Multiple Essays on Taiwan's Trade Policy: Simulating the Membership of Taiwan in RCEP, Trade Networks of Tech Products, and Political Implications of ECFA

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Dedication

"All the ups and downs eventually lead from the river to the sea, and all the separation and death happen at a certain dock—once you get on the boat, it's your whole life." (Lung Yin-Tai, "Big River, Big Sea—the Untold Stories of 1949"). I dedicate this dissertation to my parents, the mighty, gracious, and merciful Lord Jesus Christ, my brave country, Taiwan, and my beloved younger sister, who died of arrhythmia in April 2022.

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Dissertation Committee

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In the future, as an assistant researcher at CIER and the Ministry of Economic Affairs (MOEA) in Taiwan, I hope to apply what I have learned to contribute to my beautiful country. My goals include developing optimal trade policies, negotiating trade agreements with other nations, and actively participating in international organizations.

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Abstract

Multiple Essays on Taiwan's Trade Policy: Simulating the Membership of Taiwan in RCEP, Trade Networks of Tech Products, and Political Implications of ECFA

This dissertation comprises three quantitative research chapters analyzing Taiwan's trade policies and an appendix on the institutional background of Taiwan's trade policy. Each chapter can be considered the author's ongoing independent research project and is expected to be individually submitted to an academic journal shortly.

The research target of this dissertation is Taiwan, which was chosen for this study because of the limited literature on its distinctive blend of significant economic strength and political dynamics. Taiwan is a state and an economic entity with considerable impacts on the global technology supply chain. The industries that characterize Taiwan in global supply chains are closely linked to our everyday lives, including computers, cell phones, consumer electronics, and integrated circuits. Furthermore, Taiwan has drawn interest during the trade tensions between China and the U.S., which have increased the risks of conflict and the possibility of war. Taiwan's position in the ongoing U.S.-China strategic rivalry is crucial from a geopolitical perspective, as is its manufacturing contribution to global supply chains. Therefore, investigating Taiwan's trade policy is essential for the Indo-Pacific region and the world economy.

The first chapter employs the Global Trade Analysis Project (GTAP) framework to simulate Taiwan's New Southbound Policy. We use the model and experimental policy shocks to assess how Taiwan's potential RCEP membership affects the global economy. We analyze a trade protection policy from RCEP countries blocking Taiwan's participation. This chapter explores

Taiwan's potential RCEP benefits and evaluates the costs of trade protection and economic coercion from the bloc. We model the economic impacts aligned with CGE literature, focusing on China, the U.S., and RCEP countries. By modeling reduced bilateral tariffs, we forecast the outcomes of Taiwan's RCEP membership, estimate the effects of trade liberalization, and the consequences of Taiwan's exclusion from RCEP for itself and its partners. Our analysis shows that RCEP's political compromises incur disproportionate costs; Taiwan's inclusion benefits all, including the U.S. and China, though not equally.

The second chapter applies the latest graphical analysis methodology, the International Trade Network (ITN) analysis, to Taiwan's specialties in technological products. We analyze the evolution of Taiwan's technical sectors using international trade network analysis. In particular, we examine two industries in Taiwan that are well-known worldwide: "personal computers" and "integrated circuits," by obtaining the product-level trade data from the UN Comtrade database. We plot the trade network, calculate the degree of centrality for the countries, and identify the distinctions in computer chip production from the perspectives of the international trade network. We analyze the global trade network graphs to assess Taiwan's centrality at different times. We relate network theory to the commercial context of technologically exchanged items. This chapter uses several consecutive graphs to demonstrate the evolving competition among the United States, Japan, China, and Taiwan in the global market for technology products, particularly microchips and personal computers. We analyze numerous waves of technological innovation and observe that the findings are relevant to Taiwan and countries with open economies and distinctive path dependencies.

The third chapter uses the historical electoral data of Taiwan and the Regression Discontinuity Design (RDD) model to identify the potential change in the political identification of the Trade Agreement's side effects: the influx of Chinese tourists to Taiwan from 2008 to 2016. We analyze the historical electoral results of the Taiwanese presidential elections and the Annual Survey Report on Visitor Expenditure and Trends (ASRVET) from 2008 to 2016. It examines how opening borders to Chinese tourists as part of the preferential trade agreement with China affects Taiwanese constituents' political ideology and party recognition in third-level municipalities. We create a new dataset by integrating geographic data into the Taiwanese electoral database. Following the tourism literature, we devise an index to quantify Chinese tourist exposure (CTE) in each electoral district, considering the number of visits and travel time to the main tourist destinations. We conduct nonparametric regression discontinuity (RD) models using a running variable of CTE to examine the exposure cutoff points of Chinese visitors over various years for strong empirical results. Reviewing several local polynomial functions in the RD model, we demonstrate that electoral districts with more exposure to Chinese tourists experienced more significant ideological realignment following the policy shock. After the preferential trade agreement shock, the distinction between locations exposed to Chinese tourists and those not covered by the agreement is unclear.

Table of Contents

List of Figures

List of Tables

Preface

This dissertation is authored by Je-Uei Kuo, also known as Je-Uei “Jeffrey” Kuo or Jeffrey Kuo. The author goes by the preference name "Jeffrey Kuo" most of the time in the United States to increase recognition and assist non-native-Mandarin speakers without bothering by the pronunciation. The views expressed in this dissertation are those of the author alone and do not represent the dissertation committee members, faculty, and staff of George Washington University (GWU) and the Columbian College of Arts and Sciences (CCAS).

Chapter 1: Simulating the Membership of Taiwan in RCEP

1.1 Introduction

1.1.1 Preferential Trade Agreement (PTA)

Deciding on a trade policy related to joining a Preferential Trade Agreement (PTA) presents challenges for policymakers. Economists generally believe that free trade enhances overall welfare, but there are many factors that authorities must consider once the PTA is finalized (Rodrik, 2011). Signing a PTA with other nations may enhance trade volumes;[1], yet trade liberalization brings numerous challenges, such as causing income redistribution in the labor markets and the reshuffling of the returns of the production factors in different industries (Acemoglu et al., 2016; Rodrik, 2011; Suranovic, 2010). Hence, balancing economic openness and policy space management rights is very important (Rodrik, 2018). This chapter examines the potential economic impacts of Taiwan's integration with The Association of Southeast Asian Nations (ASEAN) countries. The Taiwanese government introduced a new series of trade policies in 2016, referred to as the New Southbound Policy (NSP). The NSP greatly influences Taiwan and its trade counterpart; however, there is a lack of literature that specifically addresses the estimation of the economic impacts associated with this policy.

First, we estimate the impact of Taiwan joining RCEP by primarily looking beyond the country of interest. Signing PTA establishes a new trade bloc

[1]According to neoclassical trade theory, free trade would improve a country's overall welfare simply because specialization reduces production costs, and both countries take advantage of making the goods with their comparative advantages (Deardorff, 2007).

that excludes non-member states, complicating their trade with members of the bloc. This exclusion may align with specific political implications (Lipsey, 1957). Therefore, government-initiated trade policies on whether to participate in a PTA have been a particularly contentious debate during the globalization era, domestically or internationally (Suranovic, 2010).

Since signing a PTA affects more than just the country initiating the act to join the trading blocs, the political dynamics between countries can also play an important role in signing PTAs. Conventionally, the existing members can decide whether to admit the new members. However, having a country join a partnership does not always depend solely on economic incentives. Instead, it often relies on the current members' diplomatic relationships and the regions' political climate.

For example, political disputes with China have prevented Taiwan, the economic entity we study in this project, from joining a trade bloc. Regional Comprehensive Economic Partnership (RCEP) is a trade agreement initiated by the ASEAN. Although Taiwan initiated strong efforts to become a member, the RCEP has denied Taiwan's applications to become a member state. Taiwan has not participated in the negotiations and regular meetings since the RCEP was proposed (Chang, 2019).

Then, we look at the economic impacts on the different sectors and the increasing gains from trade should Taiwan join RCEP and try to figure out how the authorities should allocate the gains from trade. The allocation of the gains from trade has consistently posed difficulties for every country's administrations (Rodrik, 2011). More so, the globalization era has connected all sectors, making it challenging to identify the individual impacts on the specific sectors. The uncertainty about the ensuing results of signing the trade agreements causes societal tensions. For example, in Taiwan, a social

uprising in 2012 was caused by public concerns about the consequences of rectifying the Cross-Strait Agreement on Trade in Services as part of the Economic Cooperation Framework Agreement (ECFA) with China (Ma and Xiao, 2018).

1.1.2 Taiwan's New Southbound Policy

The RCEP is a proposed preferential and regional trade agreement between the member states of the ASEAN member states and their partners in the existing PTA.[1] In 2016, there was a significant change in Taiwan's trade policy since the Democratic Progressive Party (DPP) won the presidential election that year and ended the 8-year Kuomingtang (KMT) presidency. The new president, Tsai Ing-wen, unlike her KMT predecessor Ma Ying-jeou, believes Taiwan should not tie up with the People's Republic of China (P.R.C.) economically for political concerns, given that China claims that Taiwan is part of its territories in international communities and is not willing to give up annexing Taiwan by force.[2]The DPP administration then set up a NSP series and tried to reduce Taiwan's economic dependence on China.

The NSP encourages Taiwan's companies and government agencies to interact more with Southeastern Asian countries and to work hard to join the existing trade agreement, the RCEP. However, Taiwan's economic cooperation efforts are only unilateral, and the efforts to join the Southeast Asian trade bloc have not received positive feedback (Hsieh, 2017; Tsai and Liu, 2017).

[1]Currently, the RCEP member states include Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Vietnam, China, Japan, India, South Korea, Australia, and New Zealand. Altogether, of the 16 countries negotiating the RCEP to reduce the trade barriers, the whole trade bloc accounts for a third of the world's GDP and almost half of the world's population.

[2]Inaugural address of ROC 14th-term President Tsai Ing-wen, `https://english.president.gov.tw/News/4893`

The economic excuse can barely explain the RCEP's trade protection policy since Taiwan ranked eighth economy in Asia and tied up in trade with southeastern Asian countries. Instead, P.R.C. has considerable market power, and most existing member states in the RCEP follow China's will (Hsieh, 2017).[3] However, this distorted trade protection policy initiated by the RCEP ultimately causes a price for its member states. This chapter aims to estimate the costs of excluding Taiwan from the RCEP and to understand the potential impacts on the United States and China should Taiwan join the trade partnership agreement.

It is difficult to accurately assess the effects of trade agreements through empirical analysis in a partial equilibrium framework, given the intricate relationship between domestic production sectors and foreign markets (Corong et al., 2017; Lee and Plummer, 2011). The trade policy of whether to join a trade bloc usually has a broad aspect across different industries (Baldwin, 2017; Chase, 2009; Krugman et al., 1991).

Hence, there are some questions that we would like to answer in this chapter; for example, would it be better for the United States if Taiwan joined the RCEP, and if Taiwan joined RCEP and the United States backed off under Trump's administration? Would China benefit or lose if Taiwan joined the RCEP? If Taiwan discontinued the PTA with China and entered the RCEP, would China encounter a benefit or loss in the welfare change? Since we are not merely examining the individual sector but evaluating the impact on the corresponding countries, the policy simulation of the Computational General Equilibrium (CGE) model becomes our primary methodology. This chapter seeks to use the CGE model to objectively demonstrate and quantify

[3]Historically, Taiwan has been excluded from most international organizations for political reasons. Therefore, the current situation of the RCEP without Taiwan was obviously due to political reasons, which is identical to the case in which Taiwan is not allowed to join other international organizations (Tucker, 2005).

the impacts on China and the U.S. if Taiwan were to join the RCEP.

In our policy experiment, we divided the world into five major groups: China, the United States, Taiwan, the RCEP, and the rest of the world (ROW). This allows us to isolate the impact of Taiwan joining RCEP. Additionally, we follow the Global Trade Analysis Project (GTAP) literature to identify 56 sectors and five main production factors for the general equilibrium model. Our data comes from the eleventh version of the input-output trade database from GTAP, with 2017 as the reference year. Then, we apply the experimental policy shock using the RunGTAP program to simulate the trade shocks and analyze the changes in welfare and economic impacts on Taiwan, the United States, and China (Pearson et al., 2018; Hertel et al., 1997).

1.1.3 Organization of the Chapter

We organize this chapter as follows: Section 3.3 explores the existing literature and critical concepts related to Asian economic integration and reviews the literature about modeling political tensions during economic integration, and we also review the institutional background centering on Taiwan. Specifically, we began our exploration from a Taiwanese perspective and gradually broadened our scope to encompass preferential trade agreements and integration. Section 1.2.1 highlights the singularity of Taiwan's political standing in Asia. Section 1.2.2 discusses the New Southbound Policy (NSP) implemented by the Taiwan government and its impact on the relationship between Taiwan and ASEAN nations. We examine the institutional history of ASEAN and RCEP in Sections 1.2.3 and 1.2.4, respectively. Section 1.2.5 discusses the complicated trilateral relationship between the United States, China, and Taiwan, coined as the "Precarious Triangle" in

the 2000s. Finally, 1.2.6 explores the other potential options for Taiwan PTAs and concludes the literature review.

Section 1.3 discusses the CGE model and GTAP system, and we give an overview review of how the computational general equilibrium model works. Section 2.4 presents a comprehensive overview of the data sources used to update the GTAP network input-output table, encompassing countries worldwide. Section 2.4 also explains how the users of GTAP report the data and update the input-output table to the Center for Global Trade Analysis process. Using Taiwanese trade data as an example of how the GTAP database was constructed, we review the literature on how Taiwanese trade data were collected in GTAP. Section 1.5 discusses the simulation setup, including regional and sectoral aggregation in the GTAP. Then, we discuss the experimental shock applied in RunGTAP, a graphical user interface program that allows us to run the simulations. We organize the experimental results in Section 2.6. Finally, in the last section, Section 3.7, we identify the results of the graphs, summarize our findings, discuss potential extensions and policy implications, and the limitations of the CGE methodology to wrap up this chapter.

1.2 Literature

Political tensions between the countries involved greatly influence economic integration policies; to some extent, forming a trade bloc is not always based on its economic incentives (Hinz, 2023). Anesi and Facchini (2019) constructed a two-country model to show that a nation can exercise coercion, or a "weak" international organization without enforcement powers can be used to direct it. Acemoglu and Yared (2010); Martin et al. (2008) highlighted that governments must work hard to sign trade agreements when tensions increase to avoid a potential war.

Little research has been done to determine the potential welfare losses that could result from the expulsion of two states with vastly different political views but a high degree of economic interdependence. The case between Taiwan and China is a good example of that. Adding the roles of the United States and Southeast Asian countries into the background and using the CGE model, this study filled the gap by estimating how much political tensions are worth, taking the potential welfare gains as the loss of opportunity cost to deter Taiwan. This chapter runs the counterfactual policy experiment to simulate the outcomes and assess the possible benefits and costs if Taiwan joins the RCEP. Using the CGE model framework, we estimate the potential gains from trade from the trade policies of including Taiwan; in other words, we can interpret them as the loss from the current member state countries of placating China.

1.2.1 Taiwan

The exclusion of Taiwan from the RCEP is a puzzling case through the lens of economists and practitioners of international affairs (He and Magcamit,

2023). Taiwan is geographically close to Southeast Asia and has served as a labor market for temporary immigrant workers from Indonesia, the Philippines, and Thailand in the senior care, fishing, and manufacturing industries.

Moreover, Taiwan is the third largest trading partner of southeastern Asian countries after China[4] and the United States. Taiwan's capital-intensive technology export industries complement the relatively labor-intensive manufacturing sectors of the RCEP countries (Cheng and Chow, 2015). Furthermore, the incumbent Taiwanese administration, led by Tsai Ing-wen and the DPP, has advocated for a "New Southbound Policy (NSP)" since taking office in the 2016 general election. From Taiwan's perspective, the current equilibrium of not being a member state of RCEP was not an ideal result of Taiwan's government's willingness.

Taiwan's role in East Asian geopolitics became even more crucial after the U.S.-China full-scale trade war broke out. However, Taiwan has been at the center of geopolitical conflict since the Cold War, while it has become an economic powerhouse after the millennium (Hsieh, 2011; Gray, 2011). Taiwanese companies have gained recognition in the age of globalization due to their export of consumer electronics and computer chips to other nations since the 1980s (Cheng, 2022; Gereffi, 2019; Brown and Linden, 2011; Kaynak and Kuan, 1993). Their success in this area has made them renowned around the world. The advanced semiconductor industry in

[4]P.R.C., China, with an estimated population of 1.4 billion, naturally becomes the most significant market other countries want to be friends with to garnish the enormous market benefits. However, three decades after the beginning of trade liberalization, China has maintained its unique authoritarian political regime, and there have still been political standoffs envisaged between the "People's Republic of China (PRC)" and "Taiwan (Republic of China ROC)." Since ideological transformation has not occurred as the Chinese economy grows, the rest of the world begins to evaluate political concessions while sharing the market with China. Foreign companies and governments face economic coercion in China due to clashes between the Chinese government and foreign companies. Taiwan had a unique dilemma when choosing between the economic market and jeopardizing its sovereignty.

Taiwan has also recently shown its vital role in the worldwide consumer electronics and computer market (Chen and Leong, 2022). The ramifications of Taiwan's trade policies, particularly its interactions with China and the United States, are not limited to the well-being of the Indo-Pacific countries but are also intertwined with the global context (Weidenbaum, 2000).

In conclusion, Taiwan has strong economic ties to the countries that chartered the RCEP. However, despite its best efforts, Taiwan was denied access to the RCEP.[5]

1.2.2 New Southbound Policy (NSP)

To expand Taiwan's presence across the Indo-Pacific, incumbent Taiwanese President Tsai Ing-wen introduced the New Southbound Policy (NSP) to strengthen Taiwan's relationships with the countries that are geographically to the south of Taiwan. The NSP started with Tsai's first term as Taiwanese president in 2016. There are 18 targeted nations in total, including Thailand, Indonesia, the Philippines, Malaysia, Singapore, Brunei, Vietnam, Myanmar, Cambodia, Laos, India, Pakistan, Bangladesh, Nepal, Sri Lanka, Bhutan, Australia, and New Zealand, ten of which are ASEAN countries. The NSP targets the economic and trade perspective and is designed to increase the impacts of Taiwan's influence on Southeast, South,

[5]RCEP was initiated in Bali, Indonesia, during the ASEAN summit in 2011. Its predecessor, the Association of Southeast Asian Nations (ASEAN), was established in 1967 by the nations of Indonesia, Malaysia, the Philippines, Singapore, and Thailand. The primary objective of establishing ASEAN was to enhance economic growth, trade, economic development, and social progress among its member states. Over time, ASEAN has expanded its membership. Brunei Darussalam became the sixth member state on January 1, 1984, followed by Vietnam, which joined as the seventh full member on July 28, 1995. Laos and Myanmar attained membership in 1997, while Cambodia joined ASEAN after resolving its internal political instabilities in 1999. In the meantime, the "ASEAN Plus Three" initiatives were formulated in 1997, which prompted extensive discussions regarding the potential inclusion of China, Japan, and South Korea into the trade bloc. Consequently, the scope of ASEAN has transcended Southeast Asia, evolving into a broader concept of a free trade agreement in Asia, which subsequently developed into the Regional Comprehensive Economic Partnership (RCEP) today.

and Pacific Asia (Glaser et al., 2022). According to the official announcement of the NSP, the purpose of the NSP is to take advantage of Taiwan's cultural, educational, agricultural, and economic assets to connect with more nations within the proximity while maintaining a stable cross-strait relationship with China. NSP is not the first policy in Taiwanese history to explore opportunities with Southeast Asian countries. It follows a similarly named guideline in the 1990s, the so-called Southbound Policy, which operated under the previous administration between 1996-2008. The goal of the Southbound Policy was clear: to counter the wave of investment and trade in China during the late 1990s and early 2000s. Under Lee Tung-Hui's tenure as the President of Taiwan, the Southbound Policy aimed to diversify Taiwan's economic reliability to mainland China and divert them toward Southeast Asian countries. However, due to the increasing volume of China's economic growth, the 1998 Asian Financial Crisis, and China's successful bid for membership in the World Trade Organization in 2001, the old southbound policies did not achieve much. China has been the trade counterpart that Taiwan has relied mainly on since then. Taiwan government opened a series of service centers, one for each of the 18 countries covered by the NSP and instructed the financial supervisory commission within the government to set up a "southbound center" financing platform for Taiwanese businesses needing capital injections to invest in target states. On the other hand, the government encourages multinational companies with a strong relationship with Taiwan, including those headquartered in mainland China, to relocate to Southeast or South Asia to take advantage of lower operating costs.

