intermediate inputs. In the second stage, the final goods are produced using intermediate goods.

The markets are perfectly competitive and international trade is costly. The price charged by the each country is a markup on the unit cost of production adjusting for the trade cost. The final price distribution in any country is derived from the minimum price offered by all trade partners. The capital and labor endowment in each country is fixed. The firms choose factors of production depending upon the final demand of each sector. The productivity distribution follows Frechet distribution.

I assume iceberg trade cost between any two countries. The trade policy changes the trade cost. For simplicity, I assume that possible trade policy changes increases the trade cost on imports from Country 2 to Country 1 [1]). The trade policy uncertainty has two components - the probability of trade policy change and possible size of tariffs.

[1] I am going to generalize this assumption in the next section

The firms make production plans at the beginning of the period before the trade policy is announced and allocates the factors of production (labor, capital ands intermediate goods) based on perception of final demand under uncertainty. I assume that the factor allocations are subject to adjustment costs and hence, cannot be modified after realization of the trade policy. This creates a wedge between potential trade diversion and actual trade diversion on account of higher tariffs imposed by Country 1.

2.2.2 Firms

The production process happens in two stages. The first stage is the production of intermediate goods. I assume that the cost function of each intermediate goods is Cobb-Douglas with labor wage, capital rent and cost of other intermediate goods. The subscripts (i,k etc.) represent countries and superscript (j,l) represent sectors.

$$C_i^j = \left(w_i^{\alpha_j} r_i^{1-\alpha_j} \right)^{\beta_j} \left(\prod_{j=1}^{J+1} (p_i^k)^{\gamma_{jk}} \right)^{1-\beta_j} \tag{2.1}$$

where α_j is the share of labor wage in value added and β_j is the share of value added in sector j. I assume that these shares are constant across countries. However, I will run robustness checks by relaxing this assumption (i.e. α_j and β_j varies across countries).

The unit cost of production of a intermediate good is $C_i^j / Z_i^j(q)$ where $Z_i^j(q)$ is the productivity of country i in sector j. I assume that $Z_i^j(q)$ follows Frechet distribution with scale parameter T_i^j and shape parameter θ. Higher value of T_i^j implies greater absolute comparative advantages of country i in sector j.

Following perfect competition and costly trade, the price charged by country

i on country k in sector j ($p^j_{ki}(q)$) is a mark-up on the unit price of production.

$$p^j_{ki}(q) = \frac{C^j_i}{z_i(q)} d^j_{ki} \tag{2.2}$$

where d^j_{ki} is the iceberg trade cost to export to Country k from Country i. I assume that the trade cost varies across sectors and origin-destination pair.

In the second stage, the final good is produced by the aggregating the intermediate goods using a CES aggregator.

$$Q^j_n = \left[\int_0^1 Q^j_n(q)^{\frac{\epsilon-1}{\epsilon}} dq \right]^{\frac{\epsilon}{\epsilon-1}} \tag{2.3}$$

where ϵ is the elasticity of substitution between varieties.

2.2.3 Trade policy uncertainty

The firms are making their production plan at the beginning of the year. They allocate labor and capital in each sector at the beginning of the period based on their assessment of the final demand in each sector. The final demand of each sector depends upon the trade cost in each sector. We assume that the trade cost between Country 1 and Country 2 in sector j (d^j_{12}) is unknown at the beginning of the year. The unknown value of d^j_{12} imbibes uncertainty in the final price distribution of Sector j in Country 1. As the demand of sector j in Country 1 responds to the unknown trade cost, the trade partners' allocation decision is affected by the trade policy uncertainty.

In order to model the trade policy uncertainty, I introduce two components namely (i) the probability of trade policy changes ($(1-\chi)$) and (ii) Distribution F(.) over all possible values of trade cost d^j_{12} [2]. Higher values of χ implies lower

[2]This specification provides mechanism to decompose the size effect of the tariffs and the

chance of trade policy changes. Further, I assume that the trade cost D_{12}^j [3] follows uniform distribution over d_{12}^j and some bounds D^j (invariant across products) where d_{12}^j is the existing iceberg trade cost between country 1 and country 2 and D^j is the upper bound of tariffs in sector j. One can relate the value of D^j as the bounded tariffs, China's pre-WTO accession tariffs or column 2 tariffs in sector j. The assumption of uniform distribution is driven the non-informative property of the uniform distribution i.e. each value over the support of F(.), is equally probable. This assumption can be generalized. [4] To avoid any such assumptions, I stick to uniform distribution to model the tariff size uncertainty.

Following the assumptions of TPU, the new tariff D_{12}^j follows a mixture of distributions

$$D_{12}^j\Big|_{\text{Under TPU}} \begin{cases} = d_{12}^j & \text{if no change in trade policy}(Pr = \chi) \\ \sim U(d_{12}^j, D^j) & \text{Otherwise}(Pr = 1 - \chi) \end{cases} \tag{2.4}$$

where $U(d_{12}^j, D^j)$ is the uniform distribution between d_{12}^j and D^j.

2.2.4 Price distribution under TPU

Under TPU, the export price distribution of country 2 to country 1 in sector j is given by

---

uncertainty around policy changes which is helpful to generalize the model

[3] I used D_{12}^j in place of d_{12}^j to highlight the stochastic process of trade cost

[4] Any parametric choice of tariff distribution necessarily entails some assumptions about the possible tariff sizes and their likelihood.

$$
\begin{aligned}
G_{12}^j(p) &= \mathbf{P}\left[p_{12}^j \leq p\right] \\
&= \mathbf{P}\left[\frac{C_2^j}{Z_2^j(q)} D_{12}^j \leq p\right] \\
&= 1 - \chi exp\left[-T_2^j\left(C_2^j d_{12}^j\right)^{-\theta} p^{\theta}\right] - (1-\chi)\frac{1}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j} exp\left[-T_2^j\left(C_2^j h\right)^{-\theta} p^{\theta}\right] dh
\end{aligned}
\tag{2.5}
$$

The probability distribution of price p_{12}^j is given by

$$
\begin{aligned}
g_{12}^j(p) &= \chi\theta p^{\theta-1}\left[T_2^j\left(C_2^j d_{12}^j\right)^{-\theta}\right] exp\left[-T_2^j\left(C_2^j d_{12}^j\right)^{-\theta} p^{\theta}\right] \\
&\quad + \frac{1-\chi}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j} \theta p^{\theta-1}\left[T_2^j\left(C_2^j h\right)^{-\theta}\right] exp\left[-T_2^j\left(C_2^j h\right)^{-\theta} p^{\theta}\right] dh
\end{aligned}
\tag{2.6}
$$

The distribution of price of sector j in Country 1, then, includes the mixture of distribution as follows

$$
\begin{aligned}
G_1^j(p) &= \mathbf{P}\left[\min_{i=1(1)N} p_{1i}^j(q) \leq p\right] \\
&= 1 - \mathbf{P}\left[\min_{i=1(1)N} p_{1i}^j(q) > p\right] \\
&= 1 - \chi exp\left[-\Phi_1^j p^{-\theta}\right] - \frac{1-\chi}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j} exp\left[-\Phi_1^j(h) p^{\theta}\right] dh
\end{aligned}
\tag{2.7}
$$

where $\Phi_1^j(h) = \sum_{i\neq 2}^N T_i^j\left(C_i^j d_{1i}^j\right)^{-\theta} + T_2^j\left(C_2^j h\right)^{-\theta}$ is the market access for any trade cost (h) from stochastic distribution of trade cost.

The final price of sector j in Country 1 is given by

$$P_1^j = \Gamma\left[\chi\left(\Phi_1^j\right)^{-\frac{1}{\theta}} + \frac{1-\chi}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\left(\Phi_1^j(h)\right)^{-\frac{1}{\theta}} dh\right] \tag{2.8}$$

where Γ is a constant.

The market access of country 1 deteriorates to $\Phi_1^j\Big|_{\text{TPU}}$

$$\Phi_1^j\Big|_{\text{TPU}} = \chi\Phi_1^j + \frac{1-\chi}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\Phi_1^j(h)dh \tag{2.9}$$

Given the uncertainty in the price distribution in Country 1, the export share of each trade partner i in Country 1 is given by

$$\pi_{1i}^j = \begin{cases} \chi\frac{T_i^j\left(C_i^j d_{1i}^j\right)^{-\theta}}{\Phi_1^j} + \frac{1-\chi}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\frac{T_i^j\left(C_i^j d_{1i}^j\right)^{-\theta}}{\Phi_1^j(h)}dh & \text{if } i \neq 2 \\ \chi\frac{T_2^j\left(C_2^j d_{12}^j\right)^{-\theta}}{\Phi_1^j} + \frac{1-\chi}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\frac{T_2^j\left(C_2^j h\right)^{-\theta}}{\Phi_1^j(h)}dh & \text{if } i = 2 \end{cases} \tag{2.10}$$

2.2.5 Effect of trade policy uncertainty on price and trade

The comparative statics with respect to TPU parameters $(1-\chi)$ and D^j on price level of country 1 shows the effect of the change in TPU. First, the comparative statics with respect to D^j indicates that increase in the upper bound of the tariff size distribution increases overall price level of the sector j in Country 1 (from Eq. 2.11) As tariffs become higher on Country 2, the trade cost increases and the the market access declines.

$$\begin{aligned} \frac{\partial}{\partial D^j}P_1^j &= \frac{1-\chi}{D^j - d_{12}^j}\left[(\Phi_1^j(D^j))^{-\frac{1}{\theta}} - \frac{1-\chi}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}(\Phi_1^j(h))^{-\frac{1}{\theta}}dh\right] \\ &\geq \frac{1-\chi}{D^j - d_{12}^j}(\Phi_1^j(D^j))^{-\frac{1}{\theta}}[1-(1-\chi)] \text{ (Due to convexity)} \\ &\geq 0 \end{aligned} \tag{2.11}$$

The comparative statics of prices with respect to the probability of trade policy changes $(1-\chi)$ also indicates increase in price in distribution in Country 1. When the probability of trade policy changes is high (i.e. $(1-\chi)$ is high), then the relative contribution of the higher tariff reduces market access and the price level increases (from Eq. 2.12).

$$\frac{\partial}{\partial(1-\chi)}P_1^j = \left[\frac{1}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\left(\Phi_1^j(h)\right)^{-\frac{1}{\theta}}dh - \left(\Phi_1^j\right)^{-\frac{1}{\theta}}\right] \geq 0 \tag{2.12}$$

(due to convexity)

Next, I conduct the comparative statics of trade share with D^j and $(1-\chi)$. I define the trade diversion intensity in following way

$$\begin{aligned}\Delta\pi_{1i}^j &= \pi_{1i}^j\Big|_{\text{TPU}} - \pi_{1i}^j \\ &= (1-\chi)T_i^j\left(C_i^j d_{1i}^j\right)^{-\theta}\left[\frac{1}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\frac{1}{\Phi_1^j(h)}dh - \frac{1}{\Phi_1^j}\right]\end{aligned} \tag{2.13}$$

Clearly, higher value of $\Delta\pi_{1i}^j$ indicates greater trade diversion possibility. Comparative statics of $\Delta\pi_{1i}^j$ with respect to TPU parameters is presented in Eq. 2.14 and Eq. 2.15. The trade intensity increases due to the increases in $(1-\chi)$ and D^j. Following the expression of trade share (Eq. 2.10), any increase in the trade cost improves the trade share of other trade partners other than Country 2 (i.e. trade diversion increases).

$$\frac{\partial}{\partial(1-\chi)}\Delta\pi_{1i}^j = T_i^j\left(C_i^j d_{1i}^j\right)^{-\theta}\left[\frac{1}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\frac{1}{\Phi_1^j(h)}dh - \frac{1}{\Phi_1^j}\right] \geq 0 \tag{2.14}$$

$$\frac{\partial}{\partial D}\Delta\pi_{1i}^{j} = (1-\chi)T_i^j\left(C_i^j d_{1i}^j\right)^{-\theta}\frac{1}{D^j - d_{12}^j}\left[\frac{1}{\Phi_1^j(D^j)} - \frac{1}{D^j - d_{12}^j}\int_{d_{12}^j}^{D^j}\frac{1}{\Phi_1^j(h)}dh\right] \geq 0 \tag{2.15}$$

However, the increase in trade diversion intensity can not be fully achieved due to the trade policy uncertainty. For instance, if the actual trade cost d_{12}^j increases to d_{12}^{j*} after the trade policy is announced, then the trade share of other countries ($i \neq 2$) increases to

$$\pi_{1i}^j = \frac{T_i^j(C_i^j d_{1i}^j)^{-\theta}}{\Phi_1^{j*}} \tag{2.16}$$

where $\Phi_1^{j*} = \sum_{k\neq 2}^{N} T_k^j(C_k^j d_{1k}^j)^{-\theta} + T_2^j(C_2^j d_{12}^{j*})^{-\theta}$ is the new market access term under the proposed trade cost d_{12}^{j*}.

The difference between trade share under new tariff (from Eq. 2.16) and the expected trade share under TPU (from Eq. 2.10) can be expressed as follows

$$\begin{aligned}\Delta\pi_{1i}^{j*} &= \pi_{1i}^{j}\Big|_{\text{TPU}} - \pi_{1i}^{j*} \\ &= \kappa\left[\chi\underbrace{\left(\frac{1}{\phi_{1i}^j} - \frac{1}{\phi_{1i}^{j*}}\right)}_{\text{Non-TPU Diff}(<0)} + (1-\chi)\underbrace{\left(\frac{1}{D - d_{12}^j}\int_{d_{12}^j}^{D}\frac{1}{\Phi_1^j(h)}dh - \frac{1}{\Phi_{1i}^{j*}}\right)}_{\text{TPU Diff} \lesseqgtr 0}\right]\end{aligned} \tag{2.17}$$

The trade difference expression (Eq. 2.17) provides a decomposition of the trade share difference of two terms - the first term is the difference of trade share possibility under the new tariffs under no uncertainty and the second term is the difference of the new trade share possibility with expected trade share under uncertainty. The contribution of each term is weighted by the probability of trade policy changes. Clearly, the first term is negative as the trade share is expected to increase for other trade partners ($i \neq 2$) due to higher tariffs on country 2. On the other hand, the second term adjusts the trade diversion intensity depending on the distribution of tariff sizes. The effect of the TPU difference (from Eq. 2.17) can be positive or negative given the relative size of exact tariff realization with respect to the belief about the highest trade cost value. The bounds of the TPU difference can be derived as the market share term $\Phi_1^j(h)$ is convex in nature with respect to h. These bounds are given by

$$\left(\frac{1}{\phi_{1i}^j} - \frac{1}{\phi_{1i}^{j*}}\right) \leq \left(\frac{1}{D - d_{12}^j} \int_{d_{12}^j}^{D} \frac{1}{\Phi_1^j(h)} dh - \frac{1}{\Phi_{1i}^{j*}}\right) \leq \left(\frac{1}{\phi_{1i}^j(D)} - \frac{1}{\phi_{1i}^{j*}}\right) \tag{2.18}$$

Eq. 2.18 provides the range of values of the trade share difference. When the difference $\Delta\pi_{1i}^{j*}$ is positive (opportunity gained), trade diversion happens as the trade partners align their production plan according to a higher possible trade cost and greater chance of trade policy changes. The difference becomes negative (opportunity lost) if the trade partners underweight the possibility of trade war and/or assumes a muted tariff increase on Country 2.

2.2.6 Household and Equilibrium

The utility of households in each country is a CES aggregator of the traded goods and non-traded goods.

$$U_n = \left(\sum_{j=1}^{J} \omega_j^{\frac{1}{\eta}} (Y_n^j)^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}\epsilon_n} \left(Y_n^{J+1}\right)^{1-\epsilon_n} \tag{2.19}$$

where η is the elasticity of substitution among the traded goods and ϵ_n is the expenditure share of traded goods. ω_j is the preference parameter of sector j good.

The budget constraint of the households is given by

$$\sum_{j=1}^{J+1} P_n^j Y_n^j = w_n L_n + r_n K_n \tag{2.20}$$

Following standard derivations, the expression of the consumer price index of country n is given by

$$P_n = B_n \left(\sum_{j=1}^{J} \omega_j (p_n^j)^{1-\eta} \right)^{\frac{1}{1-\eta}\epsilon_n} \left(p_n^{J+1} \right)^{1-\epsilon_n} \tag{2.21}$$

The competitive equilibrium of this model is the prices, factor allocations and trade shares such that (i) given prices, the firms optimize their factor allocations and the output equates with production function (ii) given prices, the consumer optimizes their utility given budget constraint (iii) price level is such that factor market and goods market clear and (iv) balance trade happens [5]. Here, the price components include the prices of traded and non-traded goods ($\{p_n^j\}$ (for j = 1(1)J+1)), wage rate w_n, rental rate of capital r_n and aggregate prices P_n. The factor allocations are given by $\{K_n^j, L_n^j\}$, the final demand allocations is Y_n^j and final production is Q_n^j. These price distributions, factor allocations should satisfy the following equilibrium conditions

[5]Here, the tariffs increases the revenue of the countries and thereby, the trade is not likely to be balance under higher trade cost. However, unbalanced trade will open up the role of financial sectors and thereby, will complicate the model framework. Further, the trade policy uncertainty will not have any implications on financial markets. Hence, we assume that the trade balance of each country is provided to the firms lump sum tax/ subsidy. The effect of trade policy uncertainty is not impacted due to the lump sum tax/subsidy on firms

2.3 Generalization of the model

2.3.1 Trade war with retaliation

The framework can be extended to trade war with retaliation where Country 1 imposes higher tariffs on Country 2 and Country 2 retaliates with higher tariffs on Country. The difference with this scenario is that the tariff distribution d_{21}^j follows stochastic distribution with upper bound of D^{j*} and a probability of trade policy changes $(1-\mu)$. Following similar derivations, the trade cost distribution under TPU from country 2,becomes

$$D_{21}^j\Big|_{\text{Under TPU}} \begin{cases} = d_{21}^j & \text{if no change in trade policy}(Pr = \mu) \\ \sim U(d_{21}^j, D^{j*}) & \text{Otherwise}(Pr = 1-\mu) \end{cases} \tag{2.22}$$

The price of sector j goods in country 2 becomes

$$P_2^j = \Gamma\left[\mu\Big(\Phi_2^j\Big)^{-\frac{1}{\theta}} + \frac{1-\mu}{D_1 - d_{21}^j}\int_{d_{21}^j}^{D_1}\Big(\Phi_2^j(h)\Big)^{-\frac{1}{\theta}} dh\right] \tag{2.23}$$

The market access of Country 2 becomes

$$\Phi_2^j\Big|_{\text{TPU}} = \mu\Phi_2^j + \frac{1-\mu}{D_1 - d_{21}^j}\int_{d_{21}^j}^{D_1}\Phi_2^j(h)dh \tag{2.24}$$

Lastly, the trade share in Country 2 becomes

$$\pi_{2i}^j = \mu\frac{T_i^j\Big(C_i^j d_{2i}^j\Big)^{-\theta}}{\Phi_2^j} + \frac{1-\mu}{D_1 - d_{21}^j}\int_{d_{21}^j}^{D_1}\frac{T_i^j\Big(C_i^j d_{2i}^j\Big)^{-\theta}}{\Phi_2^j(h)}dh \tag{2.25}$$

Using similar comparative statics, higher value of D^{j*} and $(1-\mu)$ leads to higher value of P_2^j and increases trade share of other trade partners $(i \neq 1)$.

However, the trade share may not reach the full potential with respect to the actual tariff realization depending upon the realization of trade cost after tariff changes and the belief about the upper bound of the tariff sizes.

2.3.2 COVID lockdown in China

The above framework can be extended to model different scenarios. I extend the model to capture the COVID lockdown scenario in China. Spike in COVID cases in major cities of China lead to a strict lockdown which restricted the transportation and economic activities. This scenario can be modelled with the assumption of higher trade cost (i.e. D^j is very high) and the probability of trade policy changes $(1-\mu)$ being very high. Here, the distribution of the trade costs under TPU is expressed as

$$D_{2i}^{j}\Big|_{\text{Under TPU}} \begin{cases} = d_{2i}^{j} & \text{if no change in trade policy}(Pr = \mu) \\ \sim U(d_{2i}^{j}, D^{j**}) & \text{Otherwise}(Pr = 1-\mu) \end{cases} \tag{2.26}$$

Since the trade costs of each trade partners with Country 2 (i.e. China) follows stochastic distribution, the distribution of prices of traded sectors can be derived as (given $\mu = 0$ i.e. trade policy changes with certainty)

$$P_2^j = \left(\prod_{i=1}^{N} \frac{1}{D^{j**} - d_{2i}^j}\right)\left(\prod_{i=1}^{N} \int_{d_{2i}^j}^{D^{j**}} \left(T_i^j (C_i^j h)\right)^{-\theta} dh\right) \tag{2.27}$$

Clearly, the effect of trade policy uncertainty is more severe in this context as the trade cost with all trade partners become uncertain.

2.4 Calibration

Having shown the effect of TPU parameters on the trade share and price distribution, I move to calibration of the model using two stage approaches.

In the first stage, I estimate the non-TPU parameter (i.e. all parameters except D^j and $(1-\chi)$) using Levchenko and Zhang (2011) approach. The approach estimates (i) productivity parameters T_n^j and θ (ii) trade costs under no uncertainty d_{ik}^j (iii) production function parameters (iv) labor and capital endowments and elasticity & preference parameters [6]. These parameters are estimated using annual data from 2012-2016 period. I choose the time frame to avoid any influence of trade policy uncertainty [7]. I select 62 countries for the model parameters. A list of countries is provided in Appendix 1. The sectors correspond to 2-digit ISIC codes (Rev 3). These sectors are

Table 2.1: Sectors covered

Food - Beverage (15)	Tobacco products (16)
Textiles (17)	Wearing apparels (18)
Leather and products (19)	Wood products (20)
Paper and products (21)	Printing (22)
Coke, refined petroleum (23)	Chemical and products (24)
Rubber and products (25)	NMMP (26)
Basic metal (27)	Fabricated metal (28)
Office, accounting (29)	Electrical machinery (31)
Medical precision (33)	Transport equipment (34)
Furniture (36)	Services (non-traded) (4A)

The second part involves TPU parameters D^j and $(1-\chi)$. These parameters are tested using different choices of tariff upper bounds and probability of policy changes. The possible values of D^j is drawn from (i) bounded tariffs under MFN agreements (ii) Highest value of Pre-WTO accession tariffs and (iii) maximum

[6] I skip the details of these parameter estimation. For details, refer to Levchenko & Zhang (2011) and Giovanni et. al. (2014)

[7] The trade policy uncertainty index remained low during this time

value of Column 2 tariffs. These values are represent the highest tariffs agreed under MFN agreements or highest tariffs imposed by the United States in different occasions. We assume that the trade partners form their belief about the possible tariff sizes based on the benchmark tariff rates from these references. Lastly, I calibrate the model with different values of $(1-\chi)$ between 0.1 and 0.9 [8].

2.5 Findings

2.5.1 Non-TPU parameter estimates and goodness of fit

The first round of parameter estimation provides an estimate of the non-TPU parameters. The estimate of absolute comparative advantages in each sector provides an overview about the heterogeneity of the sectors in terms of comparative advantages (refer to Table 2.2).

Table 2.2: Estimate of T_i^j

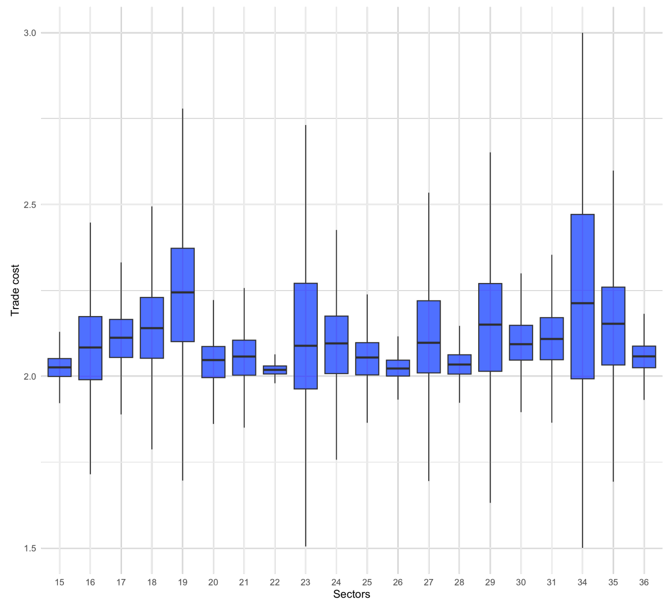
ISIC	Min	Q1	Median	Mean	Q3	Max	ISIC	Min	Q1	Median	Mean	Q3	Max
15	0.00	0.03	0.05	0.08	0.08	1.06	16	0.00	0.01	0.01	0.11	0.03	3.23
17	0.00	0.03	0.05	0.08	0.07	1.10	18	0.00	0.01	0.02	0.05	0.04	1.00
19	0.00	0.00	0.00	0.02	0.01	1.17	20	0.00	0.02	0.04	0.08	0.06	1.27
21	0.00	0.03	0.05	0.09	0.08	1.22	22	0.00	0.01	0.02	0.05	0.03	1.05
23	0.01	0.05	0.09	0.16	0.13	1.51	24	0.00	0.02	0.03	0.06	0.04	1.06
25	0.00	0.03	0.05	0.08	0.07	1.19	26	0.00	0.02	0.03	0.06	0.04	1.20
27	0.01	0.05	0.08	0.11	0.12	1.12	28	0.00	0.02	0.03	0.06	0.05	1.05
29	0.00	0.01	0.02	0.05	0.04	0.98	30	0.00	0.03	0.05	0.10	0.07	1.76
31	0.00	0.03	0.05	0.08	0.07	1.11	34	0.00	0.03	0.06	0.10	0.09	1.27
35	0.00	0.02	0.04	0.08	0.05	1.18	36	0.93	0.94	0.98	0.99	1.04	1.08

The trade cost estimates d_{ik}^j distribution, derived using the gravity equation, highlights the variation in trade cost across different traded sectors. The variation, represented in boxplot, varies between (1.5,3.0) for all sectors with major variation observed in transport equipment (ISIC = 34) and coke & refined petroleum

[8]For the calibration purpose, I only considered one sided tariffs imposed by the United States on China

products (ISIC = 23) (Fig. 2.1)

Figure 2.1: Trade cost estimates



Trade costs are estimated using gravity equations by incorporating bilateral country attributes

Using the estimated parameters, the wage and rental rate of capital are derived using LZ (2011) and the goodness of fit of these prices indicates a close fit of the data moments with the model predictions (Table 2.3)

Table 2.3: Moment matching between model and data using 2012-2016 annual data

	Model	**Data**
	Wage values	
Mean	0.34	0.42
Median	0.32	0.29
Percentile(25th)	0.15	0.11
Percentile(75th)	0.44	0.60
Correlation	0.78	
	Rental rate	
Mean	0.78	0.86
Median	0.45	0.66
Percentile(25th)	0.25	0.31
Percentile(75th)	0.74	0.90
Correlation	0.78	
	Trade share π_{ni} $(n \neq i)$	
Mean	0.0238	0.0205
Median	0.0015	0.0021
Correlation	0.65	
	Own trade share π_{ni} $(n = i)$	
Mean	0.5898	0.6256
Median	0.6342	0.7635
Correlation	0.64	

2.5.2 TPU parameters and scenario analysis

Using the baseline parameters, different scenarios are constructed to incorporate the trade policy uncertainty in the model. These scenarios were derived using different values of TPU parameters, χ and D^j. The choice of D^j, i.e. the upper bound of tariff, can be benchmarked against the higher tariff episodes. Some examples include the tariff levels under no-cooperation (i.e. US tariff on Cuba, North Korea etc.), higher tariffs imposed on China during pre-WTO accession period or upper bound of tariffs negotiated by the US on China. For calibration purpose, the higher tariff levels are set from the bounded tariff limits which were negotiated by the United States with China under trade agreements. These tariffs varied across different sectors. The scenarios were developed using values from the tariff distribution (Table 2.4 provides the variation in these tariff levels).

Table 2.4: US import tariffs

	Max	**Min**
1930 - 1950	65%	15%
1950 - 1990	15%	8%

The probability of trade policy changes, χ is calibrated over range of values varying over 0.05 to 0.95. Low values of χ represent lower chance of trade dispute whereas higher values of χ represent imminent threat of trade dispute. Lastly, the combination of discretize values of D^j and χ created different TPU scenarios. The model prediction are generated using the baseline non-TPU parameters and the choice of TPU parameters from each scenario. These predictions were matched with actual trade share data during the recent US trade dispute period. The targeted bilateral trade data is collected from WITS at ISIC 2 digit level for 2019 to capture the trade dispute outcomes. The bilateral trade shares are compared between data and model predictions using trade share ratio, defined as below

$$DD_i^j = \left(\frac{\pi_{1i}^{j,After}}{\pi_{12}^{j,After}}\right) \text{ and } \left(\frac{\pi_{1i}^{j,Before}}{\pi_{12}^{j,Before}}\right) \tag{2.28}$$

where $After$ stand for 2019 and $Before$ represents the average trade share between 2016-2017. Higher value of DD_i^j represents greater trade intensity from trade partner i to US (Country = 1) compared to trade intensity with China in the same sector. If DD_j^i increases in the after trade dispute period, it provides evidence towards possible trade diversion after higher tariffs were imposed on China [9]. Apart from the trade share, the consumer price predictions are matched for the

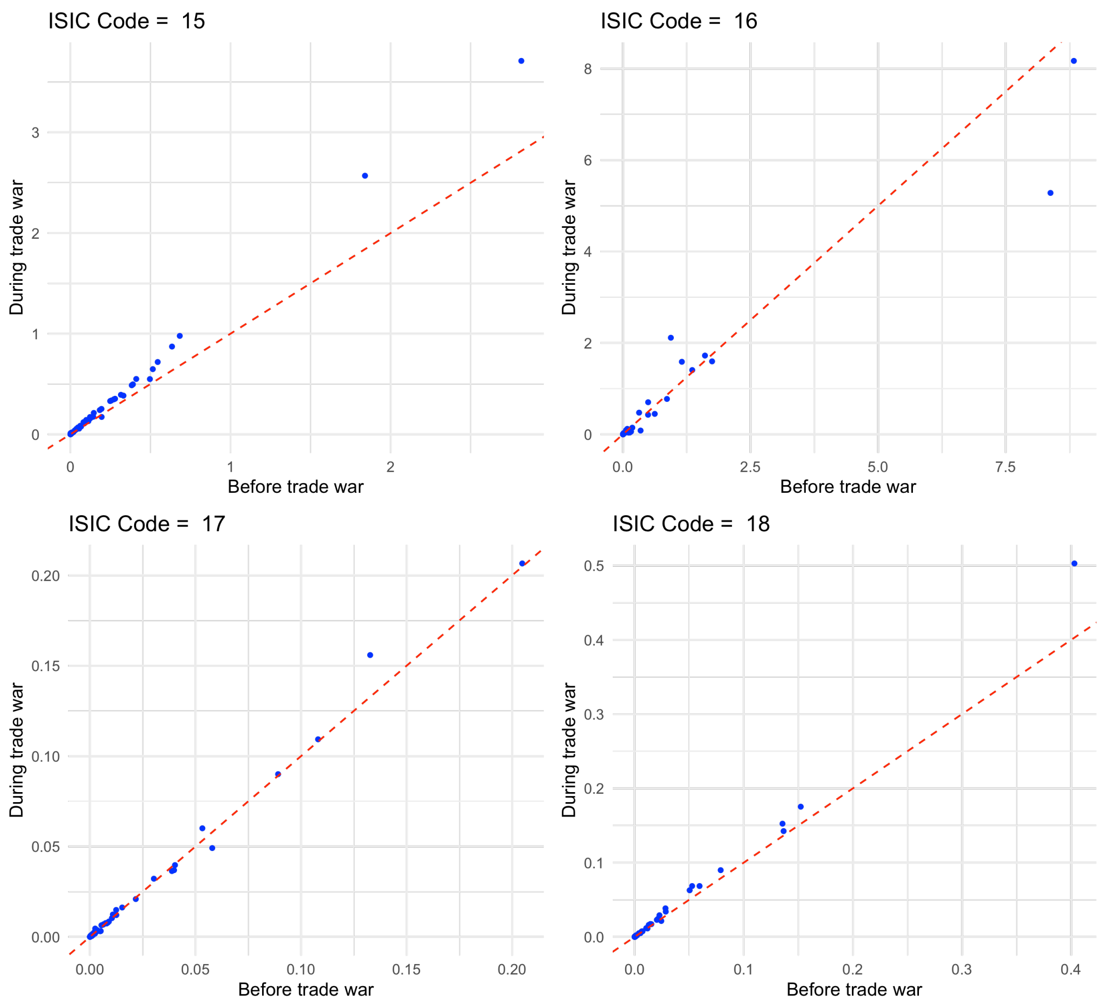
[9]One of the limitation of this ratio based measure is that D_i^j is always 1 for China. Recent literature shows that the effect of higher tariffs on China moderated the bilateral trade volume between US and China. However, I do not compare the moderation of trade volume from China

US and China with the post trade dispute data.

The model predictions are generated using the trade share equation and price distribution are generated by simplifying the TPU equations in incomplete Gamma format (Refer to Appendix for the simplified version of these equations). The scatter plot of trade share from before and after trade dispute period provides a glimpse of heterogeneity in trade re-allocations after the trade dispute. Fig 2.11 plots the average trade share ratio of other trade partners (excluding China). The horizontal axis is the average trade share over 2016-17 and the vertical axis is the trade share in 2019. The plots are fitted with a 45 degree line - any point on the dotted red line represents no change in relative trade share after the trade dispute (The plots are shown for ISIC 15-18 in the main text, other plots are available in Appendix).

in this paper

Figure 2.2: Trade share ratio plots (from data)

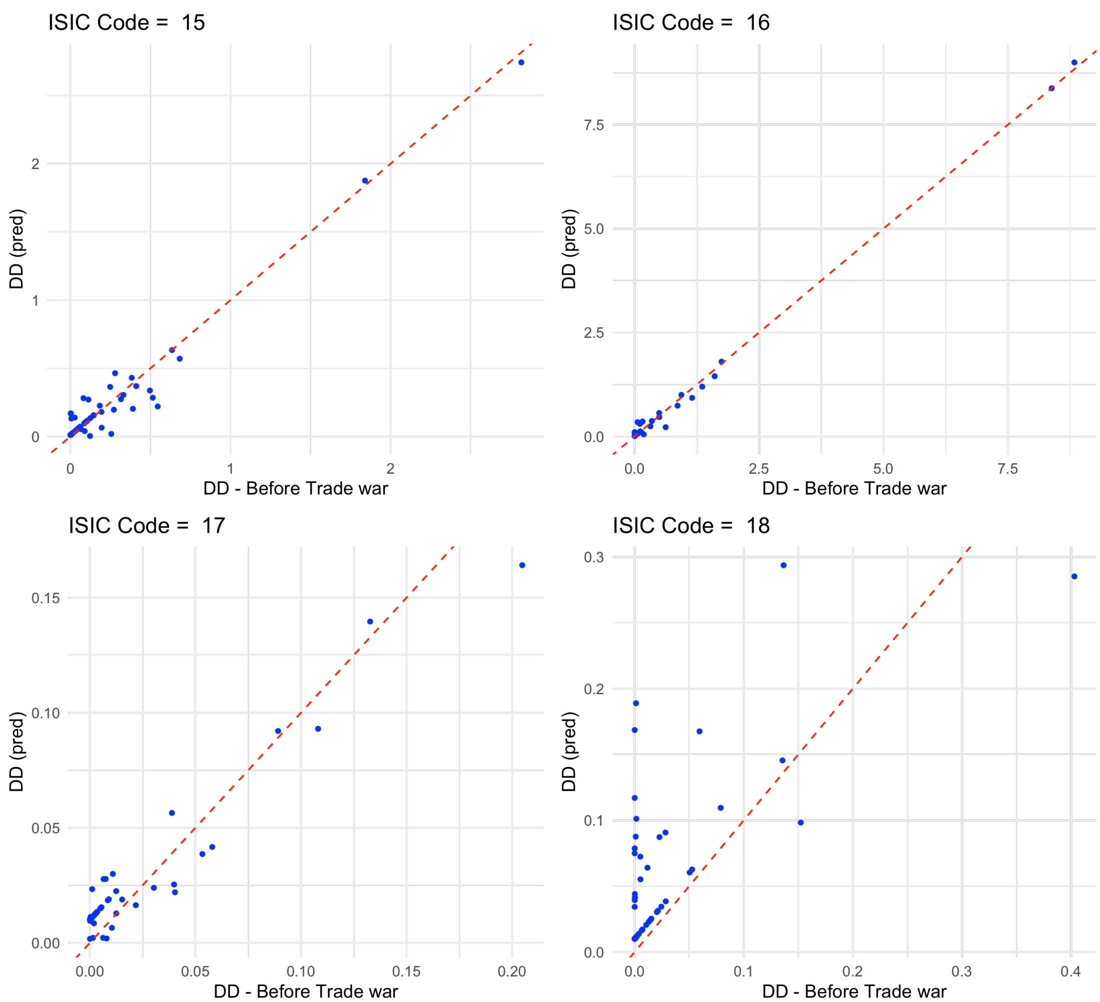


The trade shares ratios are defined across ISIC sectors using UN Comtrade data; "Before trade war" period is 2016-2017 and "During trade war" is 2019 data. The industry labeling is not incorporated in the chart for better readability. Please refer to Table 2.1 for sectors

Following Fig. 2.11, the trade share ratios increased for ISIC Code 15 (Food and Beverages) which implies trade diversion across all trade partners. However, such broad-based trade diversion intensity did not happen for other industry segments. In fact, the heterogeneity in the trade diversion is visible in tobacco products (ISIC = 16), wearing apparels (ISIC = 18), printing (ISIC = 22), chemical and products (ISIC = 24), non-metallic mineral products (ISIC = 26) and basic metals (ISIC = 27).