1.2.3 The Association of Southeast Asian Nations (ASEAN)

The integration initiated by forming the Association of Southeast Asian Nations (ASEAN) is the basis of the Regional Comprehensive Economic Partnership (RCEP). The negotiations for the RCEP started in November 2012 with ASEAN countries and their free trade agreement partners, including China, Japan, South Korea, Australia, and New Zealand. On top of the results of Southeastern Asia's economic integration, the RCEP expands the ASEAN territories to northeastern Asia in the 2010s. This action to expand the economic cooperation to non-ASEAN countries is a significant milestone in Asia, as it represents the most substantial free trade agreement regarding the volume of GDP worldwide. Since the establishment of the Association of Southeast Asian Nations (ASEAN), there has been a surge in economic integration by signing preferential trade agreements (PTA) between Asian countries (Hashmi and Lee, 2008; Baysan et al., 2006). Southeast Asia's economic integration is vibrant due to its proximity and intertwined history. As emerging markets rely heavily on international trade (Reyes-Heroles et al., 2020) and the capital and technologies from the developed markets, adding other developed countries in the Asia-Pacific region is an ideal plan for the ASEAN countries. Since 2016, Taiwan's government has been promoting the "New Southbound Policy" (NSP) to shift the country's economic reliance away from China and towards Southeast Asia. To gain more access to Southeast Asian markets, joining the Regional Comprehensive Economic Partnership (RCEP) appears viable. Taiwan has been a major source of political discord between the United States and China since the Cold War. As China has become a significant economic power, the tension between the two superpowers has only increased, which adds complexity to determining whether the exclusion of Taiwan from the RCEP was due to political or

economic reasons or a combination of both. The importance of Taiwan's participation in the RCEP has dramatically increased, as the Taiwan issue has become the main battleground for the United States and China. This research is motivated by the need to document the economic impacts of Taiwan's participation in existing regional trade agreements. We simulate the outcomes and examine the hypothetical policy effects on China, the U.S., and the RCEP countries on the policy experiment if Taiwan somehow joins the RCEP and leads to the reduction of the bilateral tariffs. Our findings suggest that the exclusion of Taiwan from the RCEP is politically motivated and has an economic basis.

1.2.4 Regional Comprehensive Economic Partnership (RCEP)

RCEP was initially built on the proposal of the Association of Southeastern Asian Nations (ASEAN). "ASEAN Plus Three" was the name of the strategy with the invitation of China, Japan, and South Korea to join the trade agreement. As a regular preferential trade agreement, the RCEP is an economic contract that governs the policy tools of international trade among its member states. They are cutting trade barriers like tariffs, subsidies, and technical trade barriers. As indicated in its bylaws, RCEP aims to increase trade flows between member states so that firms and residents can take advantage of the less costly and more diversified goods (Shimizu, 2021). In November 2011, at the 19th Annual Meeting of the Association of Southeast Asian Nations (ASEAN) held in Bali, Indonesia, the idea of a comprehensive regional economic partnership (RCEP) was first introduced. Official RCEP negotiations were initiated during the 21st ASEAN Summit in Cambodia the following year. By November 2019, all participating countries

aim to finalize and sign a deal.[6]

Following the convention of multilateralism, the RCEP aims to lower international trade barriers in goods and services and protect intellectual property among member states. RCEP also aims to create an integrated market with sixteen countries, making it easier for the products and services of each country to be available for sale in this region. The preliminary negotiation topics between the countries are trade in goods and services, investment, intellectual property, dispute settlement, e-commerce, small and medium enterprises, and economic cooperation.

RCEP is one of many major regional integration efforts in the Asia-Pacific region. During the 2010s, the Trans-Pacific Partnership Agreement (TPP), which was initiated by the administration of Barack Obama, was also in the process of development. The White House declared that the Trans-Pacific Partnership (TPP) was a trade agreement that would eliminate more than 18,000 taxes on the trading goods imposed by 11 Asian-Pacific countries, including Canada and Mexico, on products made in the United States. However, the TPP does not include the most significant trade partner of the U.S., China, for political reasons. Hence, it is believed that China pushed to form the RCEP in 2012 to counter the TPP. Since then, the RCEP has become a powerful tool for China to counter the U.S. endeavor to prevent Beijing from building its trading blocks.[7]

[6]The 19th ASEAN Summit, under the Chairmanship's theme of "ASEAN Community in a Global Community of Nations," held in Bali on November 17, 2011, was chaired by the President of the Republic of Indonesia, Dr. Susilo Bambang Yudhoyono, as the Chair of ASEAN in 2011.

[7]However, on 30 January 2017, US President Donald Trump ended the Obama administration's policy and withdrew from the TPP. The letter indicates that the United States officially withdraws from the Trans-Pacific Partnership Agreement—the Official Letter of the US Trade Representative. The remaining countries of the original TPP negotiated a new trade agreement called the Comprehensive and Progressive Agreement for the Trans-Pacific Partnership (CPTPP), which incorporated most of the provisions of the TPP and entered into force on 30 December 2018. The progress and future of CPTPP have not been clear since then.

1.2.5 US-China-Taiwan Relationship

To use "strategic triangular" to describe the cooperative and competitive relationship between three countries was first used in Dittmer (1981). Instead of describing the US-China-Taiwan relationship, Dittmer (1981) applies it to describe the US-China-USSR relationship under the Cold War framework. Dittmer (1981) also provides the game-theoretic perspective of political competitions between three countries. The usefulness of the "strategic triangle" concept is evident when examining the internal dynamics of the relationship between the United States, the Soviet Union, and China. The precondition for a triangular relationship is that each player recognizes the strategic importance of the three principles. Each player's connection to the third will affect the relationship between any two.

Dittmer (1981) then defines three distinct pattern dynamics in the triangle: the menage a "trois," consisting of mutually positive relationships among all three. Dittmer (1981) claims that a stable marriage consists of a bilateral relationship, excluding the third. This is the case if we compare the historical wave of the U.S.-China-Taiwan relationship. When the U.S. needed additional alliances to deter the Soviet Union, China became a good candidate, and that was the background of the U.S. switch to the Chinese government from Taiwan. In Dittmer (1981), The romantic triangle comprises one central figure playing off two admirers, and each behavior pattern has its own set of rational guidelines. During the times after World War II until the dissolution of the Soviet Union, the U.S. was the center player that both Taiwan and China would like to appeal to. According to Dittmer (1981), the players' efforts to solidify a particular arrangement through a treaty or a shared ideology determine the transition from one pattern to another. In this chapter, we argue that the "strategic triangle" could also

be applied to the situation between Taiwan, China, and the United States regarding regional integration.

The US-China-Taiwan triangular relationship is even more complicated due to its potential for conflicts to break it, so it has also been referred to as the "Precarious Triangle" by Weidenbaum (2000). Since the end of World War II, Taiwan has been a source of tension in the region due to its strategic position and complex history between the United States and China (Zagoria, 2011).

Jue (2016) summarizes the diplomatic history and the U.S.'s China strategy after the end of the Chinese Civil War.[8] During the Korean War, the United States saw Taiwan as a strategic location to impede the spread of communism. The U.S. Navy fleets safeguarded the newly established Republic of China (ROC), the government's official name ruling Taiwan, on the island. Despite the close ties between the United States and the Chiang family-led authority administration fled to Taiwan, some issues still caused tension. At one point, the Chiang family and the authoritarian regimes led by the Kuomintang had distanced themselves from the United States (Hsieh, 2020), creating a rift between them.

Meanwhile, the United States leaned on China since a solid ally to balance the Soviet Union was desperately needed in the Far East during the Cold War (Baldwin et al., 1995). The relationship between China and Taiwan is also long and complex. China considers Taiwan a rebellious region, even though it has all the characteristics of a sovereign nation and has become a full-fledged democracy since the 1990s.[9]

[8]The authors used his experiences as a US foreign delegate to Taiwan starting from Mao Zedong's era and Zhou Enlai's "One China" policy proposal.

[9]For example, in Taiwan, the presidents are directly elected by the legal constituents across political cycles, government officials with fixed tenure, the congressional members representing different electoral districts on the island, the autonomous military, and the currencies backed by its central bank.

Through the lens of international trade, both the United States and China plays a crucial role in business with Taiwan (Kan and Morrison, 2013). U.S. goods and services trade with Taiwan totaled an estimated 105.9 billion U.S. dollars in 2020, where exports were 39.1 billion and imports were 66.7 billion. The U.S. goods and services trade deficit with Taiwan was 27.6 billion in 2020. On the other hand, in 2020, Taiwan exported approximately 102.5 billion U.S. dollars worth of goods to China, increasing from around 91.8 billion U.S. dollars in the previous year.

1.2.6 Potential PTAs

There are two potential multilateral agreements in which Taiwan can participate. Except for RCEP, the Comprehensive and Progressive Trans-Pacific Partnership (CPTPP) was another regional trade agreement that Taiwan wanted to join.[10] CPTPP, the once US-led regional trade agreement, was previously known as the Trans-Pacific Partnership Agreement (TPP).[11] The potential impact on the world of Taiwan's decision to join either trade agreement is enormous. However, only limited literature discusses the implications or analyzes counterfactuals. Little literature targets Taiwan's impact using the CGE model, and none targets the potential outcome in the U.S. and China. In this chapter, I focus on the effect on the United States and China if Taiwan joins the RCEP and leave the discussion of the CPTPP

[10]The CPTPP is a free trade agreement signed by 11 countries in March 2018. It is an open platform for others to join, with certain conditions suspended from the prior TPP treaty. Section 2.4 discusses the institutional background of both the RCEP and TPP.

[11]In November 2009, former U.S. President Barack Obama announced the plan for the Trans-Pacific Partnership. The U.S. government aimed to participate in the TPP negotiations to establish an ambitious next-generation trade agreement in the Asia-Pacific region that aligns with American economic priorities and values. The Obama Administration intended to increase exports in the region, which includes some of the world's strongest economies and constitutes nearly 40% of global GDP. The goal was to strengthen U.S. economic growth and support the creation and retention of high-quality jobs for Americans. For more information, please visit the official TPP website.

for the next project.

1.3 Methodology

We use the CGE model as the primary methodology to carry out the policy experiment and calculate the shock of the economic impacts. Both the database and the model under the Global Trade Analysis Project (GTAP) played a critical role in this paper. Therefore, in Section 1.3.1, we review the literature relating to GTAP and the ecosystem of the CGE model. We conclude this section by providing an overview graph of the GTAP system. In Section 1.3.2, we follow Brockmeier (2001) to delineate the structure of the General Equilibrium model in the open economy assumption and document the general accounting relationship between the representative agents in the system.

1.3.1 Global Trade Analysis Project (GTAP)

The Global Trade Analysis Project (GTAP) is a system that combines updated trade data and an economic model. The invention and documentation of the entire system were first presented in Hertel et al. (1997). Due to its powerful functionality and comprehensiveness in modeling the country's global trade activities, GTAP has become an effective policy analysis tool for trade policy shocks. GTAP is also widely used in counterfactual analysis to simulate the result of regional integration. The standard GTAP model included a multi-region and multi-sector CGE model written in the GEMPACK programming language. For example, GTAP 10 has 65 sectors and 141 regions.

GTAP also had an up-to-date global trade database maintained by users who resided in different countries. The RunGTAP program is the Graphical User Interface (GUI) for the GTAP system. RunGTAP helps users to collect

the data, operate the experiment shocks, preview the results of post-shock equilibrium, and view the code in GEMPACK.

An overview of the GTAP environment is presented in Figure 1.1. Three main components are required to simulate the potential outcome of Taiwan's inclusion in the RCEP as part of the NSP: data, model, and experiment.

In our policy experiment, we first use the GTAP 10 database as our primary data resource, based on input-output tables published by governments worldwide. Second, we follow the standard GTAPv7 General Equilibrium model setting for the model part. The standard GTAPv7 has been widely used to capture the open economy setting. In addition, we do not change the closure or the default sets of exogenous and endogenous variables to construct the model economy. Finally, we add the shock on the import tariffs of goods between Taiwan and the RCEP countries to wrap up the simulation exercise.

Corong et al. (2017) provides complete documentation for version 7 of the standard Global Trade Analysis Project (GTAP) model. In conclusion, GTAP is a comprehensive static, global, and general equilibrium model based on an input-output accounting framework. In addition, GTAP is also a database that includes international economic activities around the world. We rely on RunGTAP to run the policy experiment, which is the virtual interface for users to use GTAP more easily. Pearson et al. (2018) gives several hands-on computing examples that users can perform to familiarize themselves with the RunGTAP and GEMPACK software.[12]

Young and Huff (1996) uses the GTAP database and RunGTAP shock simulating program to analyze the initiative trade agreement on the Pacific

[12]For more details about RunGTAP and GEMPACK software, please refer to the official documentation of RunGTAP. https://www.gtap.agecon.purdue.edu/products/rungtap/default.asp

Rim dated back to the 1980s, the Asia Pacific Economic Cooperation (APEC) group. The 12 member states founded the APEC to promote multilateral trade reform and facilitate Asian trade. Aguiar et al. (2019) highlights the numerous improvements to the GTAP database, version 10 (also referred to as GTAP 10). GTAP 10 database describes the world economy for four reference years (2004, 2007, 2011, and 2014) and distinguishes 65 sectors, up from 57 in the previous release, in each of the 141 countries. The 121 countries in the GTAP 10 database account for 98% of the world GDP and 92% of the world population. The GTAP 10 database reports production, intermediate and final uses, international trade and transport margins, and taxes subsidies for each country. The GTAP 10 database is the basis of most of the applied global general equilibrium models.

This chapter applies the CGE model to focus on Taiwan-China-U.S. economic co-petition, regional integration, and potentially building the new preferential trade agreement. There is abundant literature on regional integration in East Asia, mainly focusing on China and Taiwan. We make our further practical analysis based on this literature string. Wang (1997) investigates the impact of China's and Taiwan's accession to the World Trade Organization (WTO) on the United States and world agricultural trade using a twelve-region, fourteen-sector CGE model for world trade and production. The simulation results show that integrating China and Taiwan into the global trading system could induce more competition for labor-intensive products and reduce prices. It could drive up the demand for capital-intensive and skill-intensive manufactured goods, thus further improving industrial countries' terms of trade.

Quite a few papers use the CGE model to analyze the ECFA. Lee et al. (2011) concludes that in terms of total trade value, the liberalization of

ECFA would induce a trade creation effect across the Strait of more than 30 billion dollars in US dollars. There is an increase of 26.04 billion US dollars in exports to China, which is much higher than imports from China, approximately equal to 4.67 billion US dollars. Huang and Soong (2016) introduces the ECFA's goal and discusses its implications for future economic relations between China and Taiwan while reviewing general and specific statistics of international trade data and investment flows.

Many papers have also applied CGE models to East Asian regional integration from the perspective of the US. Petri et al. (2012) estimates that world income would increase by 295 billion USD per year on the TPP track and by 1.9 trillion if the tracks combine to produce free trade in the region.

1.3.2 Global Accounting

Following Brockmeier (2001), we use a graph to illustrate the structure of the default model in the GTAP. Figure 1.2 shows the global accounting categories and their labels in GTAP. The direction of the arrows represents the capital flows and the square represents the economic agents. The link between sectors captures an open economy's default general equilibrium model.

We start by assuming that a regional household is associated with each country or composite region of GTAP. This regional household collects all income generated in the economy and expenditure on domestic goods. The *per capita* utility function of this household follows the Cobb-Douglas format. This representative household exhausted all its income into three forms of final demand, including *private household expenditures* (PRIVEXP), *government expenditures* (GOVEXP), and *savings* (SAVE). The *value of output at agent prices* (VOA) is paid by producers to use endowment commodities for

the regional household. The domestic consumption of the private household is indicated by *value of domestic private household purchases*, evaluated at the agent's price (VDPA). In GTAP, the consumption behavior of the private household was captured by the implicit Constant Difference of Elasticity (CDE) expenditure function, which is less general but more flexible than the commonly used Constant Elasticity of Substitution (CES) function. Hertel et al. (1990) argues that it is easier to calibrate the model using data on income and own-price elasticities of demand.

Domestic government purchases are indicated as the *value of domestic government purchases* (VDGA), evaluated at the *agent prices*. A Cobb-Douglas subutility function is used in GTAP so that expenditure shares are constant across all commodities. The model also assumes that the savings are fully exhausted on *investment* (NETINV).

Then, we focus on the economy's production side and explore the accounting relationship of the firms in GTAP. Firms and the regional household, together with its three final goods, now become a simple model of a closed economy. Producers receive payments for selling consumer goods to *private households* (VDPA) and *the government* (VDGA), *intermediate inputs to other producers, value of purchases from domestic firms, evaluated at agents' prices*, (VDFA), and investment products to the savings sectors (NETINV). With the zero profit assumption, revenues must be exhausted from expenditures for intermediate inputs (VDFA) and primary factors of production (VOA).

In addition to consumers and producers, GTAP also includes the role of the government in the model. Taxes (TAXES) flow from the private home, companies, and government to the regional home. TAXES include taxes and subsidies, denoted as net tax revenues. In GTAP, tax revenues and subsidy

expenditures are computed by comparing the value of a given transaction, evaluated at agents and market prices. If there is a discrepancy between two values, the difference must be equal to the tax or subside correspondingly.

Then, we focus on the bottom of Figure 1.2. We could model the open economy by adding a new sector called "Rest of the World" (ROW), and the value flows related to these agents. Producers in the open economy not only sell the goods to the domestic market, but also sell the goods to the ROW. VXMD denotes these exports. Moreover, under the open economy framework, producers spend their revenues on buying domestically produced intermediate inputs and on imported intermediate inputs, VIFA. Firms in the open economy must pay the tax on imported inputs to the regional household.

The GTAP model assumes that the Armington assumptions hold in the trade setting. This means that economic agents could distinguish imported goods by origin, which explains the intra-industry trade of similar products. Imported merchandise is assumed to be separable from domestically produced goods and combined in the nest in the production tree. The elasticity of substitution in this input nest is equal across all uses. In an open economy, firms decide first to source their imports based on the resulting composite import price. The firms then determine the optimal mix of imported and domestic goods. The "Rest of the World" (ROW) is paid to sell its goods for private consumption, government, and firms. These revenues will be spent on commodities exported from one region to the ROW, denoted as VXMD, and on import taxes (MTAX) and export taxes (XTAX) paid to regional households.

1.3.3 Tariffs

Figure 1.2 can also show interventions on commodity i exports from region r to region s. This export supply represents the sales to region s, net of export supplies to all other regions included in the GTAP. The power of export tax can be calculated as the ratio of $\text{VXMD}_{i,r,s}$ and $\text{VXWD}_{i,r,s}$. The $\text{VXMD}_{i,r,s}$ values of *exports of tradable commodity i from source r to destination s, evaluated at exporter's market prices*, by destination price. $\text{VXWD}_{i,r,s}$ denotes *exports of tradable commodity i from source r to destination s, evaluated at world (fob) prices.* In the equation,

$$\text{TXS}_{i,r,s} = \frac{\text{VXMD}_{i,r,s}}{\text{VXWD}_{i,r,s}}$$

If $\text{TXS}_{i,r,s}$ is smaller than one, then it means that there exists an export tax. Therefore, the domestic price (PM) and the FOB price (PFOB) of the goods could solidify the following link.

$$\text{PM}_{i,r,s} = \frac{\text{PFOB}_{i,r,s}}{\text{TXS}_{i,r,s}}$$

Similarly, an import tax drives a wedge between domestic and CIF prices. The power of the *ad valorem* import tax, TMS, is calculated as the ratio of $\text{VIMS}_{i,r,s}$ to $\text{VIWS}_{i,r,s}$, where $\text{VIMS}_{i,r,s}$ denotes *the value of imports of a tradable commodity i from the source r to the destination s, evaluated at the prices of the importer's market* and $\text{VIWS}_{i,r,s}$ denotes *value of imports of tradable commodity i from the source r to the destination s, evaluated at world (cif) prices*. That is,

$$\text{TMS}_{i,r,s} = \frac{\text{VIMS}_{i,r,s}}{\text{VIWS}_{i,r,s}}$$

Again, the following equation shows the price linkage between the domestic price and the importing price,

$$\mathrm{PMS}_{i,r,s} = \frac{\mathrm{PCIF}_{i,r,s}}{\mathrm{TMS}_{i,r,s}}$$

This paper focuses on how joining the regional agreement would affect. Therefore, we heavily relied on adjusting the import tax $\mathrm{TMS}_{i,r,s}$ on the goods. The different levels of the import tax $\mathrm{TMS}_{i,r,s}$ are the primary control variables we adjust through the experiment.