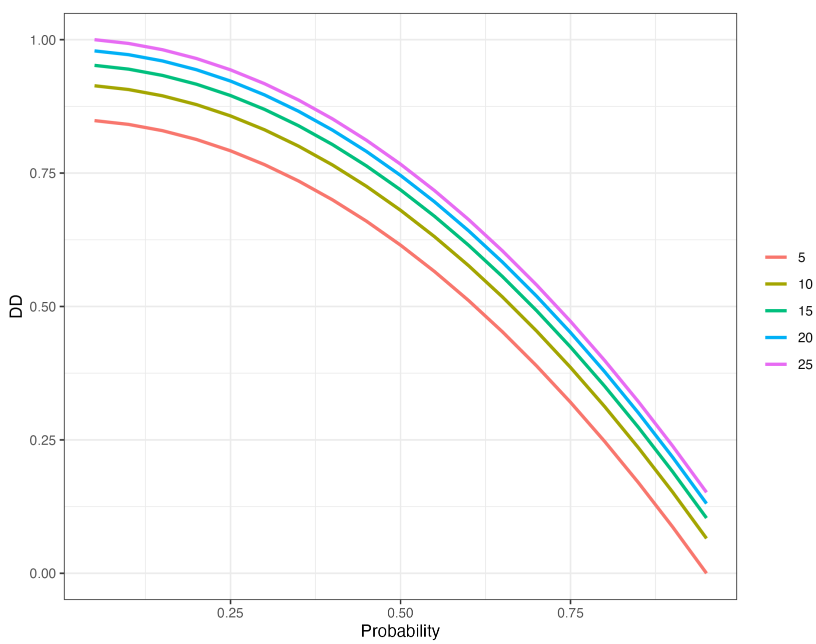
I plot the trade share ratio for the before trade dispute period from the model prediction and data. Fig. 2.3 provides scatter plot of the trade share prediction against the observed variation from data. The predicted values fall close to the red dotted line which implies that the model predictions match with data.

Figure 2.3: Trade share prediction before trade war



Next, I predict the trade share to the United States using different values of probability and tariff sizes (χ and D^j) and calculate the ratio measures DD. The average trade share ratio is plotted against the tariff size brackets and trade policy change probability. The trade diversion intensity, measured by DD, remains high when the probability of tariff changes are high (the plot uses χ in the horizontal axis which represents the probability of no change in tariffs). The trade diversion intensity increases with the probability of trade diversion. The prediction is intuitive - as the trade partners starts believing in imminent trader dispute, they make their production plan accordingly and the trade diversion happens more intensely to other trade partners. The trade diversion intensity increases with the higher bounds of tariff sizes. As the trade partners expect large tariff changes on Country 2, the high trade cost offsets the relative comparative advantages of Chinese firms and creates opportunity for other trade partners to increase their export to the United States (refer to Figure 2.4.

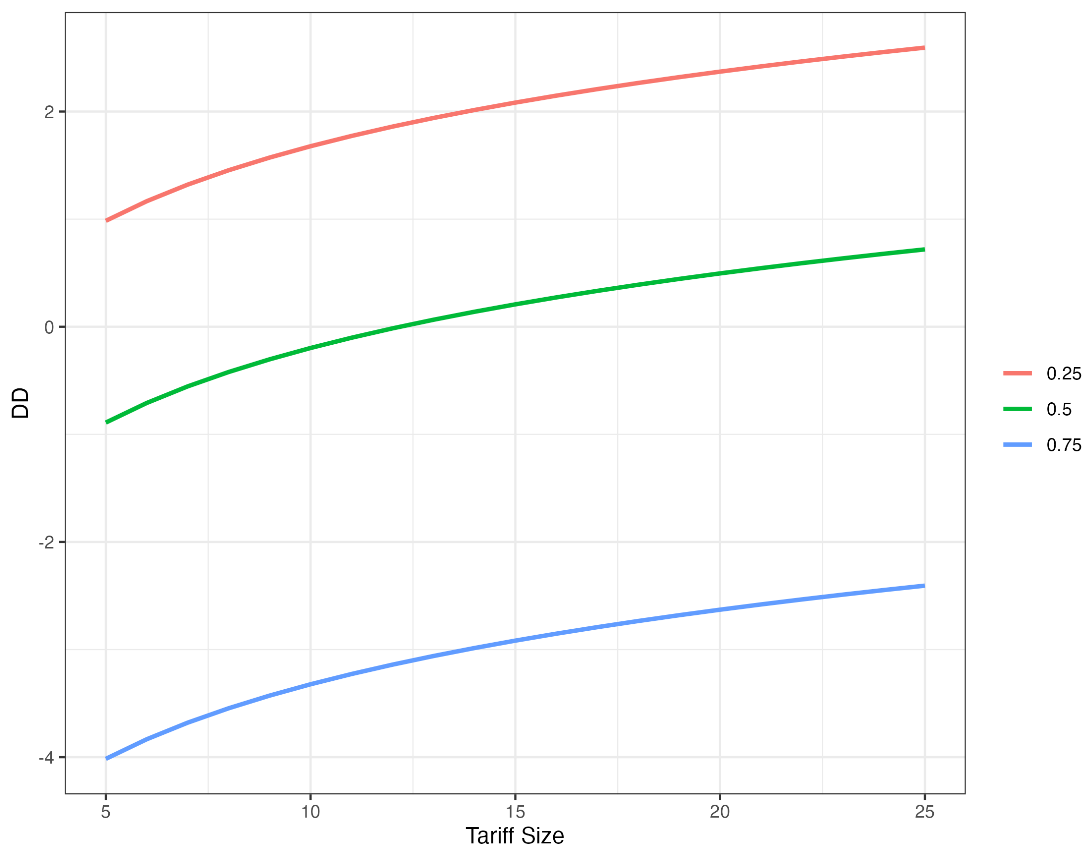
Figure 2.4: Trade share ratio under different Tariff brackets



(Different colors represents trade diversion intensity under different tariff size brackets in percentages)

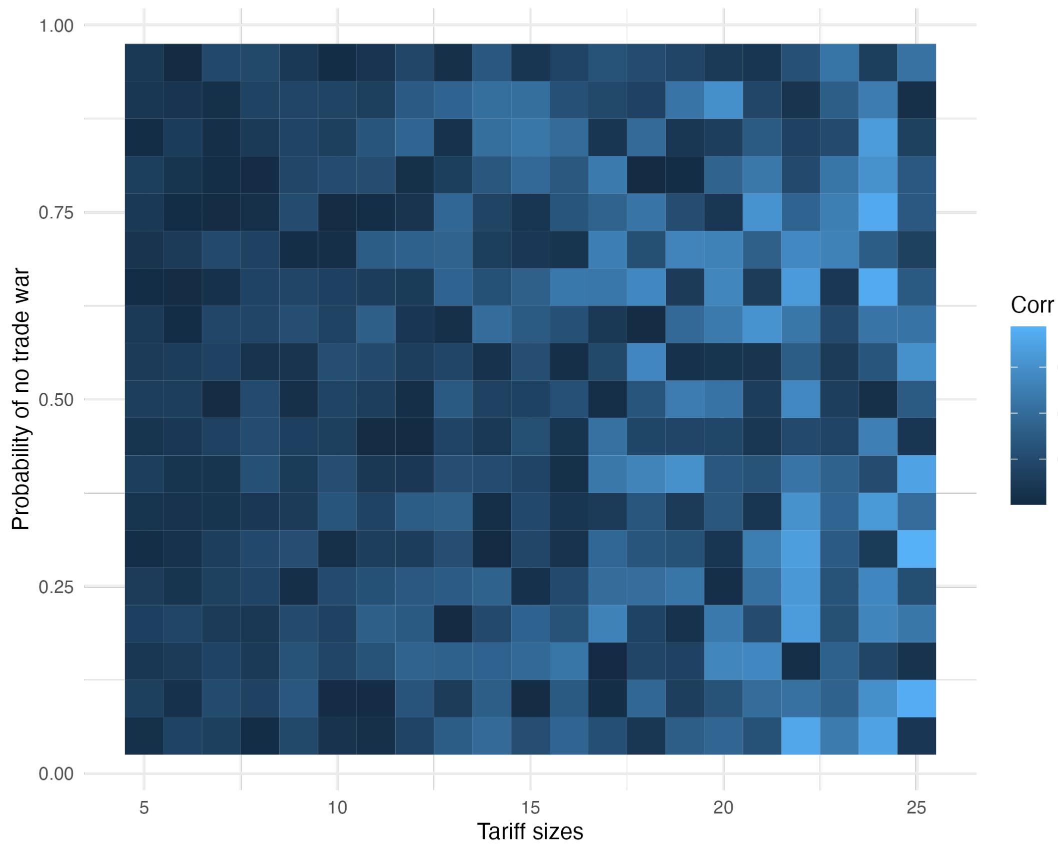
Next, the average prediction of trade diversion (DD) is plotted against the tariff sizes for different beliefs on uncertainty about trade policy changes. Here, the trade diversion intensities increases with the tariff sizes. Such increasing pattern in trade diversion intensity reflects the increase in trade partners' assessment about the final export demand to the US under different beliefs about the trade policy changes (refer to Figure 2.5.

Figure 2.5: Trade share ratio under different Probability brackets



I compare the prediction of trade diversion intensity from the model with the patterns observed from data. For that, the trade diversion ratio is calculated from bilateral trade flows data for 2019 data. The predictions are matched against the trade shares from the data and correlation between the model the model predictions and the actual realizations are calculated for each scenarios. The correlation increases with tariff sizes and probability of trade dispute. For relatively lower tariff level, the correlation is highest when the belief about the tariff dispute is very high (refer to Figure 2.6) (please refer to the annex for the prediction accuracy across various tariff size brackets and probability brackets).

Figure 2.6: Correlation of trade diversion intensity - prediction and realization



The correlation pattern provides some intuition behind the trade partners' belief about the trade dispute between US and China. The trade partners factored in higher tariff scenario under trade dispute. The rationale behind such belief of high tariff can be drawn from the average tariff on China before WTO accession.

The higher correlation values at high tariff sizes reveals that the trade partners believed very high tariffs drawing from the pattern of higher tariffs on China since 1980. At such higher tariffs, the correlation is high at relatively lower probability of trade dispute. Combining these two outcomes, the trade partners appear to be less certain about the implementation of higher tariffs but they were near certain about very high tariff values.

2.6 Concluding remarks

I asses the impact of trade policy uncertainty on the global trade flows. Previous literature has demonstrated that the policy uncertainty affects firms' decision to enter a new export market, leading to attenuation of new investment and technology upgrades. In this paper, I extend the trade policy uncertainty to a multi-country multi-sector trade model to demonstrate the effect of policy uncertainty on global trade flows. Uncertainty arises from two sources: the probability of trade policy change and the uncertainty around the tariff sizes. The framework assumes that the trade partners make their production plan at the beginning of the period when there is lack of clarity about the trade dispute. They have their belief about possible trade dispute which leads to uncertainty around the price distribution and the final demand. The trade partners' belief is modeled by assuming a uniform distribution on tariffs and probability of trade policy changes. Given the uncertainty, the trade partners decides the trade intensity by factoring in their assessment of final demand and prices.

I assess the effect of trade policy uncertainty using an analytical solution and full scale calibration of the model under different scenarios. The analytical solution establishes that the trade policy uncertainty moderates the trade diversion intensity and increases the price distribution in the destination market. The effect depends upon the stochastic distribution of the tariff sizes and the probability of trade policy changes. The calibration of the structural model is done by estimating the model parameters in two stages. The paper uses the recent US-China trade war to demonstrate the effectiveness of the proposed framework in explaining the global trade flows after the US imposed higher tariffs on China and other trade partners. In the first stage, the trade model parameters, not pertaining to uncertainty components, are estimated from bilateral trade data before the recent trade disputes of the United States. In the second stage, the trade policy uncertainty is introduced in the model using different assumptions on the tariff sizes and probability of trade policy changes. Lastly, the model prediction under different assumptions of trade policy uncertainty parameters, are matched with the trade flows data and changes in price movements.

The paper observes that trade diversion intensity increases with the belief about the upper bound of tariff level and the probability of the trade dispute. As the trade partners plan for the possible tariff imposition with certainty, they plan their production accordingly. The effect of trade policy uncertainty and the adjustment cost of production plans creates a wedge among trade partners in terms of trade diversion intensity. The model prediction are matched with the trade diversion pattern from post-trade war period. The correlation between the model prediction and realization provides an intriguing pattern about the trade partners' belief. The trade partners belief aligned with the possibility of higher tariffs imposition but they were uncertain about the implementation of higher tariffs.

The paper contributes to the increasing literature of trade policy uncertainty and Ricardian trade models by introducing the effect of trade policy uncertainty on global trade flows. The generalization proposed in this paper, adds more flexibility in the multi-country trade models by relaxing the assumption of fixed trade cost. The approach can be generalized to different situations like Brexit uncertainty or uncertainty around the lockdown measures imposed by China. The model is capable of generating the disruptions in trade intensity due to global events leading to uncertain trade environments. The main driver of the trade policy uncertainty is drawn from the belief about the trade dispute and uncertainty about the possible tariff sizes. The beliefs can be generalized to introduce heterogeneity in the country level experience of trade diversion.

2.7 Appendix

2.7.1 Simplifying TPU equations using incomplete Gamma

Export price distribution of Country 2 to Country 1

$$\begin{aligned} G^j_{12}(p) = 1 - \chi exp\Bigg[-T^j_2\Big(C^j_2 d^j_{12}\Big)^{-\theta} p^\theta\Bigg] \\ - (1-\chi)\frac{\theta}{(D-d^j_{12})(T_2(C^j_2)^{-\theta}p^\theta)}\Bigg[\Gamma(d^\theta_{12}) - \Gamma(D^\theta)\Bigg] \end{aligned} \tag{2.29}$$

Price distribution in Country 1

$$G^j_1(p) = 1 - \chi exp\Bigg[-\Phi^j_1 p^\theta\Bigg] - \frac{1-\chi}{D-d^j_{12}}\frac{\theta}{(T_2(C^j_2)^{-\theta}p^\theta)}\Bigg[\Gamma(d^\theta_{12}) - \Gamma(D^\theta)\Bigg]\Phi^j_{1,-2} \tag{2.30}$$

Price in Country 1

$$P^j_1 = \Gamma\Bigg[\chi\Big(\Phi^j_1\Big)^{-\frac{1}{\theta}} + \frac{1-\chi}{D-d^j_{12}}\int_{d^j_{12}}^{D}\Big(\Phi^j_1(h)\Big)^{-\frac{1}{\theta}} dh\Bigg] \tag{2.31}$$

Export share

$$\frac{\pi^j_{1i}}{\pi^j_{12}} = \frac{\chi\frac{T^j_i\Big(C^j_i d^j_{12}\Big)^{-\theta}}{\Phi^j_1} + \frac{1-\chi}{D-d^j_{12}}\int_{d^j_{12}}^{D}\frac{T^j_i\Big(C^j_i d^j_{12}\Big)^{-\theta}}{\Phi^j_1(h)}dh}{\chi\frac{T^j_2\Big(C^j_2 d^j_{12}\Big)^{-\theta}}{\Phi^j_1} + \frac{1-\chi}{D-d^j_{12}}\int_{d^j_{12}}^{D}\frac{T^j_2\Big(C^j_2 h\Big)^{-\theta} dh}{\Phi^j_1(h)}dh} \tag{2.32}$$

2.7.2 Distribution of prediction accuracy

Figure 2.7: Trade share ratio plots (from data)

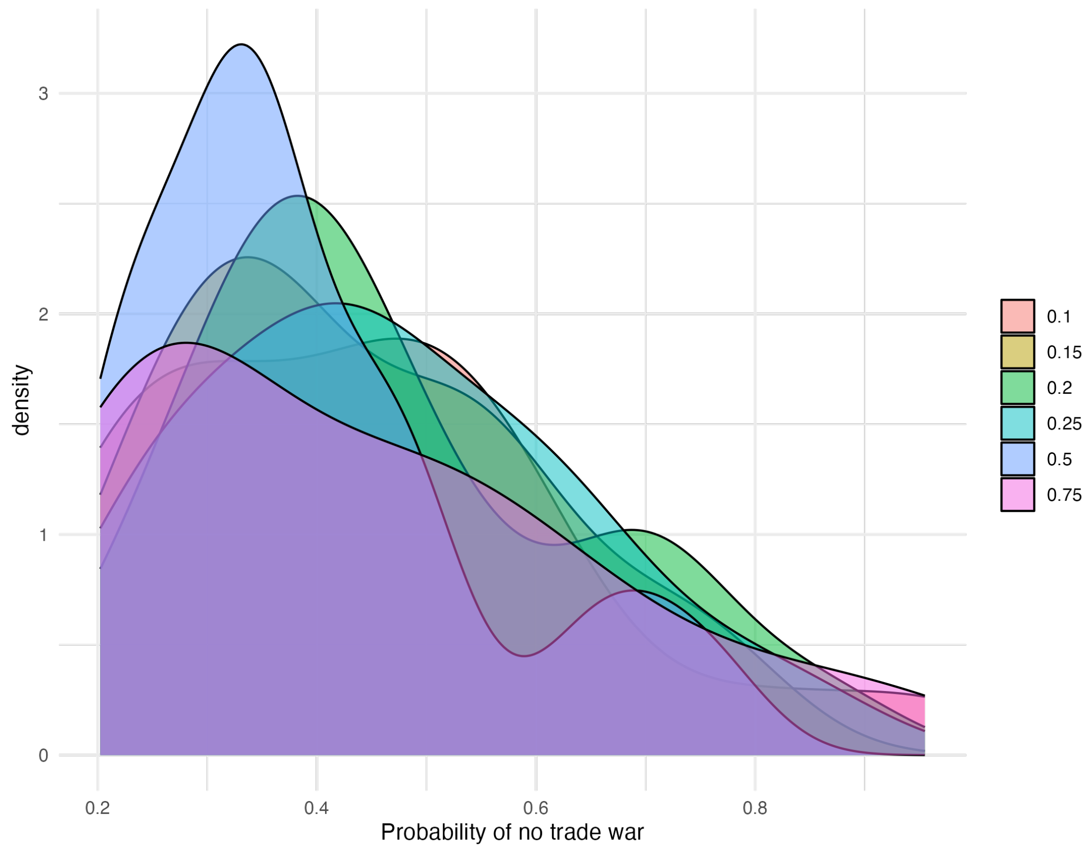
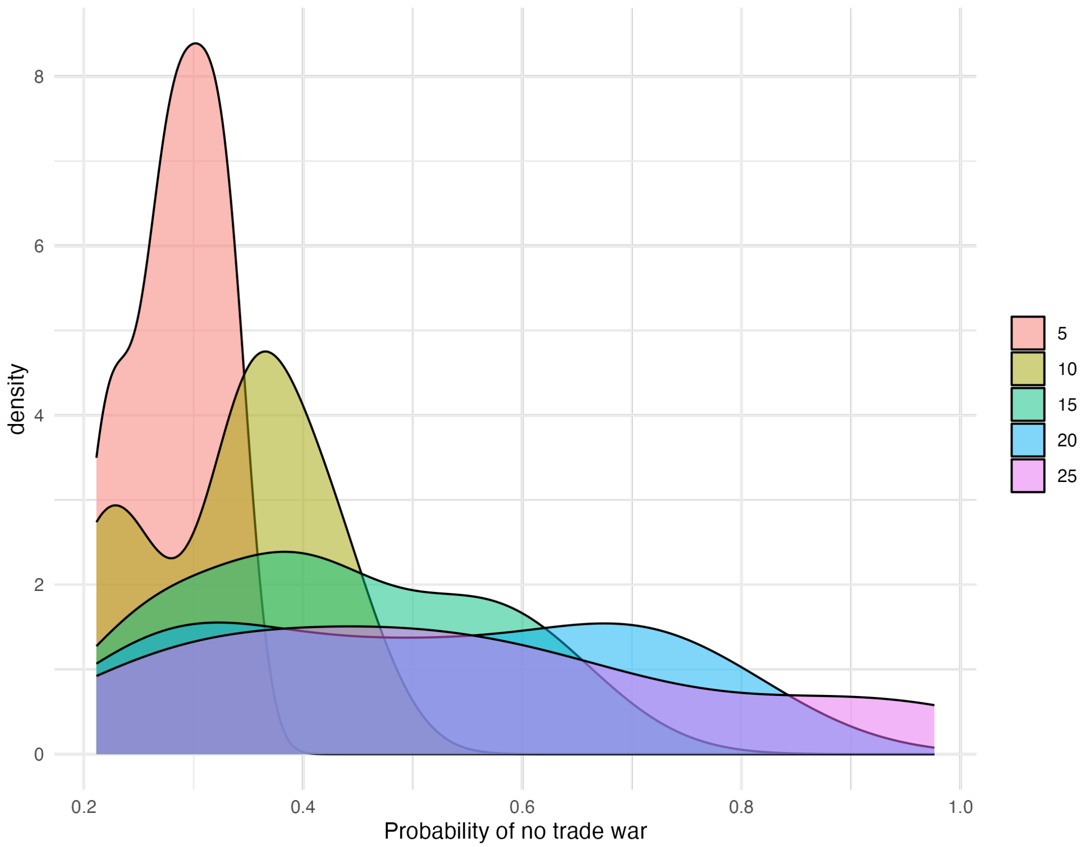


Figure 2.8: Trade share ratio plots (from data)



2.7.3 Trade share ratio across industry segments

Figure 2.9: Trade share ratio plots (from data)

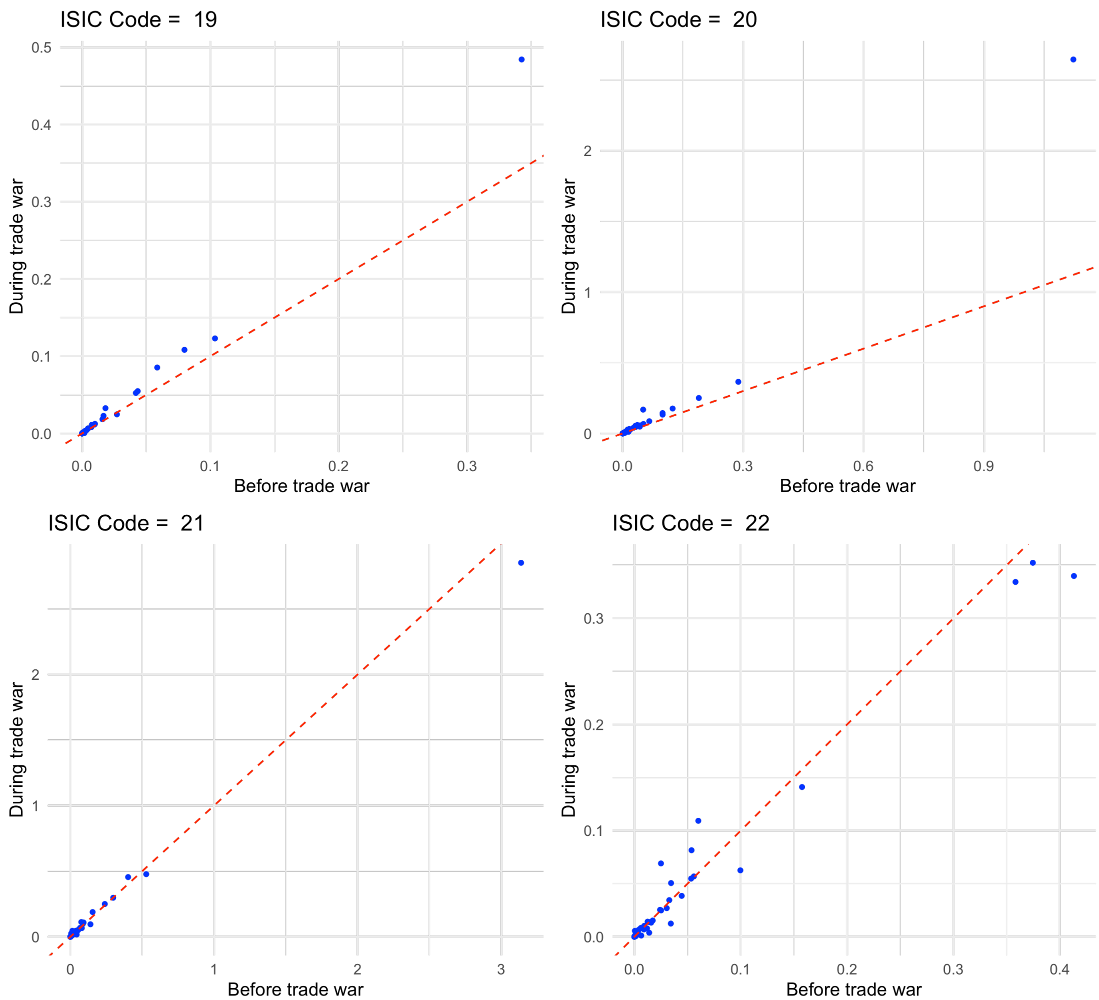


Figure 2.10: Trade share ratio plots (from data)

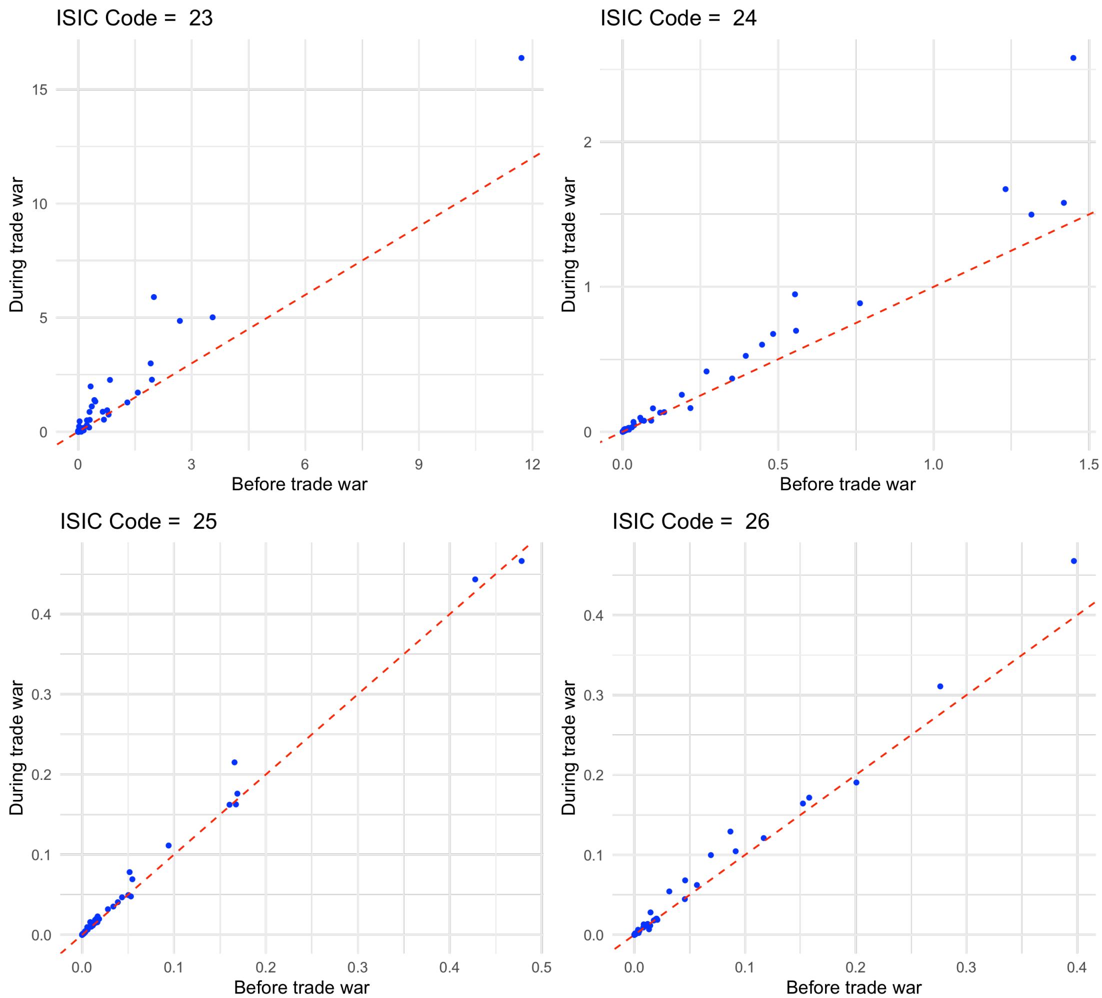
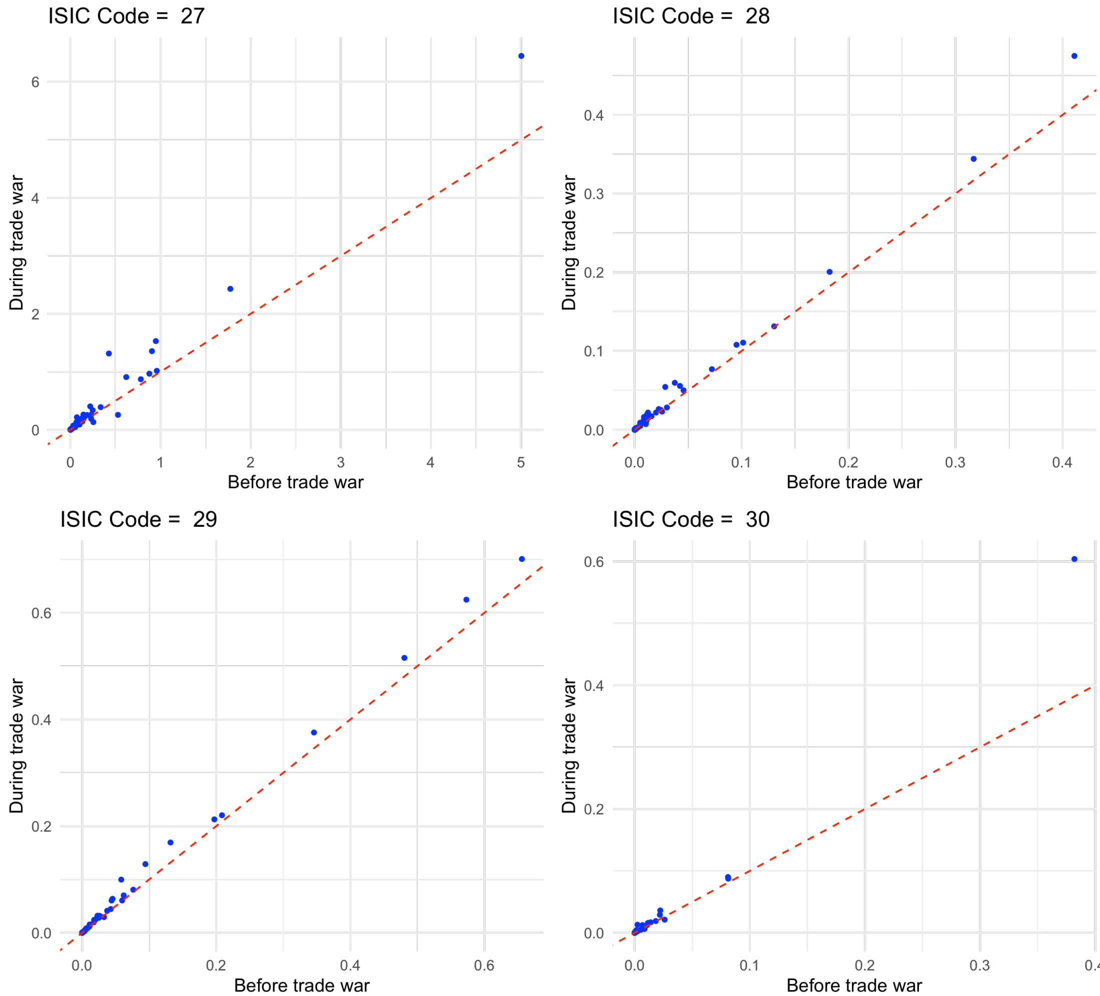
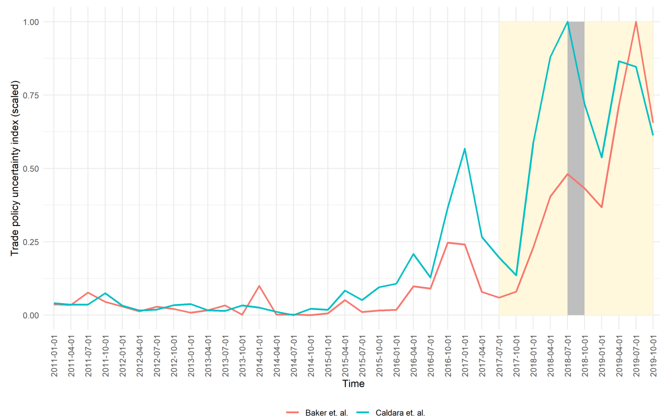


Figure 2.11: Trade share ratio plots (from data)



2.7.4 Trade war and trade policy uncertainty

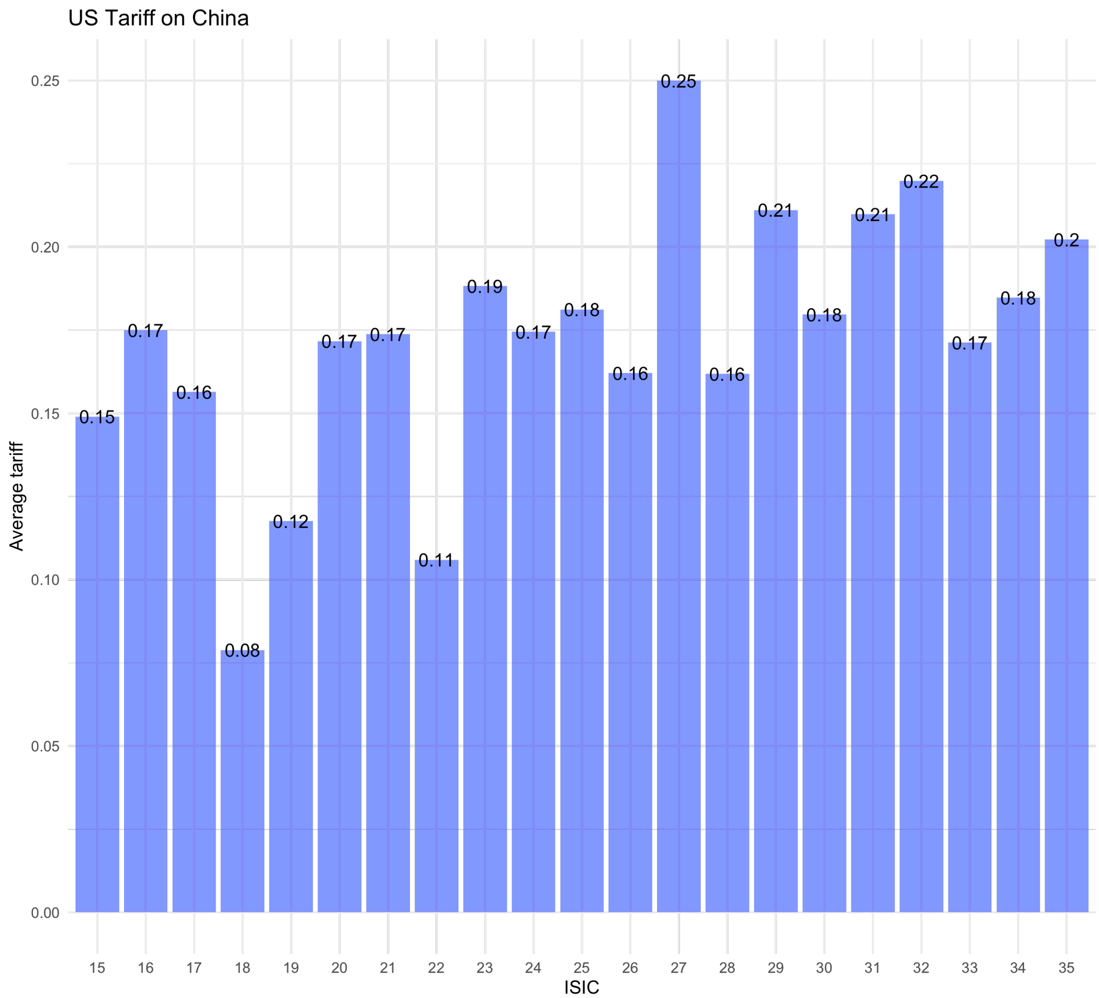
Figure 2.12: US Trade policy uncertainty



2.7.5 Stylized facts

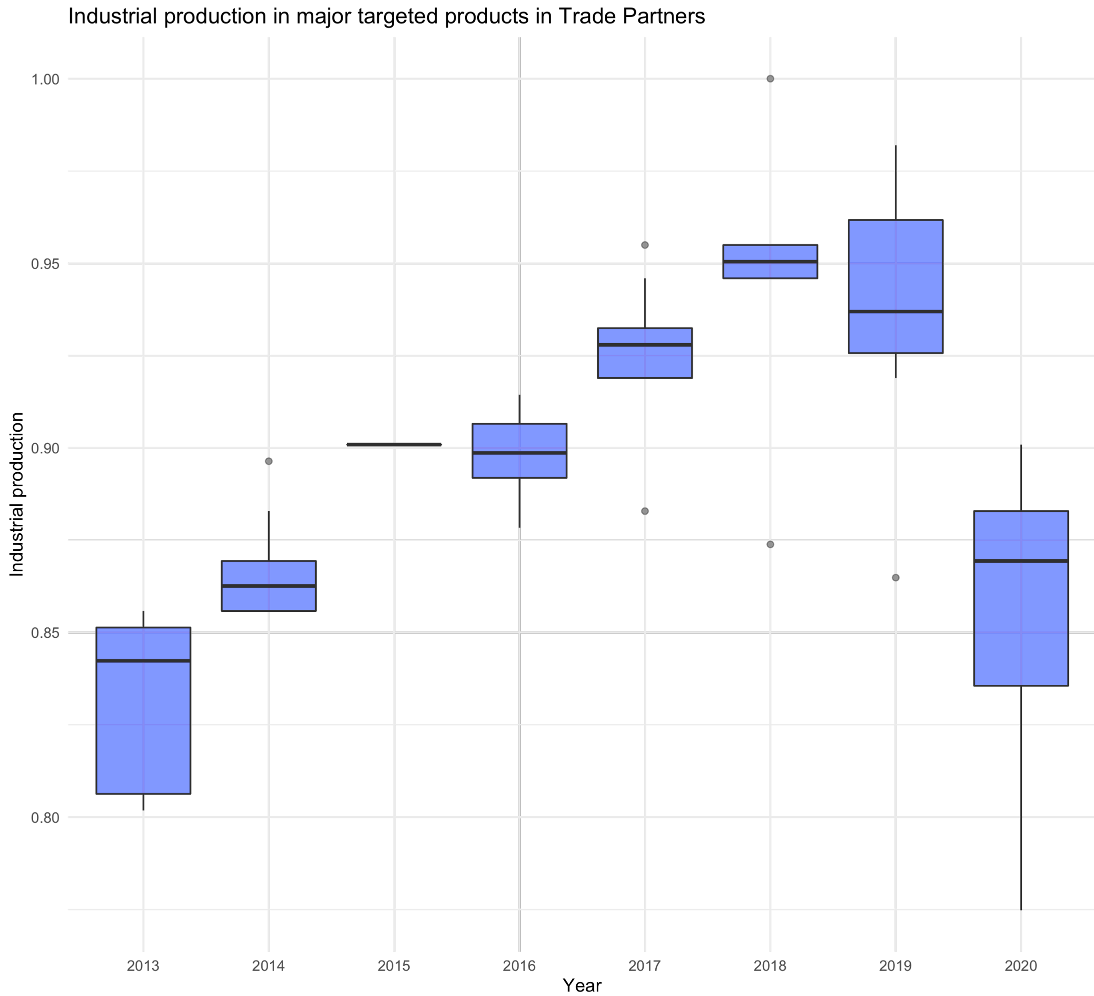
I present some of the stylized facts about the recent trade dispute and its effect on trade flows and price level. Figure 2.13 provides the distribution of US tariffs on Chinese imports across major industrial sectors. The average tariff varied between 8% to 25%. The maximum tariffs was applied on ISIC 27 (Manufacture of electrical equipment). The average tariff level was higher than the tariffs agreed under MFN status.