1.3.4 Production and Supply

A nested structure of two levels captures the GTAP model's production. The upper level is the firm's and sector's output (qo), a composite of the inputs at the next level below. The second level comprises the value-added composite, the primary factor of production, and the intermediate composite, which is the purchases of firms' output for use in production.

The production of composites at each level implies the separability between different branches. The composition of the value-added aggregate input for a given firm is independent of the price of intermediates, and the composition of the intermediate aggregate input for a given firm is independent of the price of primary factors.

In addition, the quantity demanded for the value-added aggregate at the top level depends on the relative prices of the two aggregates at the same level, implying that substituting a particular primary factor with an intermediate is standard across all intermediates. Refer to Figure **??** for delineating the production tree.

For the assumptions of firm's behavior, we assume firms are cost minimizers, firm produce at average cost, and there is constant elasticity of

substitution (CES) technology at each level of the production tree. That is, in the model, firms choose Q_i to minimize the cost $\Sigma_i P_i Q_i$ subject to $Q = (\Sigma_i B_i Q i^{-\rho_i})^{-\frac{1}{\rho}}$ given Q and P_i.

Following conventions, we solve the CES production function by log-linearization.

$$p = \Sigma_i S_i p_i$$

$$q_i = q - \sigma(p_i - p)$$

The p and q are percentage changes in output and output price. p is also the percentage change in the average cost of production without profit. If we assume that S_i is a cost share,

$$S_i = \frac{P_i Q_i}{\Sigma_j P_j Q_j} = \frac{P_i Q_i}{PQ}$$

σ is the elasticity of the substitution parameter in the CES production function. If $\sigma = 0$, the demand for any input q_i is proportional to the change in output. If $\sigma = 1$, the production function becomes the Cobb-Douglas production function, which fixes the cost shares in the production. If $\sigma \to \infty$, then the production inputs are the perfect substitutes. In conclusion, the larger the CES elasticity, the more substitutable inputs are in a given level of the CES production tree.

1.3.5 Consumption and Demand

In the model, we assume that the regional households own the factors of production and collect the factor earnings for their use. Net tax gains flow to the regional household to increase income. Regional household income is allocated to three expenditure categories: private household spending

and public household spending, i.e., government spending, savings, and investment.

Similarly to production, the model has two different levels of consumption. At the top level, all incomes in the region are collected and assigned to different expenditure categories according to the preferences of the regional household. Cobb-Douglas preferences govern the top-level utility maximization problem. At the second level, savings are used to purchase investment goods. Private and public purchases of goods were determined by maximizing utility, subject to the top-level expenditure allocation made to private consumption, public consumption (government spending), and savings.

In the second level of the consumption and savings part, a single capital good can be purchased as an investment, which means no substitution, following Leontief's assumption. The government follows the utility function of CES. The private household follows the non-homothetic constant differential elasticity (CDE) utility function, which means that the budget shares to the total income depend on the income level (Chen, 2017).

The initial equilibrium of the model solves the second-level problems, which bring out the utility composites and the corresponding price indexes for each of the three categories: private consumptions, government, and savings. By using those price indexes, going back to the top-level Cobb-Douglas problem, the regional agents choose the level of private consumption, government spending, and savings, subject to their price indexes.

1.4 Data

The GTAP system also contains an extensive global database based on the input-output table published regularly by the government. In section 1.3.1, we reviewed the model and accounting relationship between sectors, which led to the building of a multisector, multi-region, general equilibrium model. In section 1.5, we explained the setting of the aggregation scenario and the entire setup of the experiment. Now, we focus on the data side of the GTAP and review the data resources based on our regional and sectoral aggregation. In this section, we introduced the data resource and the trade data related to Taiwan that we could extract from GTAP. We use them to explain how GTAP combined the General Equilibrium model with global trade data. The original 2006 input-output table in the GTAP 9 database includes 554 by 166 sectors, valued in millions of New Taiwan Dollars (NTD), at the current producer's prices.[13]

1.4.1 Input-Output Table

According to Lin and Hsu (2015), Taiwan's initial input-output (I-O) table is provided by the Directorate General of Budget, Accounting and Statistics (DGBAS).[14]

[13]Appendix A.2 shows all regions included in the GTAP database 10, which currently consists of 141 regions and 65 sectors, based on the reference year 2014.

[14]The Directorate General of Budget, Accounting and Statistics (DGBAS) of the Executive Yuan, handles the national budget, accounting, and statistics affairs, representing the government of the Republic of China (Taiwan). It has existed for over 90 years and has been reorganized numerous times since its inception. In April 1931, the DGBAS of the Nationalist Government was established. In May 1948, after the Constitution was enacted, the DGBAS of the Nationalist Government was elevated to the Ministry of Budget, Accounting, and Statistics. It was placed under the Executive Yuan with a minister of state as its head. As the country developed rapidly, the Executive Yuan Directorate General of Budget, Accounting, and Statistics Organization Act was revised. It came into force in November 1973 and was revised in May 1983. According to the Executive Yuan's restructuring policy, the DGBAS was reorganized on 6 February 2012. The functions of the departments have been reviewed and merged with the Electronic Data Processing Center. DGBAS is the

According to the DGBAS database, two tables are available: a transaction table for domestic goods and services and a transaction table for imported goods and services. The final demand matrix in the table of domestic product and import transactions includes private consumption expenditure, government consumption expenditure, the formation of gross private fixed capital, changes in stocks and exports. The value-added matrix in the transactions table at producer's prices includes compensation of employees, operating surplus, depreciation of fixed capital, indirect taxes, and (less) subsidies. The depreciation of fixed capital was added to the operating surplus to obtain a vector of capital utilization.

The GTAP database is a consistent representation of the world economy for a predetermined reference year. Underlying the database are several data sources, including, among others: national input-output (I-O) tables, trade, macroeconomic, energy, and protection data. The underlying input-output tables are heterogeneous in sources, methodology, base years, and sectoral detail; therefore, to achieve consistency, substantial efforts are made to make the disparate sources comparable. For these reasons, the objective of the GTAP database is not to provide I-O tables, but to facilitate the operation of economic simulation models ensuring users a consistent set of economic facts. Some users interested in particular Social Accounting Matrices (SAMs) use utilities written by researchers in the network to extract them. Users building I-O tables based on this information do so at their own risk and are assumed to understand the limitations imposed by the database construction process.

The GTAP database is not a relational database of economic variables (Aguiar et al., 2019). Users interested in macroeconomic and trade data

bureau governed by the Executive Yuan of Taiwan, the principal agency responsible for collecting and organizing economic data.

only for comparative purposes are better served by sources such as the World Bank Development Indicators (WDI), the International Monetary Fund (IMF) financial statistics, or the Food and Agriculture Organization (FAO) statistics, to name a few. The data in the GTAP database accurately depict the magnitudes of economic variables, but they are presented in terms of the aggregates that serve CGE modeling.

1.4.2 Price Linkages

The variables we highlight here are the trade commodities valued at local prices, the exporting value $\text{VXMD}_{i,r,s}$, and the importing value $\text{VIMS}_{i,r,s}$. Then there is the value of trade flows, export and import, valued by the price of the world market, $\text{VXWD}_{i,r,s}$, and $\text{VIMS}_{i,r,s}$. From the data tables listed here, we can see that Taiwan's three largest trade partners are China, the US, and RCEP.

$\text{VXMD}_{i,r,s}$ represents the value of exports of a tradable commodity i from the source r to the destination s, evaluated at the prices of the export market. In the model, the representation is as follows.

$$\text{VXMD}_{i,r,s} = \text{PM}_{i,r} \times \text{QXS}_{i,r,s}$$

where $i =$ TRAD COMM; $r =$ REG; $s =$ REG, $\text{PM}_{i,r}$ is the market price of the non-saving commodity i in the region r and $\text{QXS}_{i,r,s}$ is the quantity of exports of tradable commodity i from the source r to destination s. Table 1.7 shows the data in GTAP.

$\text{VIMS}_{i,r,s}$ represents the value of imports of a tradable commodity i from source r to destination s, evaluated at importer's market prices.

$$\text{VIMS}_{i,r,s} = \text{PMS}_{i,r} \times \text{QXS}_{i,r,s}$$

where $i =$ TRAD COMM; $r =$ REG; $s =$ REG. $\text{PMS}_{i,r}$ is the market price of the source of the tradable commodity i imported from the source r to destination s, and $\text{QXS}_{i,r,s}$ is the quantity of exports of the tradable commodity i from the source r to destination s. Table **??** shows the data in GTAP based on our regional and sectoral aggregation settings.

The VXWD and VIWS follow the same logic. Instead of using the domestic market price to evaluate the trade flow, these two terms were calculated by the world market price. Specifically, VXWDirs values exports of tradable commodity i from source r to destination s, evaluated at world (FOB) prices, and VIWSirs values imports of tradable commodity i from source r to destination s, measured at world (CIF) prices. That is,

$$\text{VXWD}_{i,r,s} = \text{PFOB}_{i,r,s} \times \text{QXS}_{i,r,s}$$

$$\text{VIWS}_{i,r,s} = \text{PCIF}_{i,r,s} \times \text{QXS}_{i,r,s}$$

1.5 Simulation

1.5.1 Regional Aggregation

Since we focus on analyzing the outcome of the US and China if Taiwan joins RCEP in this study, we separate the US, China, and Taiwan in the regional aggregation in the GTAP model. By single out Taiwan, we are able to analyze the policy shock of Taiwan's government's intention and how it would happen if joining RCEP became a reality. Also, we can explore the counterfactual policy shock, particularly from the point of view of Taiwan. That is, from the perspective of the Taiwanese government, participating in the RCEP or other regional agreements is always a good economic option.

Until July 2022, the RCEP has been ratified by twelve countries, that is, Australia, New Zealand, Brunei Darussalam, Cambodia, China, Japan, Laos, Malaysia, the Republic of Korea, Singapore, Thailand, and Vietnam. We group them into the RCEP group in the GTAP aggregation scenario, plus China, Taiwan, the United States and the rest of the world (ROW) become the five main groups in the setting. China includes the two Special Administrative Regions, Hong Kong and Macau. Table 1.1 summarizes the aggregation mapping of the GTAP regions code used in this document. The GTAP code of the countries can be found in the appendix.

1.5.2 Sectoral Aggregation

Since we currently use the Limited Executive Image Version of the GEMPACK software, we could only run a maximum of ten sectors in the RunGTAP model, according to the GEMPACK license holder. Therefore, we categorize the industries into ten larger sectors and tally them in Table 1.2. The ten large sectors are grains and crops, livestock and mated products, mining

and extraction, processed food, textiles and clothing, light manufacturing, heavy manufacturing, utilities and construction, transport and communication, and other services. In the future, as we can acquire the unlimited version of the GEMPACK license, we will try to expand this study to more detailed sectoral mapping. The following table, Table 1.2, shows the industrial groups we have in this chapter. Although the current categories are general, once the GEMPACK limitation is solved, we can single out the industries we are particularly interested in; now, we will leave it to the project's next stage. The appendix details more about the mapping and the description of the sectors.

1.5.3 Policy Shock

The main shock we are looking at is the import tariffs. The exogenous variable we control is "tms", which is the label that specifies the "import tax of goods" in the GTAP system. Although the constitution and regulations of each preferential trade agreement are different, the goal of joining a trade block or signing preferential trade agreements should be to reduce the trade barriers and lower the import tariffs often documented in the preamble of the treaties. Therefore, lowering the import tariff for goods imported from the trade counterpart is a viable policy experiment. Reciprocally, goods exported from Taiwan to the member states in the RCEP should encounter identical policy shocks.

To keep our result clean and straightforward, we do not make any other changes in the setting of sector and endowment changes in the GTAP in this project. We follow the default settings for the CLOSURE tab in RunGTAP. We will leave the heterogeneous shock to the specific sectors in the next project.

We targeted the "importing tax of the goods" in the SHOCK setting in the GTAP to lower the current import tax rates on the goods of the potential trade counterpart. So, if the RCEP accepted Taiwan, the tariffs on import goods from the RCEP member states would drop, and on the other hand, exporting Taiwanese goods to the RCEP member countries would be required to eliminate the import tax, too.

We run the policy shock experiment for this scenario in the RunGTAP program following the defaulting default general equilibrium model in the GTAP. Specifically, we lower the tariffs of all goods imported from the RCEP member states to Taiwan and the other way around, starting from the power of change from 0% to 100%. In the following section, we report the welfare equivalent variation (EV) results and the value of the GDP (VGDP) change between the three targeted countries we are most interested in regarding the country's overall welfare in this chapter: China, Taiwan, and the US.

1.6 Results

1.6.1 Overview

The main results of the simulation are shown in Figures 1.4 and 1.5. The value of the EV and VGDP growth rates presented the welfare of the general equilibrium after the shock. We applied the sensitivity analysis by adjusting the shock power as we moved importing tariffs between Taiwan and the RCEP country bilaterally. As an experiment, import tariffs are lowered by 10% across all sectors.

Figure 1.4 demonstrates the welfare change using the monetary measure of the Equivalent Variation (EV). We extract the EV after applying a different level of policy shock. Starting with a 10% reduction in the bilateral importing tariff between Taiwan and the RCEP countries, we add 10% to the power of the policy shock. The EV unit in Figure 1.4 is millions in US dollars. The vertical axis represents the value of EV, and the line represents five groups of countries that we focused on in this study.

Several conclusions can be drawn from the graphs. First, if Taiwan is invited to join the RCEP, from the point of view of the benefits of trade liberalization, it should accept the offer as soon as possible. Figure 1.4 and 1.5 show that Taiwan benefits the most as the GDP growth rate and the EV increase along with the power of shock. Second, the impact of Taiwan's participation in the RCEP is surprisingly small compared to the combined effect of the RCEP and China. Although the aggregate trade values of the RCEP countries are ranked second among Taiwan's trade counterparts, we cannot see a significant impact of the tariff reductions in the RCEP countries on goods imported from Taiwan on the macroeconomic indicators we selected. Lastly, China does not appear to have many economic incentives

to dissolve the current equilibrium of Taiwan's exclusion from the RCEP, indicating that the concession could be a political tool for China to achieve economic integration with Taiwan. We will discuss its policy implications in Section 1.7.1 and discuss future work in Section 1.7.3.

1.6.2 Sectoral Impact

If we explore the results mentioned in the previous part, we can find that two magnitudes of the shock cause the change in GDP and EV to have a nonlinear impact. These two thresholds reduce the tariffs on goods to 30% and 70%, respectively.

This section examines those levels and discusses the sectoral effects in Taiwan, China, and the United States. We first decompose the effects of importing goods to different regions should Taiwan join the RCEP and the total tariff of the goods has been lowered by 30% mutually between Taiwan and China, as well as between Taiwan and the RCEP. Figure 1.6 shows the sectoral impacts in Taiwan if the country joins the RCEP and the overall tariffs on tradable goods have decreased by 30%. Figures 1.7, Figure 1.8, and Figure 1.9 show the corresponding results in the US, China, and RCEP countries.

From Figure 1.6, we can see that every importing price of goods in every sector increases after the counterfactual shock is imposed, the most effective sector is texitile manufacturing (tex) in Taiwan. We suspect that this is due to the fact that the original tariffs between Taiwan and China, as well as between Taiwan and the RCEP countries, are high. So when the shock is applied that Taiwan entered the RCEP and reduced tariffs, the demand for textiles increased; however, there is no source material in Taiwan to produce textile products, so the demand of the raw materials for making the textile

products increases, and hence the import prices of textiles related goods such as fiber corps (pfb) and wool (wol) would increase.

This is the same case in the nonmetallic mineral products (nmm), metal fabrication industry (fmp) and the motor vehicle manufacturing (mvh) industry. Taiwan lacks the resources to produce goods in these sectors. Without high tariffs in those sectors, the demand for foreign products will increase, therefore driving up the prices of goods imported in this sector. And this driven up price has of the importing goods price in Taiwan can explain that the EV change from -20% to 30% level in Taiwan does not change that much, while the RCEP countries have gained a lot from it.

1.7 Conclusion

1.7.1 Policy Implication

This study has three main takeaways. First, the results show that Taiwan would be an obvious beneficiary if it were invited to join the RCEP. As the shock power of a tariff reduction increases, the EV and VGDP will also increase. Therefore, if Taiwan receives an invitation to join the RCEP in the future, it should consider it economically.

Second, if Taiwan joins the RCEP and the US does not, the US would suffer the most. RCEP and China rank first and second in terms of trade volume. Also, due to the proximity of all counterparts, lowering trade barriers and increasing the diversity of goods should improve a country's welfare level.

Lastly, since the benefit of Taiwan's joining is not reciprocal to China, we have an economic rationale behind the current equilibrium. The financial incentives for China and the RCEP countries to welcome Taiwan are low. The present circumstances of Taiwan's exclusion from RCEP could be explained by economics. However, it implies that if the invitation did appear, political incentives might be behind it. The Taiwanese government should not ignore this while advocating the New Southbound Policies, which again retracted back to the long-standing dilemma that the Taiwanese must face, striking a balance between political concession and economic gains.

Taiwan's unique role in East Asia recently involved deciding between trade agreements led by the world's two most powerful countries. Due to the competition between the United States and China, Taiwan played a unique position in East Pacific geopolitics. Taiwan shares the same ancient Chinese culture and history as China. Still, it is divided by modern political

ideologies. However, the United States has treated Taiwan as a protector of a legion of democratic countries.

Taiwan's decision on which regional trade block it should join reaches beyond a purely economic issue, and the literature on this subject is limited. Making policies that balance national security and gains from trade with the People's Republic of China (PRC) has always been a central issue in presidential elections. Throughout the Cold War era, Taiwan has been the most sensitive political issue in the middle of the U.S.-China conflict. The battle between economic incentives and the political system has always been an issue. The distance from Taiwan to mainland China is only 68 nautical miles, about 125 kilometers, and less than one hour of air travel. And since both Taiwan and China share the same cultural and ethnic heritage, the vast Chinese market is difficult to ignore. However, China has been known to utilize its economic power to reach its ultimate goal of unifying the island. Taiwan's recent democratization has brought her closer to long-standing U.S. political values, making it more of a political issue than an economic one. As political implications are shown indirectly, Taiwan's administration might be wise to rethink the meaning and strategies of the "New Southbound Policy" and prepare for upcoming proposals that could be raised during RCEP negotiations.

1.7.2 Limitations of CGE Analysis

The Computational General Equilibrium (CGE) methodology, combined with the updated database gathered by the users of the Global Trade Analysis Project GTAP, is a powerful tool for analyzing potential international trade policy changes and understanding their full-scale impacts on different sectors and regions. In this chapter, we demonstrate the use of this

methodology by simulating the outcome of possible tariff reductions between Taiwan and current member states in the RCEP. The experimental policy shock is a way to analyze the multiple-sector and multiple-region impacts stemming from reducing bilateral trade tariffs between Taiwan and RCEP countries.

The CGE model has been widely used to analyze the impact of the Regional Trade Agreement. GTAP was initially created to simulate the outcome of the international trade negotiation during the Uruguay Round of the General Agreement on Tariff and Trade (GATT) and provide evidence for the policymakers to create the terms of the agreements. After three decades of development, GTAP has become the norm for analyzing economic integration and has been expanded to other fields as an analysis tool for different fields, such as the topics on food resources, energy, climate change, and carbon dioxide emissions (Hertel, 2013).

However, the CGE model still has limitations that need to be addressed. First, since the dataset comes from the country's input-output tables, most of the sectors included in the CGE model belong to traditional manufacturing sectors, and another big part of the trade, Foreign Direct Investment (FDI), was not included in the model. As more multinational firms and government funds invest outside of their territories, and outsourcing is a big part of international trade, this limitation of the CGE model is one of the reasons for the outcomes that deviate from reality.

Secondly, the CGE model solves a sequence of high-dimensional equations for a closed-form equilibrium solution. For example, our model in this chapter looks into the model setup of 10 regions, 65 sectors, and five production factors. For each shock we add to the simulation, the GEMPACK program behind the model's scenes simultaneously solves 16,250 (10*65*5)

market-clearing equations. It gives a closed-form solution under the shock of the original parameters in the model each time we add the different terms in the simulation. This analysis structure quickly falls within the curse of dimensionality if we would like to refine the classifications of the goods based on the classification as we have in the taxonomy of the Harmonized System (HS) Codes. It's nearly impossible to solve the model if we apply the amount of the goods we have in the HS code system.