Figure 2.13: Average tariff across sectors



Next, I plot the variation in the industrial production across major trade partners (excluding China) on the targeted products. These targeted products were identified at ISIC 2 digit level and the industrial production of those targeted sectors is tracked over time. Following Figure 2.14, the industrial production moderated across major trade partners in 2019. Also, the variation in industrial production remained very high during the same time.

Figure 2.14: Trade partners' IIP during Trade war



The next two plots provides the time movement in consumer prices in the United States and China. I plot these two countries because of their direct involvement in the trade war. Following Figure 2.15 and 2.16, the consumer price inflation increased significantly during trade war, compared to the previous years.

Figure 2.15: Consumer price during Trade War (US)

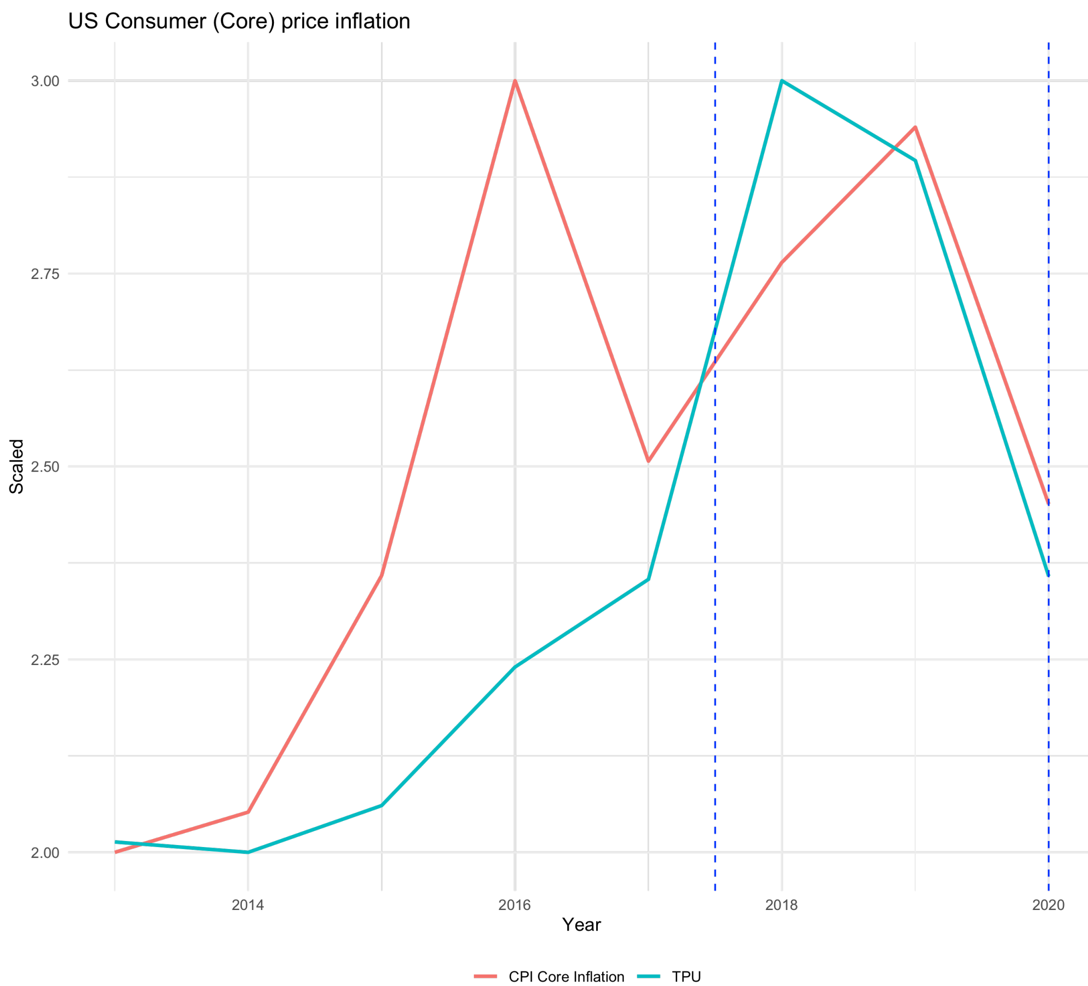
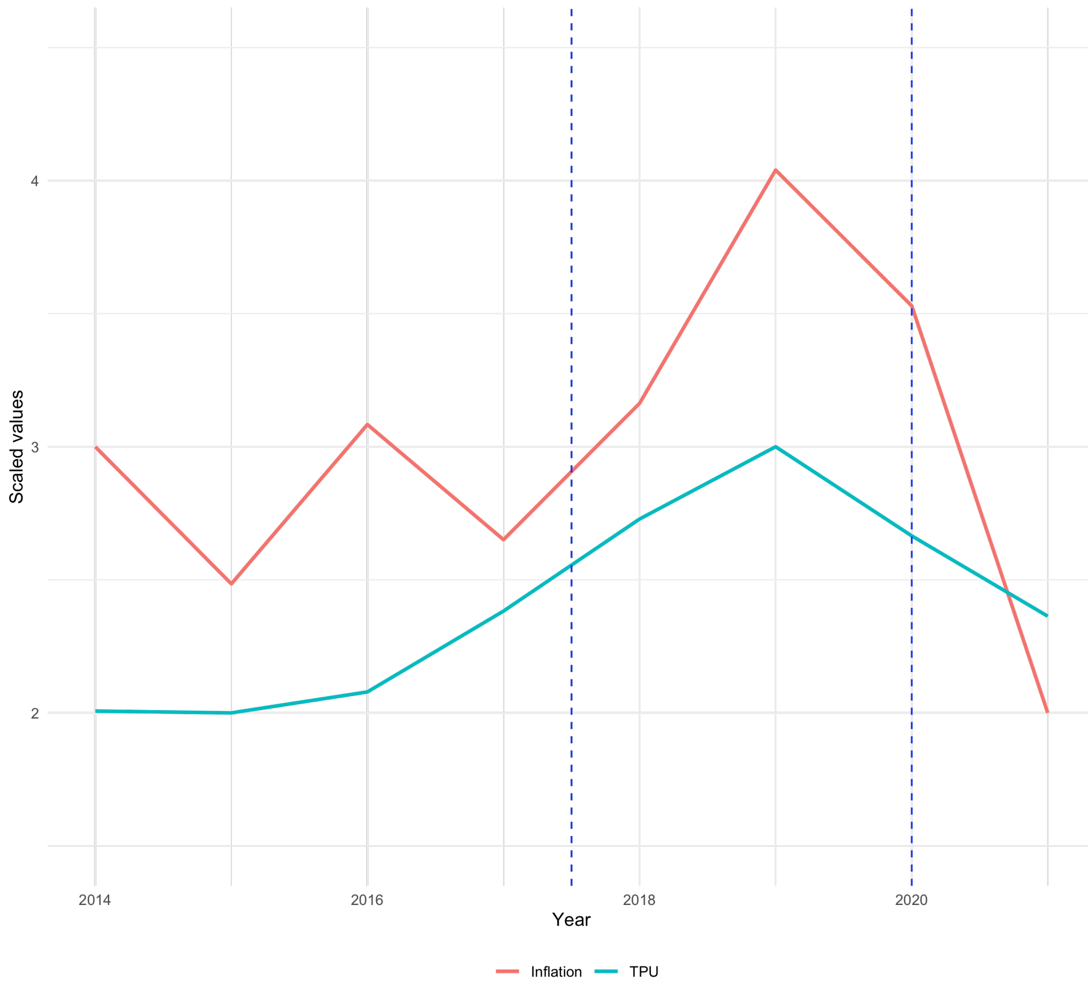


Figure 2.16: Consumer price during Trade War (China)



Chapter 3

Breaking Down Borders: The Impacts of Capital Control and Heterogeneous Spillover

3.1 Introduction

As global integration increased, emerging market economies experienced greater association with global financial cycles. Accessibility to cheap foreign capital increased during the boom phase of financial cycles whereas sudden stops triggered capital flight translating into macroeconomic crisis. In this context, capital controls appeared to be a suitable policy measure for safeguarding the domestic economy from volatility of foreign capital flows (Korinek, 2010, 2011; Jeanne and Korinek, 2010; Costinot et al., 2014). However, capital controls measures also imparts signaling effect to foreign investors about the state of domestic economy. Bartolini & Drazen (1997) and Drazen (1997) argured that the signaling effect of capital controls policies paints adverse image in the minds of foreign investors in terms of lack of domestic controlss. On the other hand, capital controls also leads to have spillovers to other countries as capital flows diverts to other destination countries. The direct and spillover effects, thereby, modulates the flows of international capital across destination countries. However, the nature of the capital flows varies widely across different institutional sectors namely Public sector, Corporate and Banks. Following recent papers by Avdjiev et. al. (2018) and Emter, Killeen & McQuade (2021), the drivers of capital flows to these institutional sectors can be very different. According to their findings, the global risk aversion appears to drive capital flows to banking and corporate sectors whereas the effect of global risk aversion is muted in case of capital flows to public sector. Following the heterogeneity of capital flows across these institutional sectors, this paper evaluates the heterogeneous effect of capital controls as policy measures on gross capital inflows to different sectors of economy in terms of the direct effect and the spillover effect. Further, the paper provides a structural interpretation of such heterogeneity by incorporating signaling effects within a portfolio choice model.

This paper addresses three major strand of literature. First, the paper analyzes the effect of capital controls in terms of direct effects and spillover effects. Second, the paper extends the effects of capital controls on capital flows across different institutional sectors and lastly, the paper proposes a structural framework to explain the heterogeneous effect of capital controls using a portfolio choice model with signaling effect. Capital controls emerged as a policy toolkit for countries facing volatile capital flows. Emerging market economies have been liberalizing capital accounts since early 1990. Greater accessibility of foreign financial markets lead to portfolio rebalancing decisions of global investors as investors searched for higher yields. On the recipient side, these countries experienced cheap foreign capital during financial boom. However, the bust episodes of global financial cycle also lead to adverse impact on these economies. As optimism about the global financial cycle faded, the foreign capital started to withdraw from these countries, leading to currency depreciation and balance of payment crisis. Existing financial integration lead to heightened macroeconomic and financial instability (Reinhart and Rogoff, 2009). The policymakers responded by restricting the capital flows. In this context, capital controls emerged as a possible toolkit to modulate capital flows in these countries.

Capital controls, more aptly known as a tool for controlling capital account of any country, is often considered as a part of macroprudential toolkit. The effectiveness of capital controls measures is debated in the literature. Capital controls restrict the volatility of capital flows, safeguard domestic economies from sudden stops and currency fluctuations, thereby leading to macroeconomic and financial stability. According to the literature, the welfare gains from capital controls provides policy justifications (Korinek et. al. (2010); Jeanne and Korinek, 2010; Costinot et al., 2014). Apart from the macroeconomic stability, the financial stability is ensured by the capital controls (IMF, 2011, 2012). The effectiveness of capital controls, therefore, provides a strong justification towards its inclusion in policy tool (Ostry, 2011 & 2011). However, the effectiveness of capital controls was questioned by the signaling effect of capital controls (Bartolini & Drazen (1997) and Drazen (1997)). The imposition of capital account restrictions was viewed as hostile policy by the foreign investors. Bartolini & Drazen (1997) argued that the foreign investors viewed these controls as lack of domestic controls and instability of domestic economy. Capital controls, thereby, appeared to have longer lasting effect on capital flows to the recipient countries. In more recent work, Jinjarak, Noy, and Zheng (2013) observed similar signaling effect of capital controls in their empirical analysis. Forbes et. al. (2016) also observed similar effect of capital controls in an interview with top fund managers of global banks ad the effect was more prominent for public sector flows. The spillover effect of capital controls, on the other hand, is observed in the deflection of capital flows to other destination countries. Following Forbes et. al. (2016),Giordani et. al. (2017),Pasrica et. al. (2018), the spillover effect of capital controls is mainly driven by risk transfer motive of the global investors. As one country increases capital account restrictions, capital flows diverts to other destinations in search of higher returns. However, the spillover exposes other destination countries to multilateral externalities on social welfare (Korinek, (2011); Costinot et al. (2014)).

This paper analyzes the direct and spillover effects of capital controls in a multi-country set up by focusing on portfolio inflows and other investment inflows separately. The rationale of differentiating between these two types of inflows is that the nature of these flows are very different from each other. The existing literature suggests that the portfolio inflows are mainly adjusted in short term and thereby, are more responsive to capital controls (Forbes et. al. (2016)). Beyond this segmentation of inflows, the paper adopts a novel identification for analyzing the direct effect and spillover effect of capital controls in a more parsimonious way. The empirical specification of existing literature on capital controls effects, imposes identifying restrictions on the particular propagation of capital controls shocks across countries. These recent works used a panel of countries for analyzing the direct effect of capital controls where the direct effect originates from own countries' capital account openness and spillover effect emerges from capital controls of another set of countries. This paper extends the spatial Durbin model to analyze the impact of direct effect and spillover effect by introducing own-country capital account openness and spatial lagged values of capital account openness of other countries (except own country) in the panel regression. The benefit of using such spatial models lies in the fact that the identification of spillovers is governed by the spatial dependence and thereby, becomes more parsimonious in nature.

Apart from identification, the paper also augments the heterogeneous effects of capital controls on global capital flows on different institutional sectors - public, banks and corporate. Recent research by Avdjiev et. al (2018) observes that the capital flows to different institutional sectors are heterogeneous in nature. The factors influencing these flows varies across the sectors. Global risk aversion modulates capital flows to banks and corporate more prominently whereas the effect of global risk aversion is not significant in case of capital flows to public sector. On similar topic, Emter et.al. (2020) analyzed the cross-border claims of banking sector to non-banking institutions for Ireland and they observed that the cross border flows to non-financial institutions are affected by tightening of monetary policy and macro prudential policies. Kim and Zhang (2020) observed that the business cycle fluctuation of global capital flows differ between private sector and public sector flows - the private sector capital flows are generally pro-cyclical in nature whereas flows to public sector counter-cyclical in nature. Such heterogeneity in the drivers and the nature of these flows underlines the importance of a sector-wise analysis of capital flows in the context of capital controls shocks. The capital controls shocks are often designed to manage capital account openness and thereby, affects the capital flows at aggregate level. However, the effect of such capital account restrictions, can be different across sectors due to the underlying heterogeneity. Hence a detailed analysis of heterogeneous impact of capital controls may provide better insights to policymakers in terms of designing suitable policy measures. Beyond the nature of the institutional flows, the role of these institutional flows also varied across different crisis episodes. For instance, sovereign debt was mainly influential in Latin American balance of payment crisis during early 1990's (Aguiar and Amador, 2011; Gourinchas and Jeanne, 2013) whereas private sector flows dried up in case of East Asian Crisis in 1997 (Corsetti et. al. 2000; Rajan, 2009). I analyze the direct and spillover effect of capital controls on capital inflows across these institutional sectors to unveil any heterogeneity in the effect of capital controls.

Using capital flows data on quarterly frequency, the paper observes that the capital controls measures moderates portfolio inflows to public sector significantly. The inflows to banks and corporate is less effected by the direct effect of capital controls. This heterogeneity in capital controls effect, can be linked to the signaling effect of capital controls. One can argue that the investors perceive the capital controls measures as lack of domestic controls in the destination countries. The private signal of investors dictate the global investors to rebalance their portfolio away from the public sector of foreign countries. Following Forbes et. al. (2016), the fund managers highlighted that the capital controls signals controls risk for sovereign bonds. Heterogeneity in the direct effect of capital controls aligns with the view. Further, the spillover effect of capital controls was observed across all sectors. The spillover effect was marginally higher in case of corporate, followed by the banking sector. The findings of spillover effect can be explained by the hedging mechanism and risk aversion of investors. The effect of capital controls follows similar pattern in case of other investments. However, the effects are not statistically significant. Further, the portfolio adjustment due to direct and spillover effect appeared to be immediate in nature. As investors face the shock of higher capital account restrictions, they adjust their portfolio debts immediately away from the destination country imposing capital controls. The adjustment happens in case of portfolio flows to public sector. The spillover effect, on the other hand, starts immediately as investors start aligning their portfolio to other destination countries and the adjustments happen over time. The corporate flows respond more strongly than public sector flows and the adjustment takes 1-3 quarter. Combining these observations, it can be argued that the effect of capital controls on capital flows is highly heterogeneous in nature. Further, the signaling effect appears to be one of the dominating factors inducing such heterogeneity.

In order to support the signaling mechanism, the paper proposes a portfolio choice model in a multi-country set up. Following Devereux & Sutherland (2006,2010) and Tille & Van-wincoop (2011), the paper extends the portfolio choice into three country set up where the capital controls shock is modeled as iceberg trade cost. The signaling effect of capital controls is introduced as incomplete information in the investors' portfolio choice problem. The paper argues that the heterogeneity in signaling effect introduces the heterogeneity in the portfolio choice which corroborates with the empirical findings. The comparative statics, further, demonstrates that the direct effect and spillover effect of capital controls is homogeneous in nature in the absence of the signaling effect. The main contribution of the paper is to validate the heterogeneity in the effect of capital controls across different institutional sectors and extending the findings to a portfolio choice model for identifying the signaling mechanism of capital controls.

Remaining of the paper is organized as follows - The portfolio choice model is described in Section 2. Section 3 describes the empirical framework, data descriptions are provided in section 4, empirical findings are illustrated in Section

5. The paper concludes with summarizing of the findings in Section 6.

3.2 Portfolio choice with signaling effect

The direct effect and spillover effect of capital controls is explained using portfolio choice model augmented with signaling effect from capital controls. The rationale of using signaling effect in capital controls is drawn from Forbes et. al. (2016). Forbes et. al. (2016) observed that the fund managers perceive capital controls as an adverse signal towards the destination country. The signal effect is considered more severe in case of sovereign bonds. I extend the signaling effect in the investors' portfolio choice problem to explain the heterogeneity in direct and spillover effect of capital controls.

3.2.1 Set up

The structural model is built upon the portfolio choice model of Tille & Van wincoop (2011). There are three countries - Country H, F1 and F2. Each country has one type of bond with maturity of 1 year. The net supply of bonds is unity in each country. There is one unit of capital and one unit of labor available for production in each country. Capital controls in this model are modeled as iceberg trade cost - as investors invest outside their home country, they lose their return from foreign bonds due to capital controls measures. Investors have different degrees of risk aversion. The signaling effect is generated due to private signal received by the investors about the future state of economy and the signal is drawn from the announcement of capital controls. Investors can invest in home country as well as foreign country bonds. The investors' choice is dictated by the optimizing their portfolio return.

Production and consumption

The non-portfolio part of the model is kept simple. Similar structure is used by Tille & Van wincoop (2011) and Devereux & Sutherland (2006,2010). The production function is Cobb-Douglas with labor and capital as input of production. The production function can be written as

$$Y_{it} = A_{it}(L_{it})^{\theta}(K_{it})^{1-\theta} \tag{3.1}$$

where θ is the labor share in the production and $(1-\theta)$ is the capital share. I assume that each country is endowed with one unit of labor and one unit of capital. Hence the production function reduces to

$$Y_{it} = A_{it} \tag{3.2}$$

Household utility is a CES aggregator of home produced and foreign produced goods. The consumers have home bias in consumption i.e. they spend more home produced goods. The utility function of Coutry i household is given by

$$C_t^i = \left[\sum_{j=1}^{3}(\alpha_j^i)^{\frac{1}{\sigma}} C_{jt}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{3.3}$$

where σ is the elasticity of substitution and α_j^i is the relative preference towards commodity produced by country j. Under the assumption of home bias, $\alpha_i^i > 0.5$. The corresponding consumer price index can be written as

$$P_t^i = \left[\sum_{j=1}^{N} \alpha_j^i P_{jt}^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{3.4}$$

Under the assumption of law of one price, the assumption of home bias ensures that the relative price of the foreign goods vis-a-vis P_t^i/p_t^H captures the movement of real exchange rate.

Asset market

Each country has their domestic bond with maturity of 1 year. The net supply of bonds is kept as unity for simplicity. The price of country i bond is $Q_{i,t}$. The holder of country i bond has a claim of $(1-\theta)$ of the total production of country i. Hence, the nominal return of bond i is given by

$$R_{i,t+1} = \frac{Q_{i,t+1} + (1-\theta)A_{i,t+1}P_{i,t+1}}{Q_{i,t}} \tag{3.5}$$

The portfolio choice of investors is given by $\kappa_{j,t}^i$ (for $i, j = 1, 2, 3$) where i represents the residence country of the investor and $\kappa_{j,t}^i$ stands for the destination country portfolio share of country j at time t by investor from country i. Hence, $\sum_{j=1}^{3} \kappa_{j,t}^i = 1$ for all i = 1(1)3. However, investing outside the home country incurs an iceberg trade cost, represented by $\tau_{j,t}^i$. Hence the portfolio return of the investor from country i is given by

$$R_{t+1}^{p,i} = \left[\sum_{j=1}^{N} e^{-\tau_{j,t}^i} \kappa_{jt}^i R_{j,t+1}\right] \frac{P_t^i}{P_{t+1}^i} \tag{3.6}$$

Since the financial market is incomplete, the wealth distribution is non-stationary in nature. Hence we assume that ϕ proportion of investors die every year and new investors born with same probability. The dying investors consume their net worth whereas the new investors are not eligible to participate in the financial market.

The new investors work for the first year and then they can participate in the financial market. Given that assumption, the total wealth of nation follows stationary distribution. The wealth accumulation of typical investor from country i is given by

$$\mathbf{W}^i_{t+1} = \mathbf{W}^i_t * R^{p,i}_{t+1} \tag{3.7}$$

The wealth accumulation of any nation differs from Eq. 3.7 as the iceberg trade cost are assumed to be paid to the new born investors as endowment [1]. This assumption is required to ensure that there is no permanent transfer of assets from any country. The nation's wealth accumulation is given by

$$W_{i,t+1} = (1-\phi) \quad \underbrace{\left[\sum_j \kappa^i_{jt} R_{j,t+1}\right] W_{i,t} \frac{P^i_t}{P^i_{t+1}}}_{\text{Wealth accumulation from investment}} \quad + \underbrace{\theta \frac{A_{i,t+1} P_{i,t+1}}{P^i_{t+1}}}_{\text{Labor income}} \tag{3.8}$$

Market clearing

The goods market clearing condition is given by

$$A_{i,t} = \phi \sum_{j=1}^{N} \alpha_j \left(\frac{P^j_t}{P_{i,t}}\right)^{\sigma} W_{j,t} \tag{3.9}$$

The financial market clears if

$$Q_{i,t} = (1-\phi) \sum_{j=1}^{N} \kappa^j_{it} W_{j,t} P^j_t \tag{3.10}$$

Signaling effect in portfolio choice

I assume that the investors get their private signal from the capital controls policy. The actual iceberg trade cost is given by $\tau^i_{j,t}$. We assume that $\tau^i_{j,t}$ is solely

[1] This assumption follows Tille & Van wincoop (2011)

due to capital controls and $\tau^i_{j,t} > 0$. The private signal of the investors arises due to information asymmetry of investor from country i about the state of economy of country j when $i \neq j$. As foreign investors lacks information about the true state of economy of country j, the information asymmetry arises. The private signal of country i investor about country j is given by

$$\theta^i_{j,t+1} | \tau^i_{jt} \sim F^j(\tau^i_{jt}, \gamma^i) \tag{3.11}$$

Here, $F^j(\tau^i_{jt}, \gamma^i)$ is the distribution of the signal which depends upon the risk aversion of investor and their perception about country j.

Given the private signal, the investor from country i creates an additional wedge $\theta^i_{j,t+1}$ about the future state of economy and investor's perceived iceberg trade cost becomes [2]

$$\tau^{i*}_{jt} = \tau^i_{jt} + \theta^i_{j,t+1} \text{ for } j \neq i \tag{3.12}$$

Following the signaling effect from Eq. 3.12, the portfolio return of country i investor is now

$$R^{p,i}_{t+1} = \left[\sum_{j=1}^{N} \underbrace{e^{-\tau^{i*}_{j,t}}}_{\text{Perceived wedge}} \kappa^i_{jt} R_{j,t+1} \right] \frac{P^i_t}{P^i_{t+1}} \tag{3.13}$$

Investor problem

The decision space of any investor is the choice of $((\kappa^i_{jt}))$ so that they can maximize their utility. The investor's Bellman equation is given by

[2] We assume that the investor has complete information about the state of economy of his home country and hence the signaling effect is assumed to be zero for home country

$$V(\mathbf{W}_t^i) = (1-\phi)\beta \mathbf{E} V(\mathbf{W}_{t+1}^i) + \phi\beta \mathbf{E} U(\mathbf{W}_{t+1}^i) \tag{3.14}$$

where $V(\mathbf{W}_t^i)$ is the value of wealth. The first part of the future value from Bellman Equation is due to the expected value of wealth given the investor survives and the last part is due to probability of dying. We assume that the utility function is given by

$$U(\mathbf{W}_{t+1}^i) = \frac{(\mathbf{W}_{t+1}^i)^{1-\gamma^i}}{1-\gamma^i} \tag{3.15}$$

where γ^i is the coefficient of risk aversion of investor i. We further assume that

$$V(\mathbf{W}_{t+1}^i) = e^{v+f_i(S_{t+1})} \frac{(\mathbf{W}_{t+1}^i)^{1-\gamma^i}}{1-\gamma^i} \tag{3.16}$$

where $f_i(S_{t+1})$ is the time variation of portfolio return which depends upon the current state of economy.

The first order condition of investor choice problem is derived by maximizing the Bellman equation subject to the portfolio return from Eq. 3.13 and wealth accumulation equation Eq. 3.7. The first order condition can be derived as

$$\begin{aligned} \mathbf{E}_t \Lambda_{t+1}^i \Big(e^{-\tau_{jt}^{i*}} R_{j,t+1} - R_{i,t+1} \Big) &= 0 \ \forall i \\ \Rightarrow \mathbf{E}_t \Lambda_{t+1}^i RX_{ij,t+1} &= 0 \ \forall i \end{aligned} \tag{3.17}$$

where Λ_{t+1} is pricing kernel,

$$\Lambda_{t+1}^i = \left((1-\phi) e^{v+f_i(S_{t+1})} + \phi \right) \left(R_{t+1}^{p,i} \right)^{-\gamma^i} \frac{P_t^i}{P_{t+1}^i} \tag{3.18}$$

The Bellman equation reduces to

$$e^{v+f_i(S_t)} = \beta \mathbf{E}\Bigg((1-\phi)e^{v+f_i(S_{t+1})}+\phi\Bigg)\Bigg(R^{p,i}_{t+1}\Bigg)^{1-\gamma^i} \tag{3.19}$$

Effect of capital controls shock

When there is no signaling effect, the comparative statics of the first order condition of the investor with respect to $\tau^1_{2,t}$ is given by

$$\begin{aligned}
\frac{\partial \kappa^1_{2t}}{\partial \tau^1_{2t}} &= \frac{1}{\Delta} * \left[-\frac{1}{\gamma}\right] * \mathbf{E}_t \Lambda^1_{t+1}(R^{p,1}_{t+1})^{-1}(RX_{13,t+1})^2 \leq 0 \\
\frac{\partial \kappa^1_{3t}}{\partial \tau^1_{2t}} &= \frac{1}{\Delta} * \left[-\frac{1}{\gamma}\right] * \underbrace{\mathbf{E}_t \Lambda^1_{t+1}(R^{p,1}_{t+1})^{-1}(RX_{13,t+1} * RX_{12,t+1})}_{\text{Hedge}}
\end{aligned} \tag{3.20}$$

where the first equation corresponds to the change in country 2 portfolio share in country 1's investor portfolio in response to capital controls shock of country 2 and the second equation reflects the re-balancing towards other foreign country bonds in response to capital controls of country 2. Here $RX_{13,t+1} = e^{-\tau^1_{3t}}R_{3,t+1} - R_{1,t+1}$ is the excess return of country 3 bonds with respect to return of investor's home country bonds. Following Eq. 3.20, the capital controls shock reduces the portfolio share of country 2 whenever the capital account restrictions increase in country 2. The re- balancing part of the investor's portfolio is driven by the covariance of excess return between country 3 bonds and country 2 bonds. If country 3 bonds provide a perfect hedge against the risk of country 2 bonds, the investor is likely to re-balance his portfolio towards country 3.

Eq. 3.20 provides the mechanism of portfolio re-balancing in response to capital controls shocks. The portfolio switching towards other foreign country bonds is dictated by hedging which explains relative broad-based impact of spillover effect of capital controls. However, following the first equation of Eq. 3.20, the reduction in portfolio share of country 2 happens in every positive shock of τ^1_{2t} and hence it does not explain the heterogeneity of the direct effect of capital controls on portfolio allocations. Here, the signaling effect comes into help. So we derive the same comparative statics under the assumption of signaling effect. The comparative statics is given by

$$\begin{aligned}
\frac{\partial \kappa^1_{2t}}{\partial \tau^1_{2t}} &= \frac{1}{\Delta} * \left[-\frac{1}{\gamma} \right] * \mathbf{E}_t \Lambda^1_{t+1} (R^{p,1}_{t+1})^{-1} \Big(1 + \frac{\partial \theta^1_{2,t+1}}{\partial \tau^1_{2t}} \Big) (RX_{13,t+1})^2 \\
&= \frac{1}{\Delta} * \left[-\frac{1}{\gamma} \right] * \mathbf{E}_t \Lambda^1_{t+1} (R^{p,1}_{t+1})^{-1} \Big(1 + \frac{\partial}{\partial \tau^1_{2t}} \mathbf{E}^*_t (\theta^1_{2,t+1}) \Big) (RX_{13,t+1})^2 \\
\frac{\partial \kappa^1_{3t}}{\partial \tau^1_{2t}} &= \frac{1}{\Delta} * \left[-\frac{1}{\gamma} \right] * \underbrace{\mathbf{E}_t \Lambda^1_{t+1} (R^{p,1}_{t+1})^{-1} \Big(1 + \frac{\partial \theta^1_{2,t+1}}{\partial \tau^i_{jt}} \Big) (RX_{13,t+1} * RX_{12,t+1})}_{\text{Hedge}}
\end{aligned} \tag{3.21}$$

Compared to Eq. 3.20, the new comparative statics from Eq. 3.21 provides better insight about the role of signaling in the change of portfolio allocations due to capital controls shock. Here, the additional term is i.e. $\Big(1 + \frac{\partial}{\partial \tau^1_{2t}} \mathbf{E}_t \theta^1_{2,t+1} \Big)$ captures the change in investor's perception about the state of economy given the capital controls shocks. The source of heterogeneity in the direct effect and spillover effect is derived from this additional term. The differential change in the expected value of $\theta^i_{j,t+1}$ represents the change in private signal of investor about country 2. Any investor will make greater change in the portfolio share of country 2 bonds in his portfolio depending upon the magnitude of $\frac{\partial}{\partial \tau^1_{2t}} \mathbf{E}_t \theta^1_{2,t+1}$.

Following the fund managers' view from Forbes et. al. (2016), the change in the investor sentiment about the future state of economy of country 2 dictates the change in the portfolio share from country 2 (direct effect). If the fund managers perceives worsening of public sector due to their private signal from capital controls measures, the investors will change their portfolio from public sector of country 2 to a greater extent. On the other hand, if the investors' private signal does not provide worsening off signal about the other sectors of economy (like banks and corporate), the direct effect of capital controls will be muted. In terms of the spillover effect, one can use similar justification to explain the broad-based spillover effect across all sectors. The degree of hedging along with investor's private signal dictate their decision to switch to other country bonds when country 2 increases capital controls.

The source of heterogeneous direct effect and spillover effect of capital controls is thereby, modulated by the change in expected private signal about future wedge in response to the capital controls shocks. The expected value of $\theta^1_{2,t+1}$ depends upon the degree of risk aversion of investors and their assessment about the sector. The change in the distribution of the signal can be visually represented in following way - higher risk averse investors will adjust the value of θ^1_{2t} in greater magnitude than an investor with lower degree of risk aversion. Similarly, greater change in capital account restrictions leads to greater adjustment of θ^1_{2t} i.e. higher capital controls in terms of greater tax on foreign investors will convey greater loss of investor sentiment. Finally, the sector heterogeneity in the private signal modulates the wedge parameter θ^1_{2t}. So combining these three factors, the final wedge θ^1_{2t} will be the source of heterogeneous direct effect and spillover effect (refer to Figure **??** for visual illustrations).

Figure 3.1: Signaling effect of risk aversion

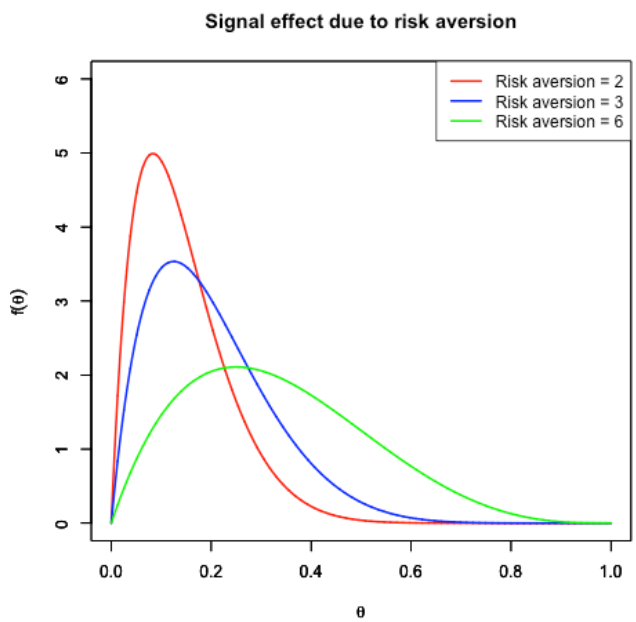


Figure 3.2: Signaling effect of capital control

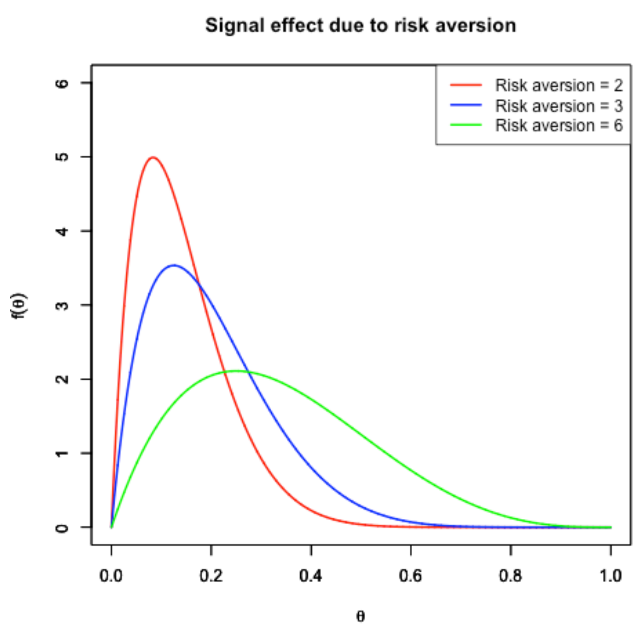
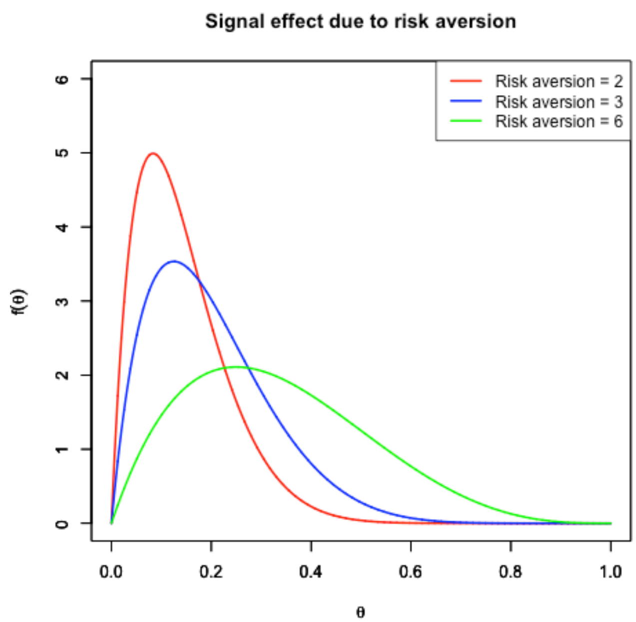


Figure 3.3: Signaling effect of sectoral heterogeneity



3.3 Empirical Framework

To test heterogeneity in capital controls effects, I use a multi country panel to estimate the direct and spillover effects of capital controls using a spatial Durbin model. Before getting into details, I discuss the rationale behind the choice of spatial models. The empirical framework is designed to estimate the direct and spillover effect of capital controls. Though the direct effect is relatively easier to identify, the spillover effect is difficult to quantify without suitable identifying restrictions. Unlike the existing literature, the spillover shock of capital controls is defined as the weighted average of capital account restrictions of other countries. For instance, the spillover effects of capital controls on any particular country (say, Brazil) depends upon the capital account openness of other similar countries. These other countries can be considered as destination substitutes for capital flows. Hence, increases in capital account restrictions in any one of these countries can divert capital flows towards Brazil. Hence the spillover effect is a combined measure of capital account restrictions in other countries (except own country). More specifically, the spillover shock variable can be written as

$$Cap_{it}^{Spill} = \sum_{j \neq i} W_{ij} Cap_{jt} \tag{3.22}$$

where W_{ij} is a suitable choice of weight matrix which estimates spillovers and Cap_{jt} is the capital account restrictions/ openness in country j at time t. We assume that the weights are time-invariant to avoid possible endogeneity in the estimation. The choice of w_{ij} dictates the spillover effects, w_{ij} can be interpreted as the weight of capital account openness/ restrictions of country j on country i. Since the choice of this weight matrix influences the empirical specification, a detailed discussion on w_{ij} is provided after the empirical specification.