Lastly, the CGE model we explore here is based on results from comparative statistics. Given the baseline model, it runs a set of comparative statistics results under different closures, models, and simulation shock settings. However, there is no dynamic environment across the various time points. The Center of Trade Policy is developing new tools called the dynamic GTAP model by extending the investment and saving equations into a dynamic behavior. However, the dynamic analysis is beyond the scope of this chapter; I will leave it to the next project to analyze the potential dynamic impacts of Taiwan joining the RCEP.

1.7.3 Future Work

The conclusion of this chapter could be extended to the interaction with other PTAs with which Taiwan was involved.

Except for reaching the ultimate goal of full integration into RCEP, Taiwan had already signed a bilateral trade agreement with China to cosign a bilateral trade agreement, the Economic Cooperation Framework Agreement (ECFA), in 2012. Although the ECFA is still in effect, few studies have focused on how it would affect the economic outcome of Taiwan joining another PTA, such as the RCEP. We are interested in how the decision to join the RCEP interacts with the existing free trade agreement.

As tension between the US and China increases, world politics is leaning toward discouraging China from becoming a superpower. As a result, the Taiwanese have begun to question their policies with China, and some pro-independent delegates even advocate the suspension of the preexisting ECFA with China.

In the future, we will also be interested in running the policy experiments in the following experimental scenario. Considering that the Taiwanese government has to choose between terminating or honoring the ECFA, they would have the option to bid for membership in the RCEP. That is, for Taiwan, there are four scenarios when it comes to RCEP and ECFA. (1) The ECFA was not terminated and is accepted by the RCEP. (2) ECFA was not discontinued and is not recognized by RCEP. (3) ECFA was discontinued and is not recognized by RCEP. (4) The ECFA was terminated and accepted by RCEP.

To have a clearer view of the outcome of discontinuing the ECFA while bidding for membership in RCEP, we can adjust the policy shocks based on other role players in the precarious triangle. Furthermore, in the previous setting, we changed the import tariff for goods from China. For example, in Scenario 1, we would reduce import tariffs on goods between Taiwan and China. Furthermore, we would reduce the import tax on goods between Taiwan and the RCEP countries. For the results, we chose 10% as the increase in the change rate and calculated the change in Equivalent Variation (EV) as an indicator of the change in welfare in the country.

Tables

Table 1.1: Mapping of Regional Aggregation

No.	New Code	Region Description	Default Region Code
1	USA	United States of America	usa
2	China	China and Hong Kong	chn hkg
3	Taiwan	Taiwan	twn
4	RCEP	RCEP without China	aus nzl jpn kor brn khm idn lao mys phl sgp tha vnm xse
5	RestofWorld	Rest of World	xoc mng xea bgd ind npl pak lka xsa can mex xna arg bol bra chl col ecu pry per ury ven xsm cri gtm hnd nic pan slv xca dom jam pri tto xcb aut bel bgr hrv cyp cze dnk est fin fra deu grc hun irl ita lva ltu lux mlt nld pol prt rou svk svn esp swe gbr che nor xef alb blr rus ukr xee xer kaz kgz tjk xsu arm aze geo bhr irn isr jor kwt omn qat sau tur are xws egy mar tun xnf ben bfa cmr civ gha gin nga sen tgo xwf xcf xac eth ken mdg mwi mus moz rwa tza uga zmb zwe xec bwa nam zaf xsc xtw

Table 1.2: Mapping of Sectoral Aggregation

No.	Code	Sectoral Description	Composition
1	GrainsCrops	Grains and Crops	pdr wht gro v_f osd c_b pfb ocr pcr
2	MeatLstk	Livestock and Meat Products	ctl oap rmk wol cmt omt
3	Extraction	Mining and Extraction	frs fsh coa oil gas oxt
4	ProcFood	Processed Food	vol mil sgr ofd b_t
5	TextWapp	Textiles and Clothing	tex wap
6	LightMnfc	Light Manufacturing	lea lum ppp fmp mvh otn omf
7	HeavyMnfc	Heavy Manufacturing	p_c chm bph rpp nmm i_s nfm ele eeq ome
8	Util_Cons	Utilities and Construction	ely gdt wtr cns
9	TransComm	Transport and Communication	trd afs otp wtp atp whs cmn
10	OthServices	Other Services	ofi ins rsa obs ros osg edu hht dwe

Table 1.4: Value of Exports from Taiwan at Destination Prices (USD million, $VXMD_{i,Taiwan,d}$)

No.	Sector	USA	China	RCEP	Rest of World
1	GrainsCrops	85.45	132.35	174.36	85.28
2	MeatLstk	30.84	70.55	271.35	34.98
3	Extraction	9.11	273.81	231.73	73.86
4	ProcFood	396.36	816.83	1538.37	449.30
5	TextWapp	1109.80	3584.23	4702.37	3272.98
6	LightMnfc	8605.41	4549.87	7238.38	12889.85
7	HeavyMnfc	25010.71	132049.44	77231.91	40242.29
8	Util_Cons	192.48	118.06	113.00	438.62
9	TransComm	2395.28	1469.41	1406.42	5456.56
10	OthServices	3500.85	2147.63	2055.57	7975.10

Table 1.5: Value of Imports to Taiwan at Source Prices (USD million, $VIMS_{i,s,Taiwan}$)

No.	Sector	USA	China	RCEP	Rest of World
1	GrainsCrops	2241.28	238.23	723.61	1805.02
2	MeatLstk	721.80	139.81	674.64	410.53
3	Extraction	84.78	587.17	14373.76	38062.09
4	ProcFood	931.13	434.12	3306.19	2480.65
5	TextWapp	110.25	1810.12	1039.18	706.93
6	LightMnfc	3295.80	4785.22	8288.82	7532.43
7	HeavyMnfc	17263.22	44582.05	70617.99	35077.88
8	Util_Cons	249.51	122.58	123.53	536.01
9	TransComm	2018.69	2473.14	1508.65	6045.51
10	OthServices	3833.73	1921.93	1913.27	7123.65

Table 1.6: Value of Export from Taiwan at World Prices (USD million, $VXWD_{i,Taiwan,d}$)

No.	Sector	USA	China	RCEP	Rest of World
1	GrainsCrops	2164.68	222.12	660.37	1761.85
2	MeatLstk	657.20	138.43	635.38	375.67
3	Extraction	82.76	574.83	14357.37	38034.42
4	ProcFood	836.26	378.86	2934.07	2307.08
5	TextWapp	104.09	1662.24	963.54	653.22
6	LightMnfc	3214.06	4613.74	7794.95	7002.08
7	HeavyMnfc	17053.13	44156.29	69645.52	34551.72
8	Util_Cons	249.51	122.58	123.53	536.01
9	TransComm	2018.69	2473.14	1508.65	6045.51
10	OthServices	3833.73	1921.93	1913.27	7123.65

Table 1.7: Value of Imports to Taiwan at World Prices (USD million, $VIWS_{i,s,Taiwan}$)

No.	Sector	USA	China	RCEP	Rest of World
1	GrainsCrops	2164.68	222.12	660.37	1761.85
2	MeatLstk	657.20	138.43	635.38	375.67
3	Extraction	82.76	574.83	14357.37	38034.42
4	ProcFood	836.26	378.86	2934.07	2307.08
5	TextWapp	104.09	1662.24	963.54	653.22
6	LightMnfc	3214.06	4613.74	7794.95	7002.08
7	HeavyMnfc	17053.13	44156.29	69645.52	34551.72
8	Util_Cons	249.51	122.58	123.53	536.01
9	TransComm	2018.69	2473.14	1508.65	6045.51
10	OthServices	3833.73	1921.93	1913.27	7123.65

Figures

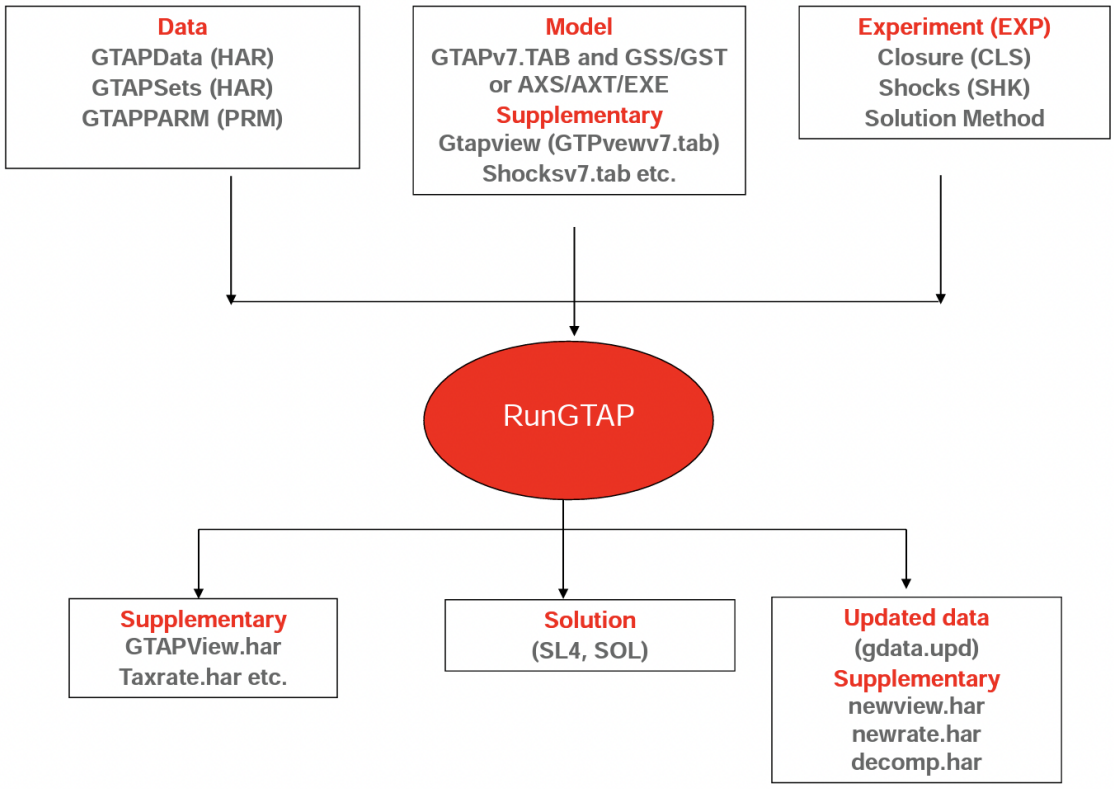


Figure 1.1: GTAP System (Hertel, 1997)

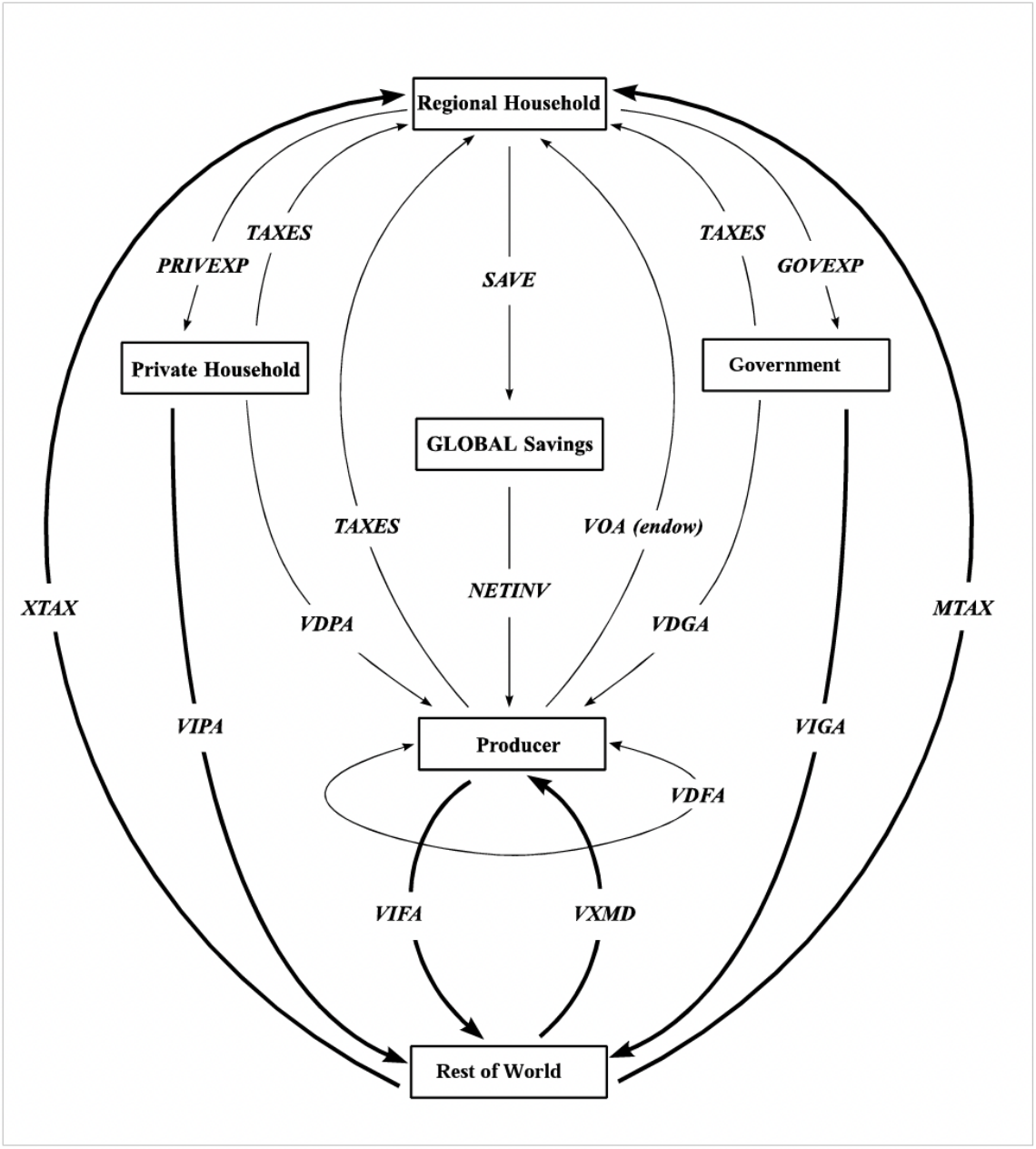


Figure 1.2: Multi-region Open Economy Model (Brockmeier, 2001)

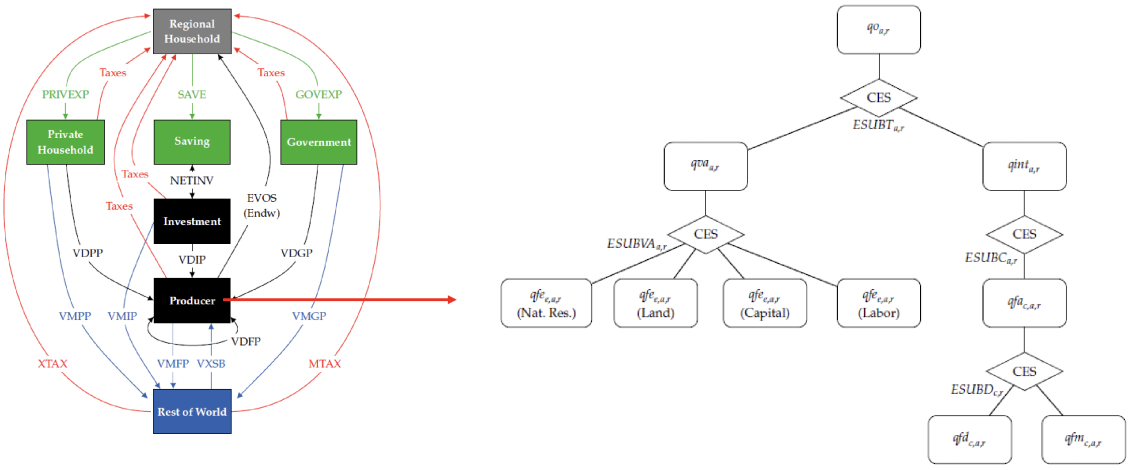
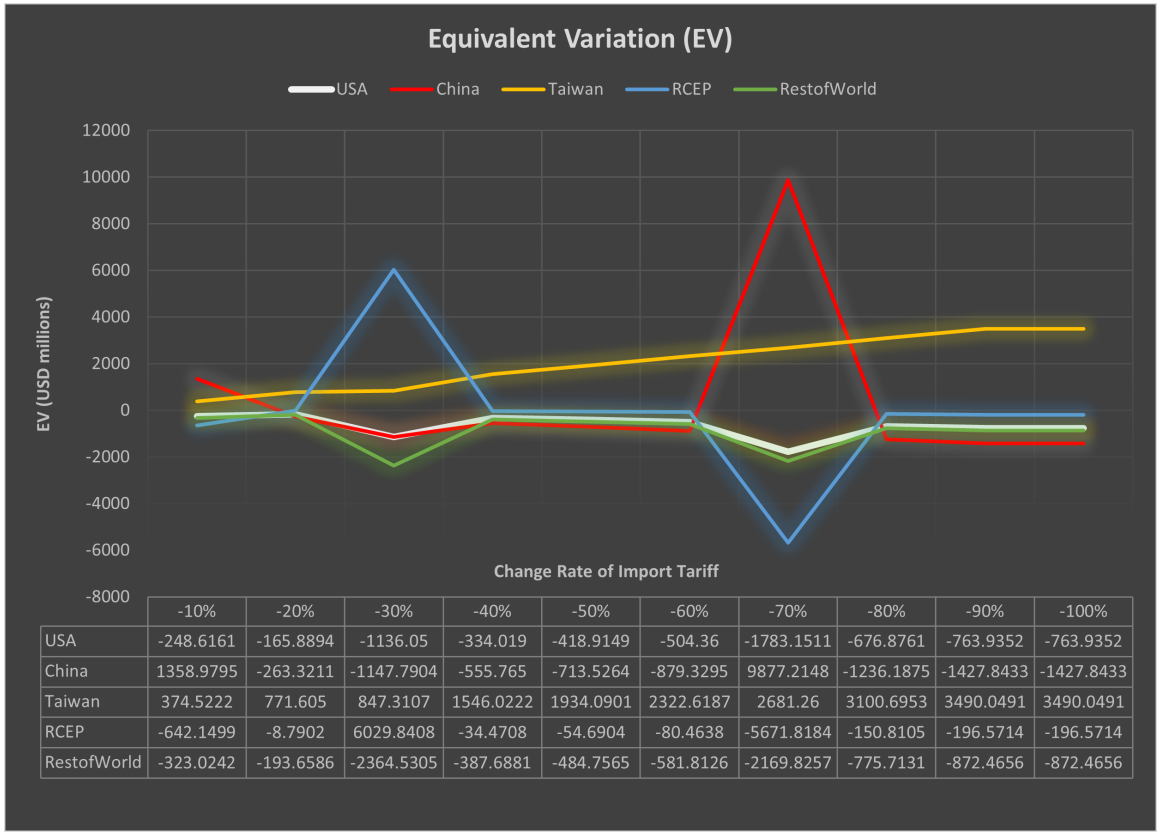


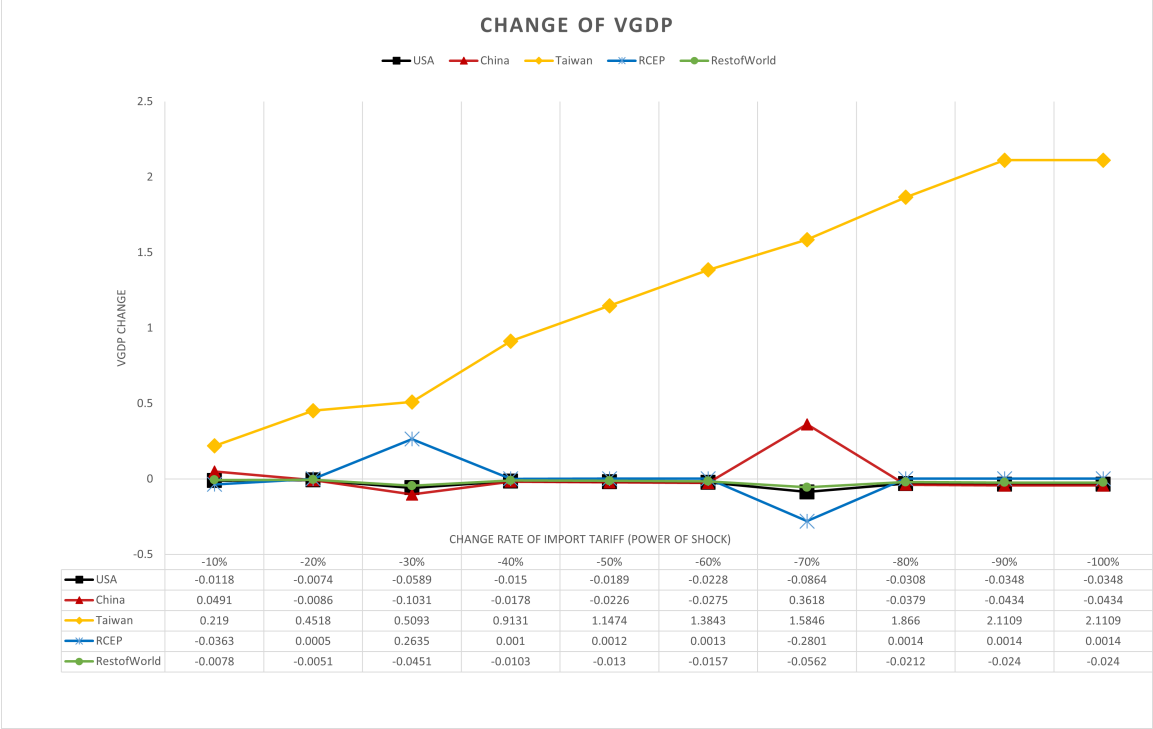
Figure 1.3: CES Nested Structure Production Tree

(Source: GTAP Course Slides)



	-10%	-20%	-30%	-40%	-50%	-60%	-70%	-80%	-90%	-100%
USA	-248.6161	-165.8894	-1136.05	-334.019	-418.9149	-504.36	-1783.1511	-676.8761	-763.9352	-763.9352
China	1358.9795	-263.3211	-1147.7904	-555.765	-713.5264	-879.3295	9877.2148	-1236.1875	-1427.8433	-1427.8433
Taiwan	374.5222	771.605	847.3107	1546.0222	1934.0901	2322.6187	2681.26	3100.6953	3490.0491	3490.0491
RCEP	-642.1499	-8.7902	6029.8408	-34.4708	-54.6904	-80.4638	-5671.8184	-150.8105	-196.5714	-196.5714
RestofWorld	-323.0242	-193.6586	-2364.5305	-387.6881	-484.7565	-581.8126	-2169.8257	-775.7131	-872.4656	-872.4656

Figure 1.4: Welfare Deviation from Baseline as Taiwan Joins RCEP (EV%)



	-10%	-20%	-30%	-40%	-50%	-60%	-70%	-80%	-90%	-100%
USA	-0.0118	-0.0074	-0.0589	-0.015	-0.0189	-0.0228	-0.0864	-0.0308	-0.0348	-0.0348
China	0.0491	-0.0086	-0.1031	-0.0178	-0.0226	-0.0275	0.3618	-0.0379	-0.0434	-0.0434
Taiwan	0.219	0.4518	0.5093	0.9131	1.1474	1.3843	1.5846	1.866	2.1109	2.1109
RCEP	-0.0363	0.0005	0.2635	0.001	0.0012	0.0013	-0.2801	0.0014	0.0014	0.0014
RestofWorld	-0.0078	-0.0051	-0.0451	-0.0103	-0.013	-0.0157	-0.0562	-0.0212	-0.024	-0.024

Figure 1.5: GDP Deviation from Baseline as Taiwan Joins RCEP

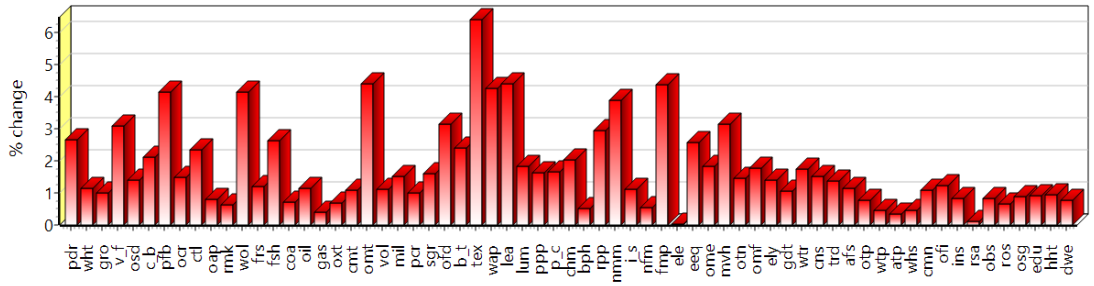


Figure 1.6: Change of Value of Merchandise Taiwan Imports by Commodity (viwcif, TW)

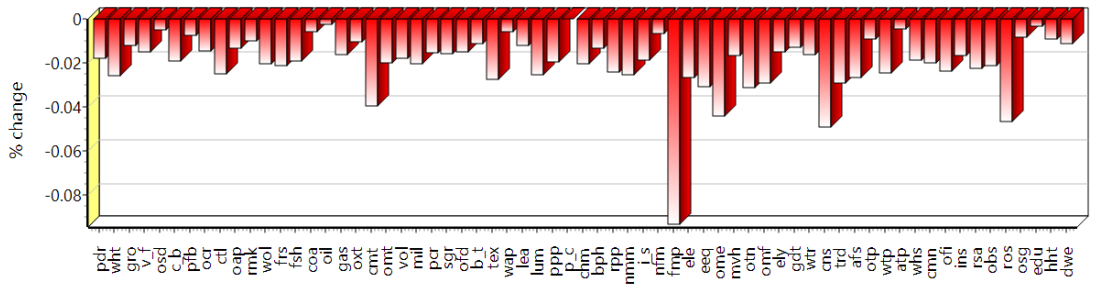


Figure 1.7: Change of Value of Merchandise the U.S. Imports by Commodity (viwcif, US)

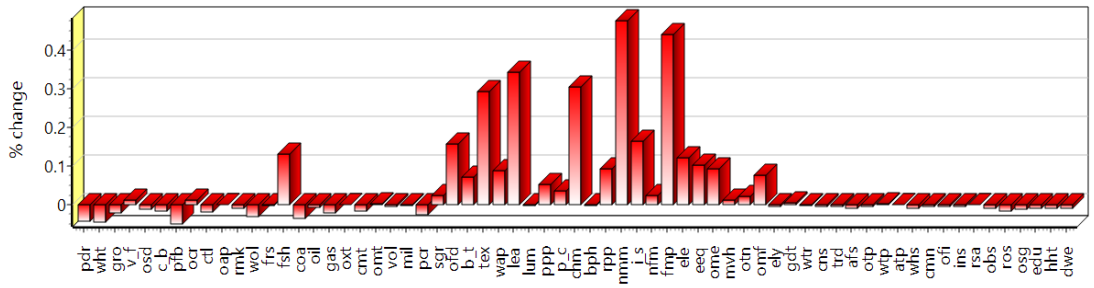


Figure 1.8: Change of Value of Merchandise China Imports by Commodity (viwcif, CN)

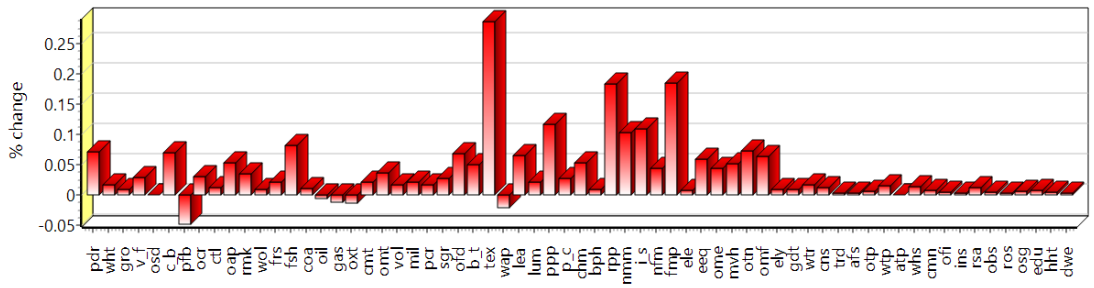


Figure 1.9: Change of Value of Merchandise RCEP Imports by Commodity (viwcif, RC)

Chapter 2: Tech Hub's Formation in Taiwan: Network Analysis

2.1 Introduction

Since the 1980s, Taiwan has been a global center for consumer electronics, producing critical components and products (Rigger, 2011; Fuller, 2020; Addison, 2001). The phenomenal expansion of Taiwan's personal computer (PC) industry throughout the previous 30 years had set the tone of Taiwan being a tech hub (Yu and Shih, 2014). Nowadays, ASUS (ASUSTeK Computer Inc.)[1], Acer, and MSI (Micro-Star International Co., Ltd) are among the top laptop and personal computer hardware brands founded and headquartered in Taiwan. Over the past 30 years, Taiwanese firms have played a crucial role in the global supply chains of personal computers with the help of established companies from other countries through the links of global trade (Yu and Shih, 2014).

Not only in the field of producing computer-related products and components, but Taiwan has also become well-known for its expertise in manufacturing integrated circuits, also known as microchips or chips, which are essential components of electronic devices like the central process unit (CPU) of computers and mobile phones. In 1987, the founder of Taiwan Semiconductor Manufacturing Company (TSMC), Morris Chang, was invited by the Taiwanese government to establish the first chip foundry in Hsinchu in northeast Taiwan to help manufacture the fabless chips designer to make

[1]ASUSTeK Computer Inc. is a Taiwanese multinational computer, phone hardware, and electronics manufacturer headquartered in Beitou District, Taipei, Taiwan. Its products include desktop computers, laptops, netbooks, mobile phones, networking equipment, monitors, Wi-Fi routers, projectors, motherboards, graphics cards, optical storage, multimedia products, peripherals, wearables, servers, workstations, and tablet PCs. The company is also an original equipment manufacturer (OEM). Asus is the world's 5th-largest PC vendor by unit sales as of January 2023.

their products. This marked the beginning of TSMC's dominance in the global supply chain of integrated circuits (Addison, 2001; Rigger, 2011; Miller, 2022).

The Taiwan Straits are a crucial location that the world cannot afford to disrupt. This is because about 90% of the world's production of advanced computer chips depends on the precarious peace in this region. People's Republic of China (P.R.C.) has threatened to reunify the island since political standoffs began in 1950 forcibly. The world has formed an intangible international alliance to protect Taiwan from being harassed by China due to its unique role in producing the chips. This alliance has been coined as the "Silicon Shield" of Taiwan, mainly because the primary materials used to produce microchips are the elements of Silicon (Addison, 2001).

There are three main factors that are widely believed to have contributed to the success of the semiconductor industry in Taiwan. Firstly, Morris Chang was the pioneer of the contract manufacturing model. This allowed chip designers to outsource their production to TSMC, which specializes in creating high-quality and complex chips at a faster speed and lower cost than its competitors. Secondly, the Taiwanese government recognized the strategic importance of the semiconductor industry and provided support, investment, subsidies, tax incentives, infrastructure, and education to foster its development. Lastly, the Taiwanese semiconductor ecosystem benefited from innovation diffusion and collaboration among a network of suppliers, customers, research institutes, and universities. They worked together to share knowledge, resources, and technology, which also benefited from the talent and experience of Taiwanese engineers and executives. Many of them had worked or studied in Silicon Valley and brought back valuable skills and connections.

However, there are still many questions remaining in the development of the technological hub. The literature on international trade network analysis is particularly sparse on the formation of the clusters of the firms making particular products. For example, what was the origin of creating the technological hub (Atiase et al., 2020)? How could a small island, desolated in global politics and economy, play such a critical role in the global supply chain of chips and consumer electronics? Does the wave of millennium globalization impact Taiwan's role in making chips? The previous literature seldom covered these topics via the lenses of the graphical network analysis, and this paper's goal is to fill in this gap to examine how Taiwan, China, and the US have changed over time in terms of making computer-related products and chips.

To identify the formation of a technological hub in the global supply chain, we use a new development methodology in the trade literature, the graphical analysis of international trade networks. The purpose of this study is to graphically determine the degree of centrality of Taiwan, China, and the United States in terms of electronic and chip trade. Specifically, we want to know what role international trade plays in Taiwan's consumer electronics and computer-associated product production. There are two main reasons to focus on Taiwan: one from the economic perspective and the other from the geopolitics perspective.

First, Taiwan is unique worldwide due to its ability to manufacture semiconductor chips and computer-related products. Integrated circuits are expected to be found in many aspects of daily life. Many consumer electronics products, such as smart cars, laptops, and cellphones, will not function without good-quality chips. Second, political tensions across the Taiwan Strait have increased since the Democratic Progressive Party

(DPP) took office in 2016. The DPP is considered a party with the core ideology of supporting Taiwan's ultimate independence, which contradicts the interests of the People's Republic of China. The bilateral relationship between China and Taiwan hit the bottom and culminated during Nancy Pelosi's trip to Taipei in 2023. The long-term political standoffs between Taiwan and China, the concurrent U.S.-China competition framework, and the irreparable ability to make the essential chips make research focusing on Taiwan, especially in the technological sector, much needed.

Using the United Nations Commodity Trade Statistics Database (UN Comtrade), we extract the trade data of the particular goods based on their 6-digit Harmonized System (HS6) codes. We could also plot the network graph for different periods. Therefore, it would be interesting to know whether the creation of a technological hub in Taiwan correlates with Taiwan's economic or political transformation. Would trade liberalization and democratization impact Taiwan's role in the global trade network in producing the chips? When is the time for the construction of these critical technical sectors? Are they correlated with the timing of Taiwan's main infrastructure projects? Or were they started when Taiwan adjusted its import substitution policy? Or is it related to the timing of trade liberalization, that is, Taiwan and China both became members of the World Trade Organization (WTO)?

Section 2.2 goes over a brief summary of Taiwan's chipmaking industry in the context of global trade. Section 2.3, we review the literature related to network theory and highlight the advantages that network analysis can do but conventional economics methodologies cannot. We also connect the network theory to the context of trade in technological trading goods. Then, we discuss the primary data source of the UN Comtrade database and how to extract the data representing Taiwan in the database in Section **??**. In

the following Section 2.5, we discuss the methodologies and the main index we are exploring, the degree of centrality. Finally, in Section **??**, we examine how Taiwan's exports and imports of computer-associated and technological products have evolved. We tend to see in the different eras, for the different products, could we indirectly identify any unique linkage to the historical event to the change of the centrality of Taiwan in the global trade network?

2.2 Stylized Fact

The integrated circuit design industry in Taiwan is renowned worldwide. As a global chip-making powerhouse, Taiwan is responsible for 20% of global wafer capacity. It produces 92% of the world's most sophisticated semiconductor products, which are used in everything from mobile phones to automobiles (Limaye et al., 2022). A significant part of Taiwan's Information Technology (IT) industry is comprised of the semiconductor industry, which includes integrated circuit manufacturing, design, and packaging. Globally, Taiwan dominates the market and differentiates itself from its competitors. The chip is crucial to producing a personal computer's Core Process Unit (CPU). Taiwan's international trade network of computer-related products can help us disentangle how the high-tech industry has developed.

As a result of Taiwan's strong capability in Original Equipment Manufacturer (OEM) wafer manufacturing and the comprehensive industry supply chain, Taiwan's semiconductor industry accounts for about 20% of global semiconductor sales, with Taiwanese companies accounting for 50% of global chip foundry sales, led by Taiwan Semiconductor Manufacturing Company (TSMC), the most significant chip foundry player in the world. In the global chip supply chain, Taiwan relies heavily on imports of capital equipment and machinery from the United States to support its

work-renowned foundry model, which produces chips for the United States' top fabled design firms. In 2020, Taiwan was the recipient of 45% of US exports of semiconductor equipment (Limaye et al., 2022).

US equipment companies also played an important role in the chip manufacturing supply chain. The Taiwan and US semiconductor industries are highly interdependent. In 2019, Taiwan represented 10% of the front-end semiconductor wafer capacity of front-end semiconductor wafer capacity of US-based firms, just behind Singapore at 17% and the United States at 44%. All the leading semiconductor firms in the United States have significant operations in Taiwan and plan to invest more in Taiwan over the coming years. According to the statistics of the Taiwan Customs Administration, total exports of electronic integrated circuits from Taiwan to the US in 2020 are around $1.6 billion.

2.3 Literature Review

We examine the rationale for applying network analysis to international trade in technical products. We review the literature on network theory to identify some unique characteristics in the scope of the political and economic network analysis study. For example, we review the terms homophily, externality, diffusion, key players, and network formation in the following subsections. We point out the differences between traditional economic analysis and network analysis. Finally, we link these points in the context of Taiwan's technological sectors and products and their roles in global trade.

2.3.1 Homophily

Homphilly plays an essential role in the construction of a network. This is not only restricted to human behavior but also includes the companies'

business strategies or governments' decisions on international policies.

Jackson (2014) discusses how network analysis differs from the existing economic literature. Traditionally, economists have attempted to identify the effects of peer pressure on human behavior, but it was not easy to isolate the group and peer effects. Instead, the network graph itself contains information about clustering and grouping, and we are able to gain more insight and understanding of these behaviors. One of the examples mentioned in Jackson (2014) is that people are highly dependent on the opinions of their peers, for example, which products they buy, whether they invest in education, become criminals, etc., are all influenced by friends and acquaintances.

Peer effects can be intuitively explained. When an economic agent faces a problem and has to make a choice, the decision she makes might not be pinned down by her own rationality or her strategic interactions with her counterparts, which lies in the scope of conventional game theory. But in reality, a person more often considers opinions of the others, or the opinions from the society she lived in. Hence, her decisions are heavily dependent on her relationship with other agents in society, or the network, as we called here. For example, if an individual's friends attended college, she might have an increased opportunity to pursue higher education. Since her friends could provide more valuable information.

As we can see in the example of human behavior, homophily also manifests itself in international business. Firms doing business with foreigners prefer to trade more with firms recommended by peers or who are more well known in the market. Jackson (2014) believes that the increased accessibility of data makes it easier to conduct research on people's interactions within groups. And international trade data between countries are probably

the most comprehensive and historical economic data that we can access, either the product level, firm level, sector level, or country level. As a result, the use of network analysis could provide more opportunities for researchers to decipher the effects of peers or measure the externalities of economic behaviors among participants. Banerjee et al. (2013) provides details of the methodology and experimental results in it to support the plausibility of identifying peer effects.

Jackson (2014) also describes how peer effects may be captured in network analysis, as well as two salient categories: macroperspectives and microperspectives. Macroperspective provides the aggregate characteristics of the network, for example, how the density of agents in the economy, i.e., the nodes in the network, affects the diffusion of information, as well as how the different structures of the networks affect the process of social learning. However, the microperspective provides individual characteristics of the network. An example might be how the nodes in the network were placed or how often the agents should communicate.

It is impossible to determine whether homophily played a role in the formation of industrial clusters without analyzing the network (Jackson, 2014). Homophily is defined as similar individuals in the group that are linked to each other, which should be unarguably a well-known characteristic of human nature. In general, people with similar traits or interests are more likely to become friends, companies located in countries sharing similar institutional and development backgrounds may be easier to coordinate, and the government sharing the same value might be easier to initiate the agreement of policy cooperations. If we consider the peer effect in the network or society without carefully considering homophily as a cause, our results may be hindered by an endogenous problem. Jackson (2014)

argues that homophily can also be interpreted to mean that there are some intangible forces that influence people to become members of a group, but if we consider this, an agent joining a group could change their behavior, and this is an illustration of the effects of peer networks. As we can see from the development of the technological hub among Asian countries such as Taiwan and South Korea. When it comes back to the trade network and the formation of Taiwan's high-technology industry, since computers relied on the assembly of many precise particles, homophily also played a crucial role in tech settlements.

2.3.2 Externality

Exploring the externalities involved in economic behavior is another essential reason for incorporating network analysis (Jackson, 2014). To capture indirect connections and externalities in a network, Jackson et al. (2016) uses a simple graphical example to show the externality created in the network due to the different positions of the participants. If we incorporate this into the context of the trade network, we can see that the countries' positions play an important role. The central nodes have more impact on the entire network than the peripheral nodes.

We use the "star network" in Figure 2.1 to explain how externality works in the network. Agent 1 is the central agent in the network, with multiple direct connections to the other three agents. The peripheral nodes, Agent 2, 3, or 4, have only a single connection with Agent 1.

Assuming connectivity brings utility to this network structure. For example, this network represents the geographical location, and the connected lines represent the accessibility of trading the goods. Agent 2 benefits through an indirect connection with Agent 3. The same ideas apply to the

relationships between all peripheral agents in this network. Agent 1 may not consider these positive externalities when cultivating friendship with agents 2, 3, and 4 individually since it is reasonable to assume that maintaining friendship is costly. Therefore, the network in Figure 2.1 implies a crucial argument in welfare economics: the rational incentive of an individual agent and the general societal welfare conflict with each other. This is the definition of "externality" through the lens of microeconomics. Using a simple diagram, network analysis demonstrates its ability to prove this essential idea of conventional economic theory.

Moreover, this straightforward diagram not only serves as a good indication of the distortion to efficiency resulting from the positive externality but also shows that the position of the node plays a significant role in the corresponding economy network, which then contributes to the heterogeneity of the agents or nodes. As we can see, the role of agent 1 in Figure 2.1 differs from the others due to its distinct, central, and pivotal location. Therefore, in terms of network analysis, Agent 1 is considered a pivotal player in the network. Recalling the Vickery-Clark-Grove mechanism, if we want to run a welfare analysis on public goods or design a mechanism to internalize externalities, first we must identify the pivot player. According to Figure 2.1, the removal of Agent 1 will reduce social welfare the most. That is, in the economic network, the more central a node is, the more influence she will have. Centrality captures direct and indirect influences on an individual. Ballester et al. (2006) proposes an alternative measure of network centrality, inter-centrality, which can be used to identify "key players" in a network.

2.3.3 Diffusion Effect

Next, we focused on another important characteristic while analyzing the network, particularly for the technological industries. We observed that the cluster of technological firms is largely driven by the share of innovative ideas. It's impossible to build a technological hub without the diffusion of ideas and the results of research and development.

Choi et al. (2010) explains why diffusion of innovation sometimes propagates throughout the whole population and why, at other times, it halts in its interim process. Choi et al. (2010) provides a potential answer to this question by developing a simple computational model of social networks. The proposed computational approach incorporating small-world graphs enables the authors to find that diffusion of innovation is more likely to fail in a random network than in a highly clustered network of consumers. A marketing implication is that the choice of initial target groups and their network structures matter in influencing whether an innovation makes full or partial penetration in markets where network effects play a role.

Then, we turn to another literature that used an experiment to see the importance of the technological diffusion effect within the network. Banerjee et al. (2013) aims to explain how economists design a social experiment to show the diffusion effect of the network. To demonstrate the existence of diffusion in the network, Banerjee et al. (2013) distributed a survey before a microfinance institute entered 43 rural villages in Karnataka, a southern state in India. The financial institute is called Bharatha Swamukti Samsthe (BSS). As BSS entered the village and began to offer micro-loans, the authors collected responses to a detailed survey of the villagers. This was about how they interact with others and transmit information. These villages rely heavily on word-of-mouth communication to spread information, and are

linguistically homogeneous.

Furthermore, before the introduction of BSS, there were no similar financial services offered, and most residents had little exposure to micro loans. Villagers can only find out about the new financial service from their friends and acquaintances. At the beginning, the BSS asks some "leaders" in the villages, such as teachers and shopkeepers, to spread information about their loan offers. As a result, the whole Indian village setting provides a good context for studying peer effects on information diffusion. In a nutshell, the authors developed a regression model to estimate the magnitude of peer effects.

$$log(\frac{p_i}{1-p_i}) = X_i'\beta + \lambda F_i$$

Following the logistic regression model, p_i is the probability that a household i participates in the loan program. Participants should be asked whether to participate in the micro loan program or not, indexed with binary variables 1 and 0. X_i is a vector of household characteristics, such as caste, wealth, profession, and others, which controls survey takers' observable facts. And F_i is the fraction of household i's friends who also take part in the program. So the coefficient λ could be indicated as the magnitude of peer effects. The authors' empirical result shows that the estimation of peer effects, $\hat{\lambda}$, is statistically significant in their sample data. Using the data, Banerjee et al. (2013) also tested the effect of communication and diffusion centrality, which some people might play a more significant role in passing information along. Furthermore, since BSS approached the village leaders at the beginning, the authors were able to explore the effects of the information injection at different points. For example, which leaders spread information more effectively?

Regarding international trade, the issue of funds may not pose as much of a problem as the thieves in India. However, since the tech industry is a highly integrated industry, the diffusion of information to reliable suppliers is also very critical. In the Taiwanese tech industry, supplier reliability is crucial to success. Whether you have a reliable supplier for the must-use particles to build your products is critical. And this factor might also play a critical role in the formation of tech settlements in Taiwan. And without the network perspective, we will not identify this effect.

2.3.4 Key Player

The peer effect is a reasonable incentive to develop network analyses. However, now we need to think about peer effects in the same network homogeneous. In standard peer effects models, this is homogeneous across members and corresponds to an “average” group influence. Or would the nodes with different positions or different structural linkages with other agents cause different peer effects? If we refer back to Figure 2.1, this argument links to centrality.

In Ballester et al. (2006), the proposed measurement replacing Bonancich centrality was mathematically modeled. The Bonacich-Nash linkage implies that aggregate equilibrium increases with network size and density and only considers the systematic distinction between nodes. For example, the more links a node has, the more important it may be. Under this construction, the previous literature pins down equilibrium. However, this Bonacich-Nash equilibrium did not consider that externalities within a group are heterogeneous between different nodes. So Ballester et al. (2006) constructs a novel n-player game model and figures out each node’s equilibrium strategies. The newly developed centrality measurement could identify a "key player"

in the network and rank each node's importance.

Ballester et al. (2006) considers a finite population of players with linear-quadratic interdependent utility functions. Assuming players $i = 1,2,...,n$ select an effort $x_i \geq 0$ and obtain the payoff as follows.

$$u_i(x_1,...,x_n) = \alpha_i x_i + \frac{1}{2}\sigma_{ii}x_i^2 + \Sigma_{j\neq i}\sigma_{ij}x_i x_j$$

Here, we can treat x_i as his benefit of being linked, and the α_i represents agent i's preference (location). σ_{ij} is the coefficient of interdependence on the network for agent i. In which agent i could build a bunch of linkages with other $n-1$ players. If we only consider the symmetric case, we can ignore the discussion of the bilateral coefficient restriction. σ_{ij} does not necessarily have to be equal to σ_{ji}. Their signs are indefinite, and the interdependence between any i and j could be either positive or negative. and assume $\alpha_i = \alpha > 0$ as well as $\sigma_{ii} = \sigma$ for all $i = 1,2,...,n$. To illustrate the game format, the authors define $\Sigma = [\sigma_{ij}]$ as a $n \times n$ square matrix of cross-effects. Or we can simply take Σ as the payoff matrix of a n-player game with strategy space $\mathbf{R}_+^n$.

At this stage, Ballester et al. (2006) has already shown an elegant n-player game with a well-defined payoff matrix and plausible strategy space. Furthermore, the only thing we need to analyze the network is a set of coefficients to capture the structure.

Ballester et al. (2006) then defines the n-square adjacency matrix $\mathbf{G}$ of a network $\mathbf{g}$ to keep track of the network connections. Let $\mathbf{G}^k$ be the kth power of of $\mathbf{G}$, with coefficient $g_{ij}^{[k]}$, where k is some integer. The matrix $\mathbf{G}^k$ keeps track of indirect connections in the network. $g_{ij}^{[k]}$ measures the number of paths in network $\mathbf{g}$ from node i to node j.

Given a scalar $\alpha > 0$ and a network $\mathbf{g}$, a matrix $\mathbf{M}(\mathbf{g},a)$ could be set as an

n-player network with structure $\mathbf{g}$ and Bonacich centralities parameter a. In plain words, the Bonacich centralities parameter a, could be treated as the identity of the whole network. This is like the density or the shape, which are fixed when the network structure settles down. And then we could map each network $\mathbf{M}(\mathbf{g},a)$ to a n vector, as a certain type of Bonacich centrality $\mathbf{b}(\mathbf{g},a) = \mathbf{M}(\mathbf{g},a) \cdot \mathbf{1}$.

Finally, to capture the heterogeneity of the nodes, the author defines the Bonacich centrality of node i is $b_i(\mathbf{g},a) = \Sigma_{j=1}^{n} m_{ij}(\mathbf{g},a)$. The term, $\Sigma_{j=1}^{n} m_{ij}(\mathbf{g},a)$, counts the total number of paths in $\mathbf{g}$ that start at node i. It is the sum of all loops $m_{ii}(\mathbf{g},a)$ from i to i itself and of all the outer paths $\Sigma_{j\neq i} m_{ij}(\mathbf{g},a)$ from i to every other player $j \neq i$, that is,

$$b_i(\mathbf{g},a) = m_{ii}(\mathbf{g},a) + \Sigma_{j\neq i} m_{ji}(\mathbf{g},a).$$

In which this term captures the heterogeneity across nodes i in the same network $\mathbf{M}(\mathbf{g},a)$.

After some derivation, if we assume the equilibrium exists, the equilibrium strategy for i could be represented as $n \times 1$ vector $\mathbf{x}^*(\blacksquare)$.[2] Also, at equilibrium, the Bonachic centrality parameter of the network is a constant, $a = \lambda^*$. The Bonachic equilibrium finally implies that each player contributes to the aggregate equilibrium outcome in proportion to her network centrality.

$$x_i^*(\blacksquare) = \frac{b_i(\mathbf{g},\lambda^*)}{b(\mathbf{g},\lambda^*)} x^*(\blacksquare)$$

As the author indicates, the dependence of individual outcomes on group behavior is called the peer effects. It means that, even though the linkages between nodes i are the same, the effect of the externalities of each node

[2]The detailed derivation and equilibrium conditions, please refer to Ballester et al. (2006) pp.1408

i is not the same. The node's position does have an effect as we see in the equation above. We not only have to take the number of connections $(\Sigma_{j\neq i} m_{ji}(\mathbf{g}, a))$ into account, but also the centralities of each nodes $(m_{ii}(\mathbf{g}, a))$. The effects of externalities are heterogeneous across n members, with a variance related to Bonacich network centrality.

2.3.5 Network Formation

We discussed the definition and existence of peer effects in the network in the literature review section. We also elaborated on the heterogeneity of agents caused by centrality in the micro-network. At this point, Cabrales et al. (2011) provides a different perspective on the theory of network formation.

Cabrales et al. (2011) provides an excellent example of education and how parents form a network via the children's school. Its arguments could be traced back to the problem of double causalities between peer effects and homophily. Cabrales et al. (2011) argues that network formation does not result from socialization. We interpret this as the authors want to reverse the sequential order between network construction and bilateral linkages. Previously, if we follow Jackson (2014) assumption in Figure 2.1, people have the incentives to build up connections with each other because they want to enjoy the future benefits of linkages. And as more links are built, the social network grows. However, Cabrales et al. (2011) believes that if the economy population is large enough, the social network between the agents exists. In addition, people participate in social groups before benefiting from pairing links. The agents' linkages should be considered a normal process instead of behaviors driven by innate rational incentives.

Cabrales et al. (2011) uses an example from family economics to support their ideas.[3] Let parents of children about to start school decide whether to form a network. Each pair of parents cares about their children's future. Parents can choose from two types of costly behaviors that might help their children's future learning.

At first, the "productive effort." They take their children home after school, play sports together, or study and do homework together. This kind of effort does not interact with other agents in the network. Secondly is the "socialization effort", participating in social activities related to children's education. For example, attending parental evenings, birthday parties, or any activities that involve other parents. By participating in those social activities, parents might be able to share some valuable information about education. For example, study techniques, school conditions, and other significant issues related to children's education. As a result of those socialization efforts, friendships between parents and children might be created. This friendship might continue to produce synergies (externalities) in the future. Throughout the paper, the authors model his idea using a quadratic linear utility function. This shows the reverse socialization process also provides multiple stable equilibria mathematically. Cabrales et al. (2011) demonstrates another perspective of the endogenous problem of network theory related to bilateral trade. Would the countries and firms form the network from the bilateral linkages first, or is it because too many firms produce the tech products so that the network is formed naturally?

In conclusion, Jackson (2014) and Jackson et al. (2016) form the basis of this literature review session. However, there is network theory literature that might be highly corrected in trade. For example, Corominas-Bosch

[3]Refer to Cabrales et al. (2011), pp. 343-345 for full mathematical derivation.

(2004) identifies the different equilibrium outcomes of the alternating public offer game. While there were the same number of buyers and sellers on the market, the different pairing structures between them might impact their bargaining power. Corominas-Bosch (2004) underscores the importance of network structure, which is also very important in the context of trade networks. Jackson et al. (2012) defines a novel term, Social Quilts, and argues the "Renegotiation-Proofness Principle" in equilibrium should also be considered. According to the Jackson et al. (2012) under specific network formats, the most detrimental result of the game, the breakdown of the economy of returning a favor, or so-called grim strategies, might not be carried out by the players involved.

2.4 Data

2.4.1 UN Comtrade

Various data sources are available to analyze international trade flows of a specific good between countries under the categories of Harmonized System Code. The most widely used data sources for product-level trade flows in international trade are the United Nations Commodity Trade Statistics Database (UN Comtrade Database) and the World Bank Group's World Integrated Trade Solutions (WITS). These sources provide comprehensive data helpful in studying international trade flow between countries under a specific category of goods.[4]

UN Comtrade database serves as the primary data source for our study. It offers comprehensive information on importing and exporting goods from nearly 200 countries, including Taiwan, although with a specific designation.

[4]UN Comtrade Database is considered the world's most comprehensive global trade data platform, regularly maintained by the United Nations Statistics Department (UNSD).

UN Comtrade database aggregates detailed annual and monthly global trade statistics by product and trading partner (Chen et al., 2022). Governments, universities, research institutes, and multinational enterprises commonly use the data they provide to conduct research relating to the trade flow. The United Nations Statistics Division (UNSD) is the agency in charge of compiling the UN Comtrade database, and it covers approximately 200 countries that represent more than 99% of global trade in goods.

2.4.2 WITS

Data and information can be extracted in various formats; we can query the specific data from the World Integrated Trade Solution (WITS) visualized website. However, in this study, since we aim to plot the networks for the products given in different time intervals, we need a large amount of data for a specific good under an identified HS code. Hence, the WITS query-by-query method is not suitable for this study. Instead, we apply the integrated International Trade Network in R (ITNr) packages in the R system to extract a large amount of data using the Application Programming Interface (API) provided by UN Comtrade.

The World Bank's highly acclaimed online platform, World Integrated Trade Solution (WITS), is an indispensable tool for accessing comprehensive international trade and tariff data. Boasting a wealth of information beyond just trade statistics, WITS provides users with a range of features related to tariff data, trade competitiveness, and trade restrictions. Moreover, it offers advanced tools for data visualization and analysis, enabling users to tailor their queries and obtain a truly personalized experience.

2.4.3 UNCTAD

The United Nations Conference on Trade and Development (UNCTAD) also published the trade data. The UNCTAD trade analysis and information system has three sets of data: tariffs and non-tariff measures, the integrated tariffs and imports database of the WTO, and the consolidated tariff schedules database of all members' bound duties. Using WITS' global preferential trade agreement module, one can also search and browse through free trade agreements that have been entered into. In addition to calculating trade indicators, it is equipped with modules for simulating tariff reductions and calculating trade indicators. With WITS software's assistance, one can access information regarding international trade, tariffs, and non-tariff measures (NTMs). In the section entitled "Country profile," we can find information on each country's exports, imports, tariffs, and development statistics.[5]

2.4.4 Taiwan's Data

It is important to acknowledge that Taiwan, sometimes referred to as the Republic of China (ROC), is not currently recognized as an official member state of the United Nations. Consequently, most UN-regulated databases do not categorize Taiwan as a country, such as the UN COMETRADE, WITS, and UNCTAD. Taiwan plays a crucial role in the global trade landscape, yet it is perplexing that its data is not included in various databases. This exclusion can lead to significant deficiencies in the accuracy and comprehensiveness of these databases, making it difficult for stakeholders to make informed

[5]In addition to summary trade statistics by country regarding total exports and imports, export and import partners, top product groups exported and imported, top exporters and importers, derived analytical databases, and a WITS application to create custom trade statistics and indicators, WITS also includes a number of sections.

decisions.

Hence, one can see the following quote if one carefully examines the annotations in the database instructions. “For most indicators, Taiwan’s data are not added to China data, but Taiwan and China are added to the world aggregate and the high-income countries aggregate.” This means there is an indirect way to identify Taiwan’s data; they are just under a specific name. Despite Taiwan’s unique political status and significant economic influence, its data is still included in the United Nations Commodity Trade Statistics Database (UN Comtrade). However, due to political sensitivities, Taiwan’s data is listed under a name that differs from its official designation.

We found the Taiwanese data under the categories named “Other Asia, nes.” The acronym “nes” denotes “not elsewhere specified.” Given that the United Nations encompasses all other Asian countries, this particular data segment of the data serves as a reliable proxy for Taiwan’s trade data.[6] According to the United Nations website on data accessibility, here is the official quote. “For political reasons, the United Nations is not allowed to show trade statistics referring to Taiwan, the province of China. Yes, the partner breakdown includes Taiwan, Province of China, under “Other Asia, not elsewhere specified” (code 490). Data for “Other Asia, nes” are available only to international organizations. In principle, trade data for territories belonging to Asia but not specified by country could end up in code 490. In practice, only trade of Taiwan, Province of China is included under this code, except for several countries (such as Saudi Arabia, which reports all of its exports to unknown countries). Trade data for Taiwan, the province of China, are not included in China’s trade.”

[6]As appears on the WITS and the World Bank’s websites, Taiwan is not listed as a separate country for World Development Indicators.

2.5 Methodology

From Section 2.2, it is clear that Taiwan's manufacturing of electronic chips and electronic consumption products is highly integrated with the global supply chain, which is essentially a network tied together by exports and imports.

We have conducted an analysis of international trade data from a network perspective in this paper. The network is a set of countries connected by directed and weighted trade ties (Smith and Sarabi, 2022; Smith et al., 2023). The international network analysis has various names, including International Trade Network (ITN), World Trade Web (WTW), and World Trade Network (WTN) (Smith and Sarabi, 2022; Smith et al., 2023). To plot the global network graphs of the different products, we use the United Nations Comtrade (UN Comtrade) database as our primary data source since UN Comtrade provides very detailed product-level trade flows.[7] Then we follow the international trade network in the R software package (ITNr) to plot the trade network at different times concerning different products and calculate the degree of centrality of the node representing Taiwan (Smith et al., 2016; Amighini and Gorgoni, 2014b).

The international network analysis of computer-related products is primarily based on a study by Amighini and Gorgoni (2014a). The study aims to evaluate how the rise of new countries as significant suppliers to the world's leading car producers has impacted the structure of the interna-

[7]The United Nations Comtrade database aggregates detailed global annual and monthly trade statistics by product and trading partner for use by governments, academia, research institutes, and enterprises. The data compiled by the United Nations Statistics Division cover approximately 200 countries and represent more than 99% of the world's merchandise trade. Information can be extracted in various formats, including API developer tools for integration into enterprise applications and workflows. Subscribers have access to additional functionality to improve efficiency and specificity. URL:https://comtradeplus.un.org/

tional organization of auto production over the last decade. It has simply caused a shift in the geography of the suppliers. Using network analysis, Amighini and Gorgoni (2014a) shows that emerging economies have caused a structural change in the international organization of auto production.

To analyze the settlement process of the Taiwanese tech industry, we will focus on the trade flow of personal computers and semiconductor products instead of the global motor vehicle trade flow mentioned in Amighini and Gorgoni (2014a). We will determine the trade flow of computer-related goods with the partner who imports them from Taiwan and China. To do so, we can use the UN Comtrade database.

The primary programming tool we used here is R, and the R package we applied was "ITNr," International Trade Network in R (Smith, 2023). We then performed our data cleaning and plotting according to the ITNr documentation. "ITNr" offers functions for cleaning and processing international trade data downloaded directly from the UN Comtrade database through Application Programming Interfaces (APIs). The downloaded data are then used in a function provided by the R package "comtradr." This function is done by the "comtradr" package in R (Muir, 2022).

Therefore, the international trade network can be analyzed using its functions in R. These include backbone extraction, centrality, block models, and clustering. We can examine the key players in the ITN and regional trade patterns by adding various data periods. For demonstration purposes, we will use 2016 as an example. We selected the top ten countries with the most technological expertise: Japan, the United States of America, China, Taiwan, Germany, Canada, South Korea, India, Mexico, and Singapore. According to the HS system, we select "data processing machines" from the 4-digit HS code, "8471." But this could be expanded to the HS 6 code

products in the extension.

Our first step was calling out all the packages we needed in R and searching for product codes. We put this keyword in the "comtradr" package in R to search for computer-related products. Then, we use the "ITNr" package to make data available for network analysis. Finally, we plot the network graphs and calculate the degree of centrality.

We run the same algorithm to determine network graphs for different years. This allowed us to identify Taiwan's role and position in manufacturing "data processing machines" under the HS-4 digit code "8417" representing the computers, and the HS-4 digit code "8415" representing the semiconductor products.

Our aim in this paper is to analyze Taiwan's position in trade networks by examining the years 2011, 2006, 2001, and 1996. The UN Comtrade API limits queries to five years at a time, hence our choice of these specific years. We have selected 1996 as it marks the year when Taiwan introduced direct presidential elections, which is widely considered the starting point of democratization on the island. The year 2000 was when the long-time authoritarian regime lost its power, which is seen as the culmination of Taiwan's democratic process. We hope to use a graph and a historical timeline to investigate how Taiwan's role in the global trade network of producing the "data process machine" has changed and overlapped with democratization.

2.6 Results

Our empirical results are all shown in the graphs. In the graph, the lines between the countries are the inflow of goods, and the colors represent that the trade was located in the same region, and the countries' regions were

classified under the UN M49 system.[8]

In the network graphs, the color line indicates trade in the same regions, whereas the gray line represents inter-regional trade. Also, in the network graph, the line's thickness represents the trade product's total value, and the country's location indicates its centrality in the network. The higher its centrality, the more it connects to other countries, and the more central the country will be in the graph, the more influential the country's industries are regarding these products.

2.7 Conclusions

Two things are apparent from the sequential graphs: 1996, 2001, 2006, 2011, and 2016. First, trade between regions has become increasingly significant globally in recent decades. If you compare the graph between 1996 and 2016, we observe that the gray line has become broader and more dense in the network. However, the color line becomes thinner as time passes. This could be another evidence of globalization regarding the product trade under the category of personal computers.

Second, the graph shows that China's position in producing computer-related products changed the most between 2001 and 2006. The distance between Taiwan and China reversed during that period. The United States of America has always been at the center of the network over this period. However, the distance to centrality for Taiwan is shorter than the distance from the Chinese to the central network. However, in 2006, we could see that the wave of trade liberalization appeared in terms of China's central role. China became more linked to other countries than Taiwan at that

[8]UN M49, or the Standard Country or Area Codes for Statistical Use, is a standard for area codes used by the United Nations for statistical purposes. It was developed and maintained by the United Nations Statistics Division (UNSD).

time.

However, this does not sufficiently demonstrate Taiwan's centrality was lost due to democratization. However, this paper offers an alternative perspective demonstrating that the timelines overlapped. It may be difficult for a traditional econometric or other empirical model to replace the results of this analytical method. Network analysis has been suggested to solve many intangible economic behaviors (Jackson, 2019). And this paper is an excellent example and a starting point. We use a small number of sequential graphs to illustrate the dynamics of competition developed between a pair of rival countries in selling technological goods, specifically computer-related goods, to the world.

Firms exporting and importing goods from other firms link countries and corporations worldwide. Network analysis provides a direct observation of how well these countries are connected and what the shape of the network is. The result here focuses only on Taiwan since it has a unique status as the hub of producing electronic goods and has a political status worldwide. Since Taiwan is not considered an official member state of the United Nations, obtaining Taiwan data in the UN Comtrade database is another contribution to this study. In this paper, we find that the results apply to Taiwan and countries with open economies and unique path dependencies. As a result of international trade, countries can bridge the gap between them and develop a sense of trust and reliability. Using network analysis in trade is critical and inevitable in future studies of global trade.

Figures

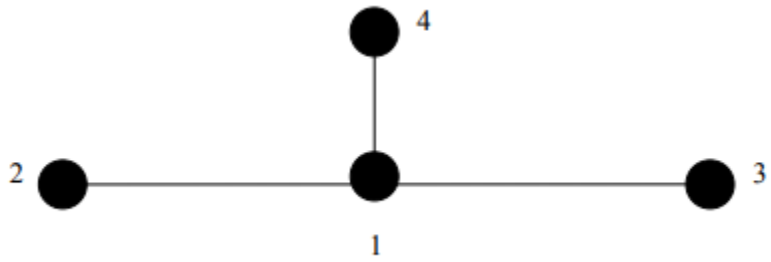


Figure 2.1: Star Shape Network

HS Code	Description
8471	Automatic data processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data n.e.s.
847110	Data processing machines; analogue or hybrid automatic type
847120	Data processing machines; digital automatic, containing in the same housing at least a central processing unit and input and output unit, whether or not combined
847130	Data processing machines; portable, digital and automatic, weighing not more than 10kg, consisting of at least a central processing unit, a keyboard and a display
847141	Data processing machines; digital, automatic, (not portable, analogue or hybrid), comprising in the same housing at least a central processing unit, an input and output unit, whether or not combined
847479	Data processing machines; digital, automatic, (not portable, analogue or hybrid), presented in the form of systems, n.e.s. in item no. 8471.41
847150	Units of automatic data processing machines; processing units other than those of item no. 8471.41 or 8471.49, whether or not containing in the same housing one or two of the following types of unit: storage units, input units or output units
847460	Units of automatic data processing machines; input or output units, whether or not containing storage units in the same housing
847170	Units of automatic data processing machines; storage units
847180	Units of automatic data processing machines; n.e.c. in item no. 8471.50, 8471.60 or 8471.70

Figure 2.2: Harmonized System Code for Personal Computer

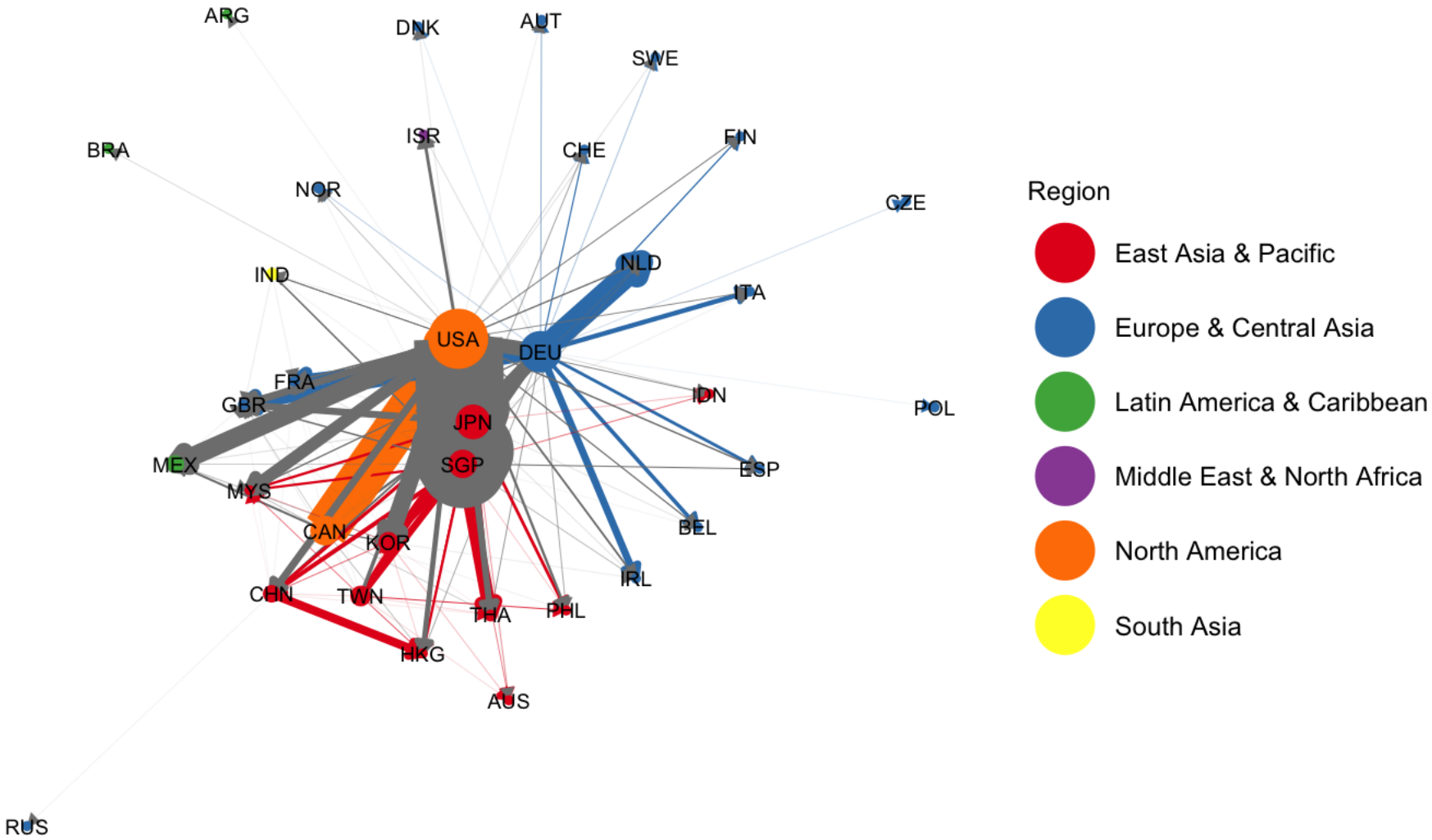


Figure 2.3: Personal Computer's Global Network in 1996

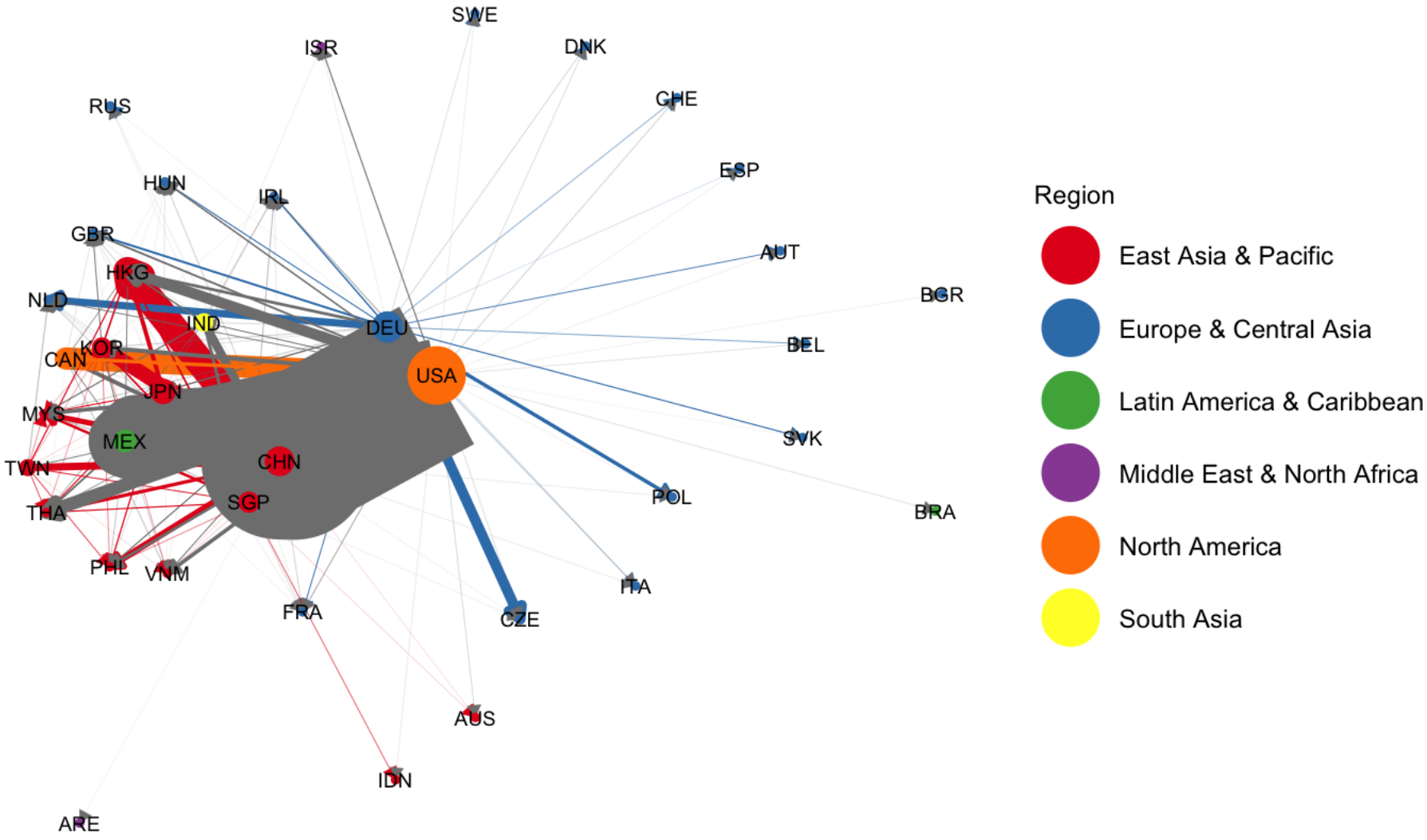


Figure 2.4: Personal Computer's Global Network in 2016

Chapter 3: Does Open to the Mainland Tourists Redefine Taiwan's Ideological Boundaries?

3.1 Introduction

How would the lift of long-standing travel bans and different levels of exposure to unacquainted visitors affect party identification and political ideology? This paper uses the district-level presidential electoral results and the Annual Survey Report on Visitor Expenditure and Trends (ASRVET) in Taiwan between 1996 and 2020 to test how the shock of open policy to mainland Chinese visitors changed the political ideology among the Taiwanese constituents living across the municipalities. Firstly, we build a new dataset by merging geographical information into the Taiwanese electoral database. Then, we utilize the regression discontinuity (RD) design model according to the running variables of driving times and distances to the top-rank tourist attractions in Taiwan and categorize the treatment and control groups as high and low tourist-exposure areas. Finally, we estimate and compare the treatment effects between the high and low-exposure regions across the presidential election outcomes. We run the robustness check by testing various local polynomial functions in the RD model. We show that after ECFA went into effect; the local treatment effect became more significant. In other words, electoral districts exposed to more Chinese tourists encountered a larger scale of political-ideological realignment. The result hence demonstrates EFCA as a counter-example of the progressive economic integration theorem.

3.2 Institutional Background

3.2.1 Bipartisanship: DPP v.s. KMT

Like most of the democratic nations in the world, the modern politics in Taiwan is built upon bipartisanship. Democratic Progressive Party (DPP) and Kuomingtang (KMT, also known as the Chinese Nationalist Party) are considered two major political parties in Taiwan in the modern democratization era.[1] Two parties have nominated the presidential candidates since the first direct presidential election held in 1996. Moreover, both endorsed the candidates, held campaign activities and participated in most local elections for public officials.

Given the historical path that the two parties have taken, KMT and DPP hold very different views on cross-strait relationships and national identification. The KMT is more policy-friendly to China, whereas the DPP seeks more of Taiwan's national self-determination. The dispute of national identification is uncommon to see in other countries, but in Taiwan, any topics relating to China will become controversial. The debate on national identification boils down to the official name of the nations. While KMT insists on being called the "Republic of China (R.O.C.)," DPP prefers to use "Taiwan" as the promotion name in the international community. This bipartisanship gradually forms the political ideology in Taiwan.

From 1949 to the 1970s, the Chiang Kai-shek and the KMT-led government made the island a military base to reconquer mainland China. However, after the 1970s, due to the change in international politics, the KMT realized it was unlikely to reclaim the mainland and switched its focus

[1] Here, we denote the democratization era began around the 1990s after the Martial Law ended. Since the contemporary democratization in Taiwan in the 1990s, DPP and KMT have been the only two parties that nominated candidates across seven general presidential elections from 1996-2020.

to building up the infrastructure in Taiwan.[2] Since then, the political ideology of the KMT has leaned toward inheriting the "real China" legacy even without the support of other countries and seeking the opportunity in the future to unify the mainland.[3]

In contrast, DPP started as a group of anti-authoritarian activists extradited by the KMT government and was the only voice to demand democratization and political reform during the authorization regime. Hence, there is a substantial ideological cleavage between the two parties. The KMT inherited their Chinese roots to deem the current Taiwanese government legal representative of "real China." Also, KMT holds a more conservative stance on claiming Taiwan's independence and focuses more on economic cooperation with China. For example, KMT under the Ma Ying-jeou administration (2008-2016) proposed maintaining the status quo on the cross-strait, building a peaceful relationship, and targeting the enormous Chinese market.

On the contrary, the DPP was considered an illegal party during the KMT-Chiang family ruling period. The DPP chartered members were against the Chiang-KMT administration and wanted to disconnect with China. Members and politicians affiliated with DPP advocate the self-identification of Taiwan and claim to normalize Taiwan as an independent sovereignty country. DPP's stands to China are more progressive, resistant, and not lean toward solely relying on the market of China, whose ultimate goal was to transform Taiwan into a normal country.

Also, the two parties have been fighting for their political beliefs since

[2]There have been two generations of Chiang's family ruling since Chiang Kai-shek retreated to Taiwan. The Chiangs, both represented KMT, held power from 1949 to 1988. However, the political goal of the then KMT-led government adjusted with time as well. Chiang Ching-kuo, the eldest son of Chiang Kai-shek, took over the president's seat in 1978 and shifted his attention to building the infrastructure on the island.

[3]Since retreating to Taiwan, the Republic of China government *de facto* only controls several areas, including Penghu, Kinmen, and Mastu, in addition to Taiwan.

the democratization era. The Cross-strait and national identity topics have played important roles in every presidential election. Although domestic politics in Taiwan look reasonably stable nowadays as the elections of public officials are held regularly, and the transition of power is relatively peaceful, bipartisanship is still relatively young compared with other democratic countries worldwide.[4]

3.2.2 Political Ideology

Kuomintang (KMT) is considered the right-wing, meritocratic, and conservative political party in modern Taiwan, whose political stands on national identification generally following the ideology recognizing "The Republic of China on Taiwan."[5] The Chiang Kai-shek and the KMT retreated to Taiwan in 1949, which opened the Chiang's family ruled the era under the most extended martial law in the history of the world. The KMT remained the sole legal ruling party in Taiwan was under the "Dang Guo" system until democratization were enacted in the 1990s.[6]

Unlike the KMT representing the traditional and conservative power, as they still consider themselves the legal delegates of the Republic of China, the Democratic Progressive Party (DPP) was the hub of non-Kuomintang supporters under the Chiang-family-Kuomintang authoritarian regime. Under grounded for about decades, DPP was officially formed in 1986, under

[4]Taiwan's period of martial law in Taiwan (1949-1989) had been the most prolonged period of martial law in the world. The long-existing martial law was not lifted until 1990, and the president's first general direct elections occurred in 1996.

[5]KMT was the organization that Dr. Sun Yat-sen initially founded in 1984 to overthrow the Qing Dynasty during imperial China, whose main goal was to build a modern republican based on the new democratic system. Since KMT's early establishment in 1919, it became the dominant ruling party of the Republic of China on the mainland. From 1928 to 1949, the Kuomintang-run China, led by Chiang Kai-shek, represented the "China" to engage in the political activities of the international community, such as World War I and II. However, after losing the Chinese Civil War to the Chinese Communist Party (CCP).

[6]"Dang Guo" in Chinese means using a single party to run the country, which is the system KMT used during Chiang's administration in Taiwan.

the proclamation of pursuing the nationality of Taiwan and cutting ties with the old relationship with the PRC under the control of the Chinese Communist Party. After the democratization that started in 1989, the DPP became the major opposition party. Traditionally, DPP represented the mainstream "non-Kuomintang" voice in the Chiang-family-Kuomintang period and was deemed lining to the left on the political spectrum. One of the charted goals of DDP was to ultimately declare the independence of Taiwan and make the island officially become an actual sovereign state.

To sum up, the DPP is the leading party with the anti-China ideology. In contrast, KMT is deemed pro-China, given it embraces the image of the true inheritance of the Chinese legacy and would like to use the "Republic of China" or "ROC" as the nation's official name. This paper defines the pro-China margin as the winning votes and shares of the KMT candidates in each election, as specified in Equation 3.1. The t will represent the year of the elections and the pro-China margin will be the primary dependent variable capturing the political ideology in the following analysis in this paper.

$$\text{Pro-China Margin\_}t = \text{Vote to KMT\_}t - \text{Vote to DPP\_}t \tag{3.1}$$

3.2.3 Presidential Elections in Taiwan

The election of Taiwan's president and vice president is a universal direct election through secret votes by the Taiwanese citizens. After the democratization that started in the 1990s, the single-district, two-vote system was introduced to Taiwanese society. The legal constituent has two ballots regarding the general elections for the presidents. One ballot is for

the presidential candidate, and another is for the political party.[7]

There is no early vote or absentee vote in Taiwanese elections. The president and vice president are nominated on a joint ticket. Political parties that have gained at least 5% of the last presidential or legislative election votes may directly appoint a set of candidates. For example, during the 2012 elections, only the KMT and DPP were qualified to nominate candidates through this rule. Alternatively, candidates may be nominated by a petition signed by eligible voters numbering no less than 1.5% of the electors in the last legislative election.[8]

3.2.4 Cross-strait Relationship

The cross-strait relationship between Taiwan and China has been complicated, thanks to long-term historical and political disputes. Despite being largely ethnic Chinese societies, Taiwan and China, are very different due to their differentiated histories, which have been influenced by multiple factors, including foreign colonial rule, their separate independent governments, and experiences with democratization (Kwan, 2016). As China started to bring in foreign investment in the 1980s and soon became the world's factory, the economic power of Chinese firms and consumers, in addition, plays another important role regarding cross-strait politics. Meanwhile, while as China was embracing the world market, Taiwan encountered the process of democratization and tried to find a path to cut ties with the name of China (Rigger, 2003).

The tension across the Taiwanese Strait has also been fluctuating due

[7]The most recent election occurred on January 11, 2020. The Presidential and Vice Presidential Election and Recall Act of R.O.C. states that a candidate for President or Vice President must be a citizen of the Republic of China, at least 40 years old, and a resident of Taiwan for no less than 15 years with a physical presence of no less than six consecutive months.

[8]This equals 252,848 signatures for the 2012 election.

to globalization and modern democratization in Taiwan after the Chiang family's authorization stepped down. The political uncertainty in China is also highly correlated with the political cycle in Taiwan. In general, since the KMTs and their supporters are leaning to consider themselves as the Chinese, during the period of the KMT being the incumbent (1996-2000, Lee; 2008-2016 Ma), the cross-strait relationship was usually more peaceful, and the communication between Taipei and Beijing is smoother. On the other hand, since the DPP was chartered with the consensus of normalizing Taiwan as a real country, the relationship with China was usually colder when the DPP's presidents were in office. There have been four different presidents who the people in Taiwan elected. They are Lee Tang-Hui (KMT) in 1996-2000, Chen Shui-bian (DPP) in 2000-2008, Ma Ying-jeou (KMT) in 2008-2016, and Tsai Ing-wen from 2016 to the present.

From a historical perspective, although without the recognition of most countries in the international community, Taiwan has been *de facto* self-ruled as a sovereign state since 1949.[9] In Taiwan, it is well believed that the growing economic power of China has cultivated her political ambitions to carry out the ultimate plan to reclaim the island's autonomy and officially annex it as a part of the territory. The pending hostile relationship and ambiguous definition of national identification hence created physical and psychological trade barriers among the citizens living on the different sides of

[9]This dispute of sovereignty is the so-called "*Undetermined Status of Taiwan*." The origin could date to the undecided Chinese Civil War since 1949, when the Chinese Communist Party led by Mao Zedong took over mainland China's control, while the Kuomintang lost to the civil war and fled to Taiwan under the leadership of Chiang Kai-shek. Although there was never an official fire-ceasing agreement between the two political identities, the main battlefield transformed into a diplomatic format as the Cold War Era began. Both sides started to fight for the legitimacy to represent the real "China" and seek official recognition and allegiance from the rest of the world. For example, the Republic of China (ROC) government in Taiwan led by Chiang Kai-Shek of Kuomintang (KMT) was the representative of China and a chartered member of the United Nations until the People's Republic of China (PRC) replaced her seat in 1979.

the straits. The international community's representative rights' prolonged diplomatic war consolidated as the world split on the political ideology. The consequence of this impact lasts until recently, halting the trade across the Taiwanese straits for nearly forty years.

The recent hostility to China culminated at the point of the Sunflower Student Movement that broke out in March 2014, which originally came from the distrust of the government in dealing with the service trade agreement with China. The rise of civic nationalism in Taiwan indicates the prominence of an ethnonational Chinese identity imposed by Beijing (Kwan, 2016). The surge of nationalism and the higher volume of seeking the official declaration of independence in Taiwan has puzzled many in the Chinese administration, who once believed that cultural interactions and economic benefit sharing on the island might bring in higher public support for the idea of reunification, which happens to be consistent with what the conventional economic integration theory advocated.

3.2.5 Open Border to Chinese Visitors

As Ma claimed victory in the general election in 2008 and ended Chen Shui-bian's eight-year tenure,[10] he did not take too much time after taking office to explore the various opportunities to cooperate with Beijing and adjust the previous policies to take advantage of the vast market for Chinese consumers. At that time, it was well believed that Ma and KMT's victory in the 2008 election was the result of the sluggish economic performance in

[10]Chen Shui-bian, the 2000-2008 president of Taiwan in office was once considered the "Son of Taiwan" and praised by the majority of the constituents. He ended the KMT's fifty-five-year authoritarian regime, which held a salient position to keep China in the distance and pave a path for Taiwanese nationalism identification. For example, Chen had tried to push the movement to rejoin the United Nations by using the name of Taiwan and justify the state-own companies' brand names from the Republic of China or R.O.C. to Taiwan.

Taiwan and the Taiwanese constituents were eager to seek a more friendly environment for doing business with mainland China.

The episodes of the policy shocks began in 2008, led by the newly elected President, Ma Ying-jeou of Koumingtong (KMT), who proposed to sign a preferential trade agreement with China to take advantage of the lower trade barriers in both goods and service sectors. Besides, the long-time separated citizens are allowed to travel as part of the economic cooperation agreements. Ma advocated for policy change for tourists coming from mainland China. Unlike his predecessor, the Chen administration of the DDP, Ma took a more China-friendly stance and gradually imposed a series of policies that made commerce across the straits more available. The tourism industry has the most media exposure. Ma opened up the Taiwanese borders to welcome long-time banned Chinese tourists. Even though the process only started in a few cities with higher development, the impact has gradually prolonged. Table 3.2 documents the timeline of open-border policies, as permission to travel to Taiwan became applicable. Within less than four years, the Chinese cities on the list are eligible to travel to Taiwan, which has grown from three to forty-seven. Moreover, Ma also amended the education bill to loosen Chinese students' restrictions on applying for university or graduate schools in Taiwan.

The swerve of the political attitude from the previous administration to the long-time foe made the Taiwanese concerned, and public opinion has highly diverged. Some believe that this is an excellent opportunity for mid-level exporting firms, tourism, and educational sectors in Taiwan to grab the fruits of China's enormous market. In contrast, many believed Beijing sugar-coated the trade agreement policies and tried to use their economic influence to achieve their ultimate political goal: to reunify the

island.

I translate and organize the whole series of policies relating to the trade and economic integration between Taiwan and China in Table 3.2, from the website of the Tourism Bureau. Table 3.2 documents the policies relating to Chinese tourists from the mainland, which also shows the political climate at that time. Ma administration cashed in their commitment to exploring the Chinese market after the KMT victory in the 2008 presidential election. Table 3.1 chronologically documented the cities that are open to tourism in Taiwan. As indicated in the 3.1, the open-border policies to allow the mainland Chinese to visit Taiwan started from three metropolises in China in 2011, which were Beijing, Shanghai, and Xiamen. However, these policies only took two years to extend to the other twenty-six cities in mainland China.

On the other hand, Figure 1 and Figure 2 show the series of incoming visitors to Taiwan categorized by their residences. As we can tell from the two graphs, the absolute number and the proportion of Chinese visitors increased rapidly after the EFCA was enacted in 2008.

3.3 Literature Review

3.3.1 Trade and China Shock

Discussions about the dynamics of the trade policies and the politics in a country is not new in the trade and political economy literature. Irwin (1994) examines voting patterns in the 1906 general election in the United Kingdom to explore the support for and opposition to free trade with the British electorate. Irwin (1994) also tests the hypothesis that support and opposition in each parliamentary district are closely related to the

economic interests of the district's constituents, which in turn hinges on the international trade performance of the sectors in which the constituents are employed. Although the British voting and political system are unique globally and different from the Taiwanese political system, the result of Irwin (1994) still provides a broad picture of how trade policies affect the decision to vote and its consequent political outcomes.

Young and Magee (1986) utilizes a simultaneous game model to delineate the strategic behavior by two contending coalitions of factor owners and also political competition between two rival parties contending to the political office. A Heckscher-Ohlin style of the trade model is assumed in this paper. Each political party pre-associates itself with the interests of one of the production factors and proposes policy intervention which benefits the factor owners support. In short, Young and Magee (1986) considers a Heckscher-Ohlin-Samuelson trade model with two lobbies representing the interests of factor owners and two political parties. The lobbies contribute resources to politics, equating their returns to political and economic activity at the margin, while the parties maximize their probability of election, trading off general voter dissatisfaction with protection against electioneering resources that favorable policies attract from the lobbies.

On the other hand, since we focus on the Chinese tourists coming to Taiwan, in this paper, we should not ignore the string of the literature that captures the growing power of China in global trade. Since China became a member of the World Trade Organization, its large market power has fundamentally changed the global economy. Many papers have already evaluated China's impact on the U.S. labor market, mainly regarding the penetration of Chinese imported goods. For example, Autor et al. (2013b) exploiting the rising import competition of Chinese goods on US labor

markets and concluded that the increasing import competition from the Chinese importing goods explains one-quarter of the aggregate decline in the employment of the US labor market (Autor et al., 2020). Most of the empirical literature regarding the China syndrome on the local market focuses on the manufacturing sectors and the trade in goods. (Autor et al., 2013b,a, 2014, 2019). This string of literature regarding the China shock mostly focuses on the manufacturing sectors and seldom touches on the impact of trade shock on the service sector. This paper aims to identify that the municipalities in Taiwan have encountered a larger swerve of the political ideology, which fills in the current literature gap.

Guo and Jiang (2022) focuses on the political effects of the open border policies, in which they defined it as cross-border tourism of Chinese tourists to Taiwan. However, instead of using data from historical presidential elections in Taiwan, they ran the regression discontinuity using the time series survey data on Taiwanese national identification and the number of tourists. Guo and Jiang (2022) has also shown that cross-border tourism did not help achieve Beijing's original political goal. The empirical results in Guo and Jiang (2022) differ from this study. They show that the independence–unification views that the arrival of Chinese tourists have not influenced the majority of Taiwanese hold. The increase in the number of Chinese tourists does not significantly affect the proportion of Taiwanese supporting independence and maintaining the status quo. By contrast, the number of Taiwanese who support unification has reduced. This implies that cross-border tourism may not be an effective means of achieving political goals.

3.3.2 Trade in Tourism

Recently, the literature analyzing the relationship between International trade and tourism have been growing. But little do these papers touch on the political effects and barely look at the particular the shock of the open-broader policy for Chinese tourists. For example, **?** tests a connection between international trade and international travel flows using time series econometric techniques by using data for Australia and four important travel and trading partners, the U.S.A., the U.K., New Zealand, and Japan.

Also, there is no consensus in the literature on how to estimate the exposure of the tourist. However, in the literature, we could find that travel distance and time play important roles in the spread of tourists. There have been many papers discussing the measurement of tourist exposure. One area's exposure to the incoming tourists highly depended on tourist dispersion. Becken et al. (2008) identifies the itinerary prototypes based on the characteristics of the tourists and examines the tourist behavior across space and time. They found that the spatial distribution of the tourist itinerary is shaped by a wide range of factors, including country of origin, port of arrival, travel style, repeat visitation, the purpose of travel, and the presence of children under fifteen years old.

? is the latest paper on tourism in trade and its effects on the labor markets. The authors develop a new strategy to capture the region's tourism effect and ask, "Is tourism good for locals?" This paper also focuses on the regions with political tensions, such as the Catalonia region in Spain, even though they did not test the political outcomes of the Catalonia region. **?** uses detailed spatial data on expenditure and income patterns of residents in Barcelona. The result shows that plausibly exogenous shifts in tourist expenditure due to compositional differences in their country of origin across

time and over space in the city crowd out local expenditure by increasing prices but partially compensating through wage increases. However, the incidence of the tourism shock is highly heterogeneous across the city, with inner-city residents bearing the most significant welfare losses and peripheral residents enjoying the most lavish welfare gains.

3.4 Data and Variables

Since this study focuses on exploring open-border tourism policies and their political effects on the presidential elections in Taiwan, there is no database. We have to merge different data resources published by four governmental agencies in Taiwan. We extract the data published by three Taiwanese government agencies: first, the Central Election Committee for the historical electoral data, the boundaries, and the geographical shape data from the Ministry of Interior, and finally the Annual Survey Report on Visitors Expenditure and Transportation (ASRVET) from the Tourism Bureau of the Ministry of Transportation and Communication. I detail them in the following subsection, starting from the historical electoral data.

3.4.1 Presidential Election Data

First, we pulled the historical presidential elections' voting data from Taiwan's Central Election Commission (CEC) database.[11] All historical electoral data are recorded and downloadable from the online database of CEC, the highest government agency in charge of government officials' elections, and conducted and supervised elections that occurred in twenty-

[11]The English version of the official website of the Central Election Commission in Taiwan, https://web.cec.gov.tw/english/

two second-level municipalities in Taiwan.[12] CEC also governs the local election commissions that administrate the logistics of the all-level elections. All elections in Taiwan's democratized period are operated according to the "Public Officers Election and Recall Law" and "Presidential and Vice Presidential Election and Recall Law." CEC has also been granted its political independence and ensures the fairness of elections and campaigns. Local and central election commissioners serve a four-year term, are not subject to party affiliation, and are given independent discretion.

In this chapter, I focused on the presidential election results of the third-level governmental administration, where there are three hundred and sixty-eight municipalities, including those governed by the cities located in the outer islands of Taiwan. The names of these third-level municipalities are different depending on their upper-level government is. It is called "district" in Chinese if the area is under "special municipality," whereas "town," "village," or "county-administered city" is the names of the municipality under the county. There are one hundred and sixty-four districts, six aboriginal mountain districts, fourteen county-administrated cities, thirty-eight towns, one hundred and twenty-two villages, and twelve aboriginal mountain villages.[13]

The third-level municipality provides sufficient variation on the vote results to explore the causal effects in the empirical model, which has also been the traditional administrative division since the Kuomingtang retreated to Taiwan. In addition, the third level is the finest level that avoids

[12]The second level refers to the special municipality, city, and county. In 2021, there are twenty-two second-level administrations. There are six special municipalities: Taipei, New Taipei, Taoyuan, Taichung, Tainan, Kaohsiung; three cities, Keelung, Hsinchu, Chiayi, and thirteen other counties.

[13]There are 368 third level municipalities include 164 districts, 6 mountain districts, 14 county administrated cities, 38 towns, 122 villages, 24 mountain villages. $368 = 164+6+14+38+122+24$

the problem of gerrymandering. Even with that CEC database providing further detailed fourth-level electoral results, I am afraid that the consistent realignment in history will hinder the results we would like to explore.

3.4.2 Chinese Visitor Statistics

Secondly, I extract the annual statistics of the incoming visitors worldwide from the Annual Report Survey of Visitors Expenditure and Transportation (ARSVER). This survey was constructed by the Tourism Bureau under the Ministry of Transportation and Communication (MOTC) in Taiwan at the tourist attractions or the airports in Taiwan.[14] This yearly published report includes the ranking of the relative visits of the tourist's interests, as well as the number of tourists coming to Taiwan and what their purposes for the stay are. While this report provides the data on how many tourists stay in different counties or cities annually, there are no more exemplary statistics on the county or city level of tourism, let alone the district levels that I explore. Hence, to estimate the potential tourists' exposure, we used the driving distance and time from the districts to a particular tourist attraction as a proxy of tourist exposure, a convention documented in the tourism literature. In other words, I assume the possible distribution of exposure to tourists follows a uniform distribution. If the district is closer to a particular tourist attraction or the major airport, the residents living in the neighborhoods should have a better chance to interact with the tourists. The assumption hidden from our RD model is that the tourist exposure is proportional to the inverse of the travel distance or time. To represent them mathematically in the following Equation 3.2 and 3.3. For every district i to tourist attraction j,

[14]The official homepage of the Tourism Bureau, Ministry of Transportation and Communication in Taiwan.https://admin.taiwan.net.tw/English/index.aspx

$$\text{Tourist Exposure of District}_i \text{ from Attraction}_j \propto \frac{1}{\text{Driving Distance}_{ij}} \quad (3.2)$$

$$\text{Tourist Exposure of District}_i \text{ from Attraction}_j \propto \frac{1}{\text{Driving Time}_{ij}} \quad (3.3)$$

3.4.3 Geographical Data: Travel Distance and Time

As mentioned in the subsection, we proxy the distance to estimate the exposure of Chinese tourists across the towns in Taiwan. However, by using geographic data, we can create an index that approximates the degree of exposure of tourists in every district.

Hence, we started by extracting the geographic data maintained and published by the National Land Surveying and Mapping Center (NLSC), governed by the Ministry of Interior of Taiwan. First, according to the database that NLSC published, we locate the coordination of every town, airport, and yearly ranked tourist attractions based on the Annual Survey Report on Visitor Expenditure and Trends (ASRVET). We then use the Stata package `geodist` (Picard, 2010) and the mapping services provided by the HERE company[15] to calculate the driving time from each Taiwanese town to the tourist attractions as a proxy of tourist exposure. We use the driving distance and time as the proxy of the tourist exposure is because driving or taking the touring bus is the main transportation for the tourists coming to Taiwan for the first time. There might be a slight difference between the driving distance and the driving times, considering the infrastructure of

[15]The homepage of HERE Technology, `https://www.here.com/`

the West Coast of Taiwan is better than the East Coast of Taiwan.

3.5 Methodology and Identification

3.5.1 Regression Discontinuity Design

Since there is a data limitation in our ability to know the tourists' stay and travel, we proximate the exposure of the tourists by using the driving distance and time to the tourist attractions in Taiwan. The Regression Discontinuity (RD) design is a quasi-experimental impact-evaluation method is used to evaluate programs with a cutoff point to determine who is eligible to participate. RD models allow researchers to compare the sample approximately the differences between the control and the treatment groups (**?**). In other words, the discontinuity around the cutoff point (**?**), which we set by the sample mean in each model. We expect that the treatment effect will not be statistically significant before the shock of trade policies. There are minor differences in the high- and low-Chinese tourist exposure regions. In contrast, after the trade shock, the treatment effects will become more significant.

There are considerable merits for us to run the RD model to tease out the swerve of the political ideology before and after the trade shock (**?**). First, even though we could create an index of the exposure to the Chinese tourists, there is still much cause that might potentially confound the electoral results. For example, the demographic variables of the constituents, such as the average income, educational level, gender composition, and age composition of the citizens who resided in the regions could potentially be factors to affect the electoral outcomes. Although we could add more controls in our traditional parametric regression models, there is always room to argue

another potential variable that might endogenize the electoral outcome.

The appropriate regression discontinuity design could eliminate missing observed variables since, by definition, we focus on the areas around the imaginary cutoff of either driving distance or time. The distance to particular tourist attractions is not supposed to affect political ideologies directly. The only difference between a tourist site's close and away regions is the traveling time. The rest of the missing variables should be very similar for those municipalities.

There are more reasons regarding the external validity of using the RD design. First, the unobserved factors that impact the results of the elections tend to be continuous—for example, the level of education, the income, or the demographic of the constituents. Secondly, the district can not directly manipulate its treatment, whether getting tourists' exposure or not. Third, we need not additionally assume the distributions of the unknown factors.

3.5.2 Identification

To capture the realignment of the political ideology, I use the winning margin of the KMT as the primary outcome variable. As mentioned in Section 3.2.2, since many variables potentially will affect the outcomes of the elections, the Regression Discontinuity design on the proper cutoff of the driving distance and time could solve it. Using the Regression Discontinuity (RD) method, we only focus on the boundaries of the treatment and control group in the sample. Our goal in this paper is to tease out whether the various degrees of tourist exposure impacts the votes before or after the shock coming from China. In other words, I compare the treatment effect of tourists' exposure across the different years of the electoral results. In the model, the confounder X_i is the real tourist exposure in the town i that we

can not observe and accurately estimate. However, according to the tourism literature, we know that tourist dispersion is highly correlated with the distance and travel time to the main tourist attractions. By understanding this mechanism, we can use the driving distances as a proxy of tourist exposure.

Those towns distanced from tourist attractions or the airport as the low-exposed towns are the control group in our model. On the other hand, the high-exposed districts are near tourist attractions or airports. We then calculate the sample average as the cutoff between the high and low exposure regions and estimate the treatment effects in each election. Finally, we run a regression of these treatment effects on the incoming Chinese tourists in previous years to see if the increase in Chinese tourists impacts the treatment effects in the RD models.

The following is the RD model in each election year: a sharp RD design. (**?**, **?**) where the variables: Y_i represents the Pro-China Margin, as our primary outcome variables capturing the ideology realignment. D_i is the treatment, deciding