Following the definition of spillovers and a suitable choice of weight matrix, the empirical framework can be described as follows

$$C_{it} = \gamma_D Cap_{i,t-1} + \gamma_S \sum_{j \neq i} w_{ij} Cap_{j,t-1} + \theta_D^M Macro_{i,t-1} + \beta X_{i,t-1} + \alpha_i + \epsilon_{it} \tag{3.23}$$

Here, i and j stands for destinations of capital flows and t represent time. C_{it} is the cross-border gross flows of capital to country i at time t, $Cap_{i,t-1}$ is the measure of capital account restrictions at time (t-1), $\sum_{j \neq i} w_{ij} Cap_{j,t-1}$ is the spillover measure, $Macro_{i,t-1}$ is the macro prudential policy in country i at time (t-1), $X_{i,t-1}$ is the pull-push factors of capital flows which act as controlss in the regression. α_i is the spatial fixed effects which captures country heterogeneity.

The primary coefficients of interest are γ_D and γ_S. γ_D measures the direct effect of capital controls and γ_S is the spillover estimate. Here capital account restrictions, macro prudential policies and other controlss are included with a lag of 1 quarter to avoid endogeneity bias.

Eq. 3.23 is equivalent to spatial lagged exogenous model (SLX in short) where w_{ij} are the bilateral spatial weights. The model can be estimated using ordinary least squares. However, Eq. 3.23 fails to include the unobserved characteristics of investors which dictates capital flows to foreign countries. A typical example of such unobserved characteristics include investor sentiments towards these destination countries. These unobserved effects pose threat to the coefficient estimates due to omitted variable bias. In order to over the bias, I use an instrument which is weighted average of capital inflows to other destinations as proxy of investor unobserved characteristics. The rationale behind the instrument, can be drawn from the seminal work of Autor, Dorn and Hanson (2013). If the other destination countries are experiencing higher capital flows, the global investors are likely to be upbeat about their investment sentiment and that is likely to increase capital flows to destination country i. I use the same weight matrix w_{ij} to estimate the instrument variable. Here, the underlying assumption is that the influence of other country's capital controls spillover is proportional to the weight of those countries capital flows.

With this modification, the revised version of Eq. 3.23 can be written as

$$C_{it} = \rho^S \sum_{j \neq i} w_{ij} C_{jt} + \gamma_D Cap_{i,t-1} + \gamma_S \sum_{j \neq i} w_{ij} Cap_{j,t-1} + \theta_D^M Macro_{i,t-1} + \beta X_{i,t-1} + \alpha_i + \epsilon_{it} \tag{3.24}$$

The first term $\sum_{j \neq i} w_{ij} C_{jt}$ is the instrument controlsling for unobserved investor characteristics.

Eq. 3.24 includes spatial lagged values of capital inflows and the specification follows a Spatial Durbin Model (SDM). SDM models cannot be estimated using ordinary least squares due to the presence of spatial lagged terms (Elhorst, 2009). I follow the estimation methodology suggested by Elhorst (2009) and LeSage (2006,2010) to estimate the model at a quarterly frequency.

Next, the empirical specification is modified by relaxing the assumption about lagged impact of capital controls. Here Eq. 3.24 is modified by introducing different lag length (including positive and negative lags). The negative lag value corresponds to the leading effect of capital controls. A significant value of the direct and spillover effects should indicate possible anticipation effect given a negative lag value. On the other hand, statistically significant coefficient value corresponding to positive lag value refers to gradual adjustment of the portfolio choice given the capital controls shocks. The empirical specification can be written as

$$C_{it} = \rho \sum_j W_{ij} log(C_{jt}) + \gamma_{D,k} Cap_{it-k} + \gamma_{S,k} \sum_j W_{ij} Cap_{jt-k} + \theta^M_{D,k} Macro_{i,t-k} + \beta X_{it-1} + \epsilon_{it} \text{ for k = -1(1)5} \tag{3.25}$$

Eq. 3.25 is estimated using the same quarterly data and the lag values varied. All the lagged variables are not included at the same time in the regression due to possible multi-collinearity issue. As the capital account restriction are slow moving variables, the subsequent lag values can be exactly identical in nature and hence, multiple lag values will create multi-collinearity, resulting in oversize coefficient estimates.

3.3.1 Choice of spatial matrix

As indicated previously, the choice of weights w_{ij} plays a crucial role in the estimation of the direct and spillover effect. The spatial weights are derived as correlations between cross-border gross capital flows to destination i and j over time. Here the rationale is that if two countries receive similar gross capital inflows i.e. high correlation in absolute terms, they are deemed to strategic complements (if correlation is positive) or strategic substitutes (if correlation is negative). A typical global investor is likely to consider Country j as destination for his investment portfolio when country i increases capital account restrictions. With this rationale, the weights are also justified for spatial lagged variables. The choice of correlation coefficient as the weight matrix can be justified from the gravity models of portfolio flows. Following the gravity equations, two countries with highly correlated capital flows are likely to have similar profile in the investors' choice set and thereby should be highly influenced by capital account restrictions of each other. However, the criticism of using time invariant correlation comes with the choice of time episodes. As countries experience different levels of capital account openness over time, I use full sample and sub-sample based correlation weights to quantify the spillover variable and lagged spatial variable. The weights w_{ij} is normalized such that sum of weights for country i adds up to 1 and own country weight become 0 i.e.

$$w_{ij} = \begin{cases} \frac{r_{ij}}{\sum_j r_{ij}} & \text{if } j \neq i \\ 0 & \text{if } j = i \end{cases} \tag{3.26}$$

where r_{ij} is the correlation coefficient between C_{it} and C_{jt} over time.

3.4 Data used

The Spatial Durbin Model (from Eq. 3.24) is estimated using quarterly data. This choice of high frequency is dictated by the findings of recent studies of capital flows (e.g. Avdjiev et. al (2018); Emter et. al. (2020) etc.). These studies observed immediate adjustments of capital flows in higher frequency. The time period of estimation is from Q1 1997 till Q4 2018. The choice of time period is dictated by the availability of quarterly cross border flows, capital account restriction index and other controls variables. I consider 20 emerging market economies for the analysis given quarterly data availability. These countries are

Table 3.1: Choice of countries

Argentina	Brazil	Chile	Colombia	Mexico
Peru	China	India	Indonesia	Malaysia
Philippines	Thailand	South Africa	Costa Rica	Latvia
Poland	Romania	Hungary	Turkey	Ukraine

The effect of capital controls is estimated on gross capital inflows given our choice of countries and the fact that majority of capital controls measures adopted by these countries targeted capital inflows (Forbes et. al. (2016)). The cross-border gross capital flows data is sourced from BIS CBS and Avdjiev et. al (2018). BIS Consolidated Banking Statistics (CBS) provides cross border flows of capital inter-mediated by the banks. The data covers capital flows to banks and non-financial institutions. However, the coverage of capital flows in BIS data is mainly confined to cross-border loans and deposits. To get a better understanding about the overall portfolio and other investment flows, the newly constructed data from Avdjiev et. al (2018) is used. This quarterly gross capital flows data provides a comprehensive coverage of capital flows covering data from IMF Balance of payments, BIS LBS and CBS data, BIS Debt Securities, World Bank data (Quarterly Debt Statistics and Debt reporting system) data with suitable imputation methods following BPM 6 accounting techniques [3]. In this data, the capital flows are segregated into portfolio flows and other investment flows. Currency & Deposits, Loans, Trade credit and Account receivables constitute other investments. The portfolio flows mainly represent portfolio debt flows as portfolio debt constitute majority of portfolio flows in balance of payment.

The shock variable is sourced from the capital account restriction index constructed by Fernandez et. al. (2016) and Pasricha et. al. (2018). One of the advantage of using these capital account restriction index is that it differentiates between inflow and outflow based restrictions across different asset categories. Since the analysis primarily focuses on the portfolio flows and other investment flows, we use overall inflow based restriction index as our primary shock variable. The other and most commonly used index is due to seminal work of Chinn-Ito (2008). However, Chinn-Ito index is constructed at aggregate level and does not differentiate between inflows and outflows. I provide the following comparison of these three indices for reference

[3] For more details, refer to the data appendix of Avdjiev et. al (2018)

Chinn & Ito (2008)	**Fernandez** (2016)	**Pasricha** (2018)
IMF Report on Exchange controls and Exchange Openness		
		Local authority announcement
4 asset classes	6 asset classes	6 asset classes
181 countries	100 countries	16 countries
1970-2021	1995-2019	2001-2015
Aggregate	Inflow - Outflow	6 dimensions
Multiple exchange Rate Current Account Capital Account Export proceeds	Money Market Bonds Equity Mutual Fund Financial Credit Derivatives Commercial Credit Guarantees (LOC) Real Estate FDI	Portfolio Debt Portfolio Equity FDI Financial Derivatives Other Investment

(Source: Author's compilation)

Next, the SDM model also includes country level macro-prudential policies as controls of capital flows. The country level macro-prudential policy is sourced from IMF iMaPP database. The database provides the status of macroprudential policies by tagging binary dummy variables across each category of macro-prudential policies and the category-wise policy status is sourced from survey information sought from each country. The index, constructed by Alam et. al. (2019), is averaged across all policy categories to construct the overall index of macro-prudential policy.

The choice of controls variables are sourced from existing literature of capital flows. Following Forbes and Warnock (2012), Ghosh et. al. (2014) and Giordani et. al. (2017), different pull and push factors of capital flows are included as controlss in the main regression. The destination-wise pull factors include real GDP growth, domestic inflation, financial openness index (proxy by Chinn-Ito Index), exchange rate regime and exchange rate. The exchange rate regime data is sourced from Ilzetzki, Reinhart and Rogoff (2021). Domestic macro variables are sourced from IMF International Financial Statistics database and real exchange rate data is sourced from BIS. The global push factors are global risk aversion (proxy by global VIX) and 2 years Treasury yield (as proxy of global interest rate).

Lastly, the spatial weight matrix is derived from the correlation coefficient of gross capital inflows between two countries for the full sample as well as sub-samples. I consider two sub-samples 2000-2007 and 2012-2018 to incorporate time variation in correlation values prior to global financial crisis and in recent times.

3.5 Empirical Findings

3.5.1 Direct and spillover effect of capital controls

The first set of findings are reported from BIS CBS data. Table 3.2 reports the coefficients estimates of spatial lagged term, direct effect, spillover effect and effect of macro-prudential policy. The first few rows of the estimates are derived by using absolute value of correlation coefficient, the middle portion of the table reports the coefficient value for countries with positive correlation coefficient (i.e. strategic complement countries) and the last portion reports the coefficients for strategic substitutes. Following the coefficient values, the direct effect of own capital account restrictions is found to be negative which implies that greater capital account restrictions, reduces capital inflows to destination countries. The spillover effect, on the other hand, is positive and weakly significant. This implies that the capital inflows increase in response to capital account restrictions in other countries. Another noticeable feature from the coefficient estimates is that the estimates are stable with respect to strategic complements and strategic substitutes which implies symmetric effect. Further, it justifies to use absolute value of correlation coefficient to define spillover shocks.

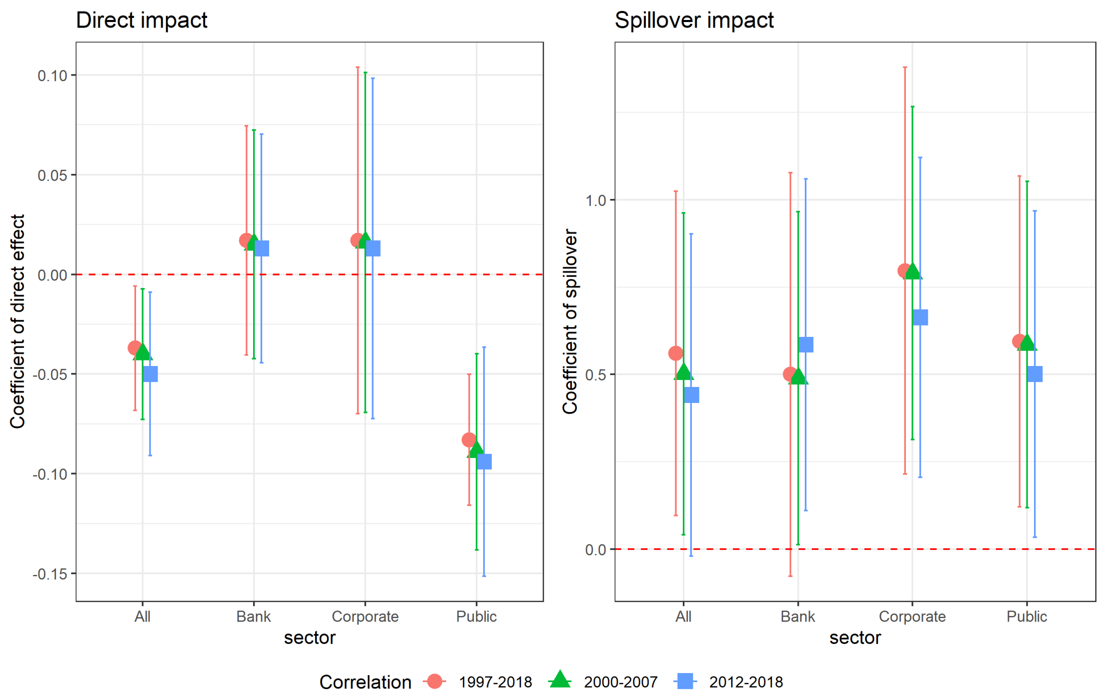
Table 3.2: Spatial Durbin Model Estimates using BIS CBS Data

	ρ^S (Spatial AR)	γ_D (Cap. A/C Openness)	γ_S	$(\theta_D)_M$ (Macro-pru)
Absolute value of correlation coefficient				
Full sample	0.38***	-0.05	0.18***	-0.01
(1997-2018)	(0.00)	(0.11)	(0.00)	(0.44)
Latest Period	0.37***	-0.05	0.12*	0.01
(2012-2018)	(0.00)	(0.12)	(0.09)	(0.44)
Strategic complements				
Full sample	0.38***	-0.04	0.15***	0.01
(1997-2018)	(0.00)	(0.11)	(0.00)	(0.44)
Latest Period	0.37***	-0.05	0.11*	0.01
(2012-2018)	(0.00)	(0.15)	(0.08)	(0.44)
Strategic substitutes				
Full sample	-0.38***	-0.03	0.22***	0.01
(1997-2018)	(0.00)	(0.12)	(0.00)	(0.46)
Latest Period	-0.39***	-0.05	0.20*	0.01
(2012-2018)	(0.00)	(0.11)	(0.08)	(0.34)

p-values are reported in parenthesis.
* p<0.05, ** p<0.01, *** p<0.001

Next, we run similar regression on the portfolio flows and other investment flows data from Avdjiev et. al (2018). The coefficient estimates of direct effect and spillover effect along with 90% confidence bands are reported in Fig 3.4. The direct effect of capital controls appears to moderate capital inflows to public sector whereas the inflows to banks and corporate remain unaffected due to the own-country capital controlss. On the other hand, the spillover effect of capital controls appears to be broad based compared to the direct effect. The portfolio inflow increases in response to the capital account restrictions in other countries. The spillover effect appears to be higher in case of portfolio flows to corporate sector. These results correspond to the absolute value of correlation coefficient in the weight matrix [4]

Figure 3.4: Direct and spillover effect on portfolio flows

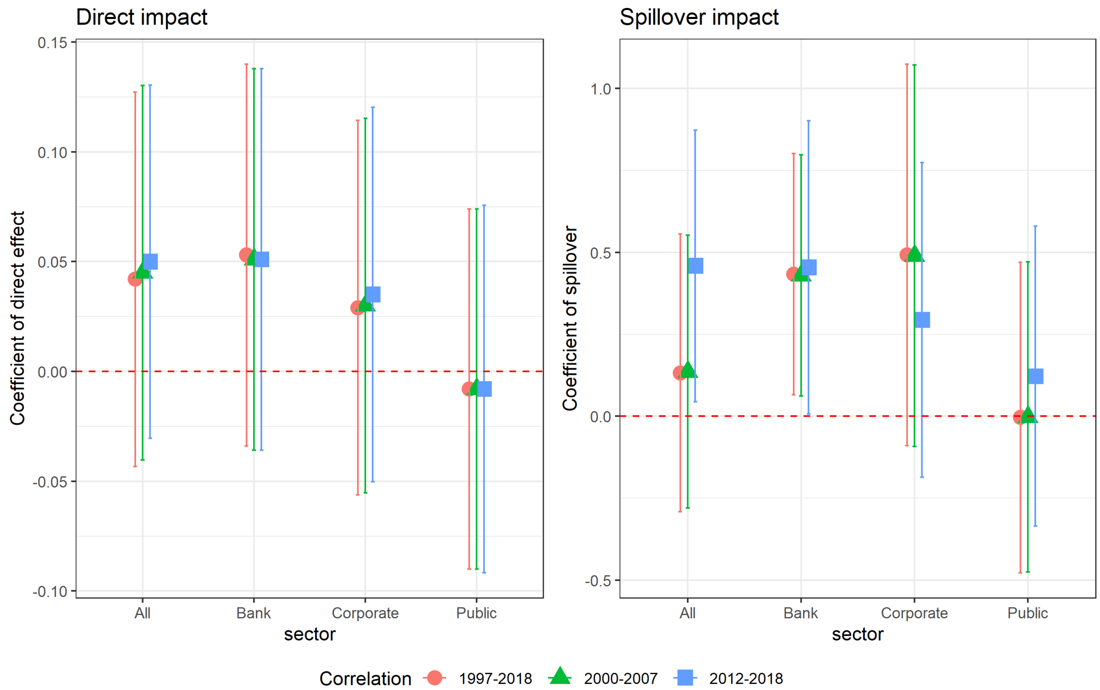


(Portfolio flows data sourced from Avdjiev et. al (2018))

Next, I analyze the coefficient plot of direct and spillover effect of capital controls on other investment flows. The point estimates of direct effect indicates marginal negative effect of capital controls on other investment inflows. However the effects are statistically insignificant. The spillover effect is found to be more pronounced in case the flows are directed towards corporate and banking sector. The spillover effect of capital controls is almost in case of other investment flows going to public sector (refer to Figure 3.5).

[4]Separate regression is run for strategic complements and strategic substitute countries and results are found to be in similar lines

Figure 3.5: Direct and spillover effect on other investment flows



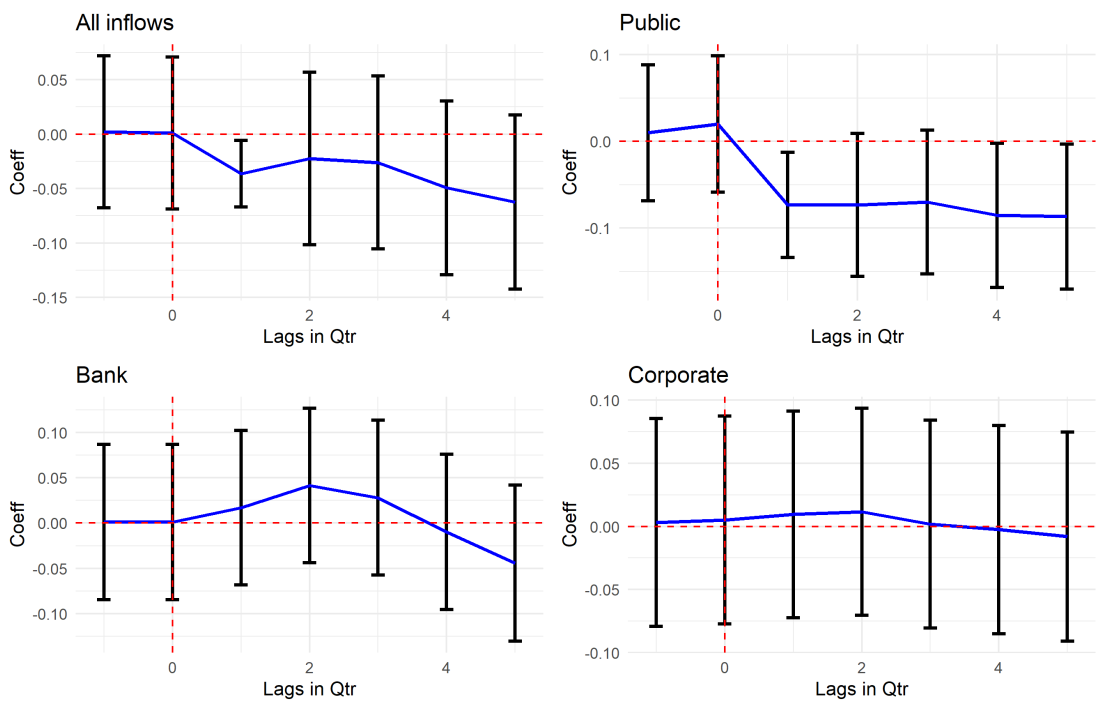
(Portfolio flows data sourced from Avdjiev et. al (2018))

3.5.2 Direct and spillover effect of capital controls with varying lags

Next, the same SDM framework is estimated with varying lag structure. The effect of the capital controls is represented in terms of coefficient plot with 90% confidence bands. The coefficient values along with confidence bands are plotted against the lag values for all inflows and inflows to different sectors. In the plots, the red vertical dotted line corresponds to lag value of 0 (i.e. current quarter). If the confidence bands of the coefficient estimates includes the zero line (red dotted horizontal line), the effect is considered to be insignificant in nature. I consider the correlation matrix from latest time period (i.e. 2012-2018) for the presentation of results. Similar findings were found using full sample correlation estimates also. Further we restrict our analysis on the portfolio flows only following the empirical findings from previous sub-section [5].

Following Figure 3.6, the direct effect of capital controls appears to reduce overall portfolio inflows. The rebalancing appears to immediate in nature as the direct effect dissipates with higher lags. Among the sectoral flows, the inflows to public sector adjusts in response to the capital controls shock whereas inflows to banks and corporate does not demonstrate any statistically significant effect.

Figure 3.6: Lagged direct impact of capital controls on portfolio inflows



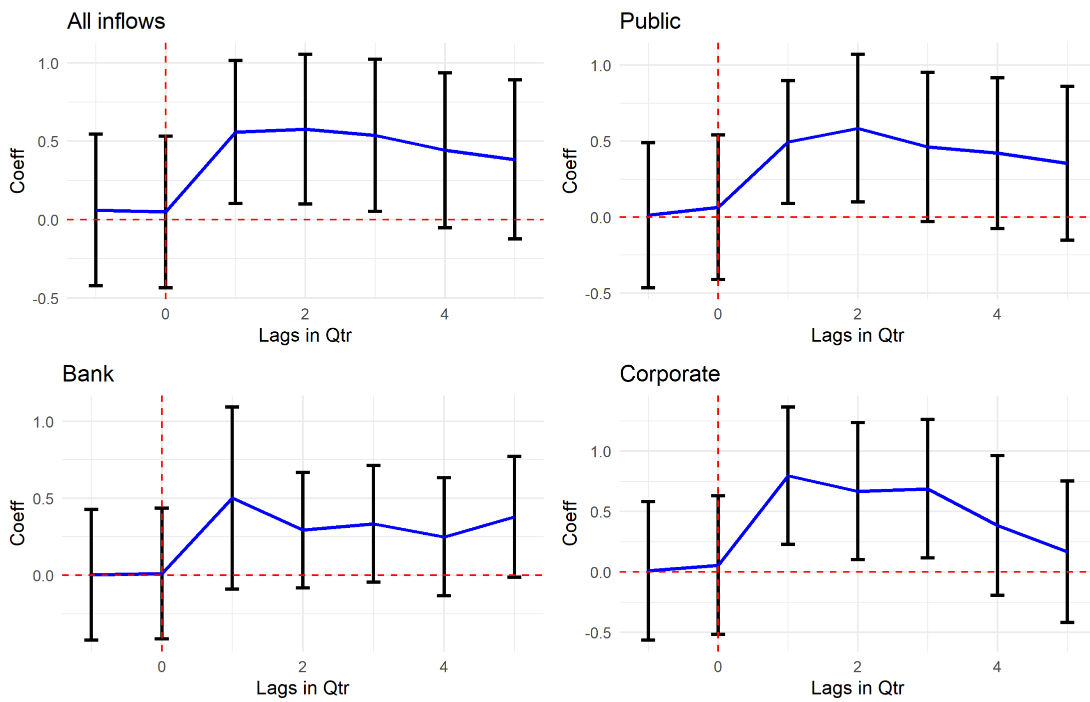
(Portfolio flows data sourced from Avdjiev et. al (2018))

The spillover effect, on the other hand, appears to be adjusting gradually and

[5]The coefficient plots of lagged effect of capital controls on other investment inflows is available in Appendix A1

the effect persists over relatively longer horizon. Total portfolio inflows increase in response to capital account restrictions in other countries and the portfolio rebalancing effect continues till 3 quarters. The effect appears to be entirely driven by the flows going to the corporate sector and public sector. Similar effect is observed in the inflows to banks, However the effect is marginally insignificant in nature (refer to Figure 3.7).

Figure 3.7: Lagged spillover impact of capital controls on portfolio inflows



(Portfolio flows data sourced from Avdjiev et. al (2018))

3.5.3 Robustness checks

As indicated previously, the empirical specification relies heavily on the choice of the spatial weight matrix w_{ij}. In order to validate the robustness of empirical findings, some alternative choices are considered in the weight matrix. These alternatives include absolute distance measures between pairs of countries. I use inverse of geo-distance of major populated cities and inverse of geo-distance between country capital cities for each pair of countries in the weight matrix. The distance data is sourced from CEPII. In order to standardize the distance measures, the spatial weights are normalized to the sum of 1 for each row i.e.

$$w_{ij} = \begin{cases} \frac{d_{ij}}{\sum_j d_{ij}} & \text{if } j \neq i \\ 0 & \text{if } j = i \end{cases} \tag{3.27}$$

where d_{ij} is the distance between country i and country j. The results are robust with respect to the distance measure in the choice of weight matrix.

Further, additional controls are introduced in the spatial regression model to factor in destination country heterogeneity. These additional controls are fiscal deficit as percentage of GDP and size of country (proxy by nominal GDP size). The results are found to be stable under these alternate specifications. Lastly, I exclude China from the collection of countries in the panel to check robustness. The results appears to be robust under alternate country choices.

3.6 Concluding remarks

Global financial integration provided investors with easy access of financial markets across countries. The search for higher returns lead to greater portfolio allocations to emerging market economies. However, the financial integration also exposed these countries to the risk of sudden stops and capital flight resulting in currency depreciation and balance of payment crisis. In this context, capital controls emerged as a possible policy tool for managing the flow of foreign capital into domestic market and thereby, safeguarded the domestic economy from the disturbances in global financial cycle. Capital controls measures helped in safeguarding domestic economy but the signaling effect of the capital controls left an adverse impact on the investors about the future state of domestic economy. On the other hand, the capital controls adopted by one country lead to portfolio adjustments of global investors which lead to greater capital inflow to other destination countries. In this background, this paper analyzes the effect of capital controls on capital inflows to different sectors in terms of the direct effect and spillover effect. The advantage of using sectoral analysis lies in the fact that the drivers of capital inflows to different sectors vary widely. Further, the nature of different sector-wise capital inflows vary with respect to business cycle and the resulting effect of these inflows to sectors can be very different. Aggregate analysis of the effect of capital controls does not provide enough insight about the sector-wise heterogeneity.

The paper evaluates the direct and spillover effect of capital controls using a spatial econometric model on quarterly data. The reduced form specifications analyze the direct effect and the spillover effect of capital account restrictions on cross-border gross inflows of portfolio flows and other investment inflows using Spatial Durbin model. The spillover shocks are defined as spatial weighted shocks of capital account restrictions in other countries. The empirical findings indicates possible heterogeneity in the direct effect of capital controls. Inflows to Public sector moderated in response to the own capital account restrictions whereas inflows going to the banks and corporate did not get impacted The findings of the paper provides valuablein response to capital controls. The spillover effect of capital controls was found to be broad-based as inflows to all sectors increased significantly in response to other country's capital account restrictions.

The direct effect was found to be immediate in nature implying almost immediate adjustments of portfolios from public sector bonds in response to capital controls. However the spillover effect appeared to be gradual in nature and the portfolio re-balancing persisted over 1-3 quarters after the change of capital account restrictions in other countries. The spillover effect was found to be marginally higher in case of inflows to corporate sector.

The paper, then provides an explanation of heterogeneity in the direct and spillover effect by extending the portfolio choice model in multi-country set up under the assumption of signaling effect. Inspired by the fund managers view about capital controls from Forbes et. al. (2016), the paper introduces heterogeneous signaling effect of investors about the state of foreign country's economy when the foreign country imposes capital controls measures. Using investor problem and the derived first order conditions, the analytical derivations of comparative statics provided a theoretical justification of the heterogeneity in the capital controls effects as a change in private signal of the investors about the foreign economy. The private signal, derived from the investors' belief given capital controls shock, modulates the wedge between tomorrow's expected return in the mind of the investors. The paper argues that the investors adjustment about future return from public sector accelerates their portfolio withdrawal from public sector bonds to a greater extent. The spillover effect, on the other hand, is purely driven by the change in private signal and the degree of hedging between two foreign country bonds.

The findings of the paper provides valuable insight for the policymakers. As capital controls safeguard the domestic economy from foreign capital inflow fluctuations, the signaling effect moderates the investment sentiment of investors away from certain sectors. The portfolio re-balance become greater as the investors change their perception about the future state of economy. The paper identifies the importance of sector-wise analysis of the effects of capital controls and provides justification towards more targeted policy approach to manage the direct effect and spillover effect of capital controls. The future scope of this research is enormous - the optimal policy design in view of the sectoral heterogeneity and the resultant welfare analysis will provide a greater insight of interest to policymakers.

3.7 Appendix

3.7.1 Direct ad spillover effect of capital controls on other investment inflows

Figure 3.8: Direct effect of other investment inflows over lags

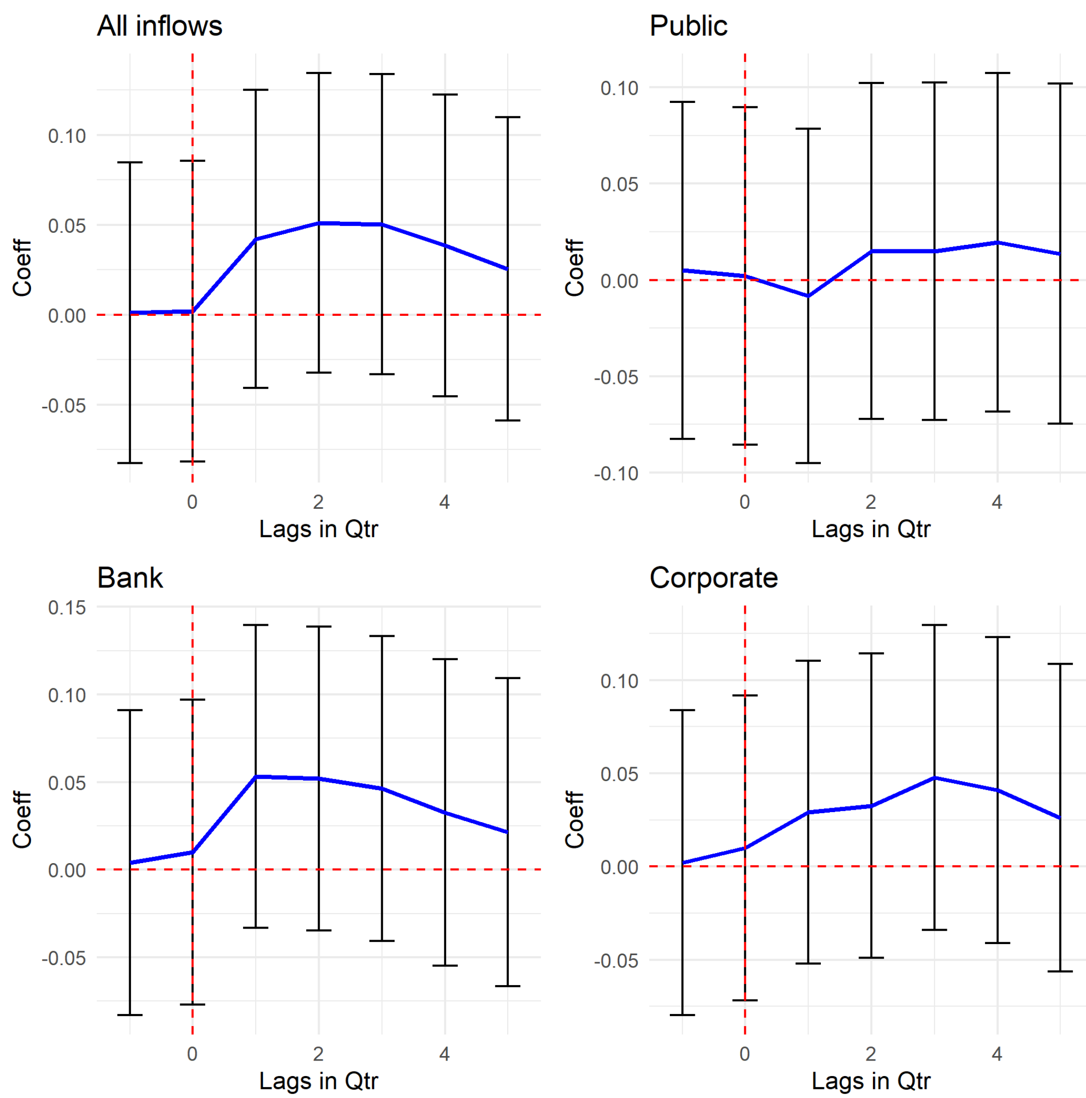
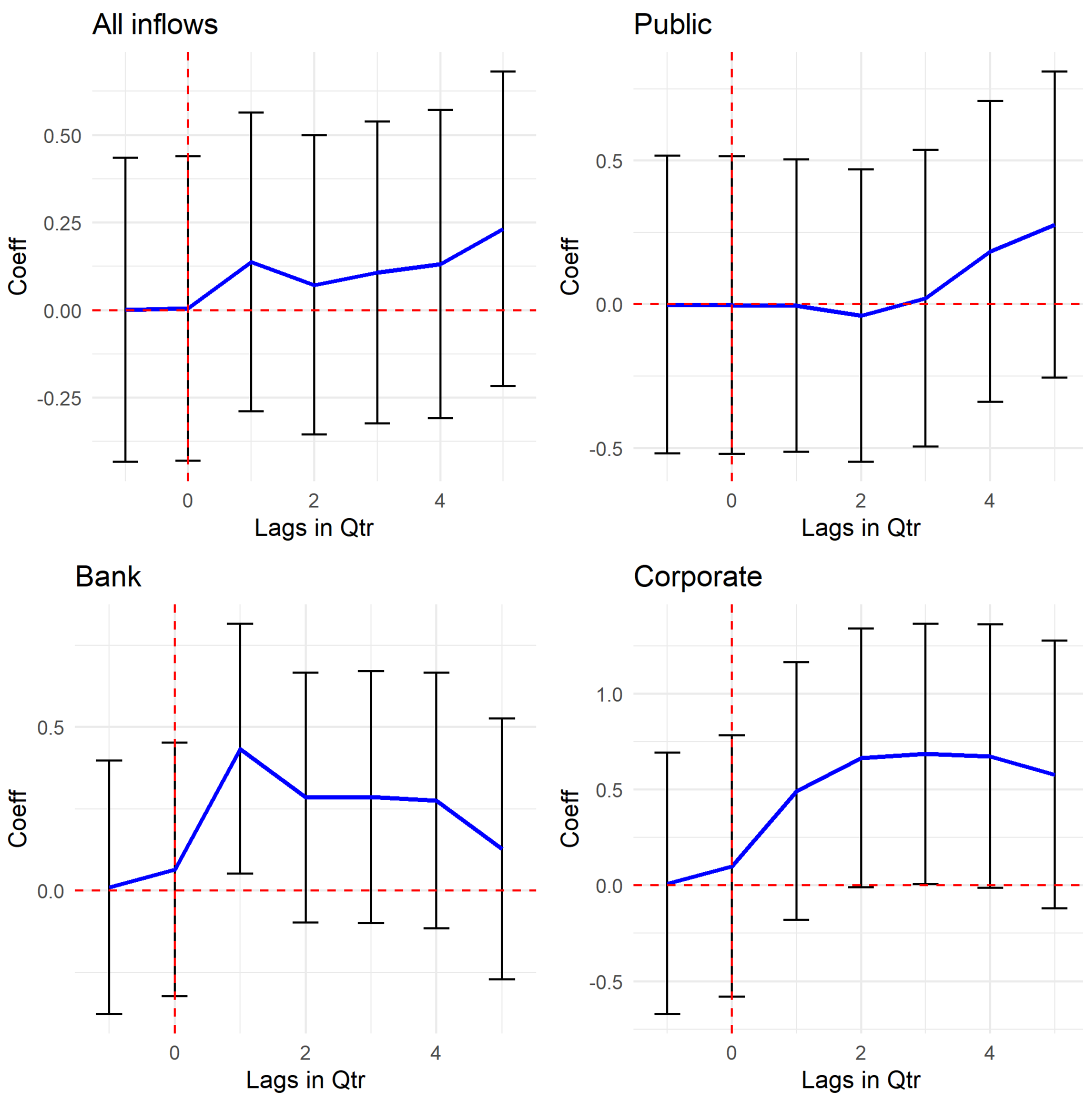


Figure 3.9: Spillover effect of other investment inflows over lags



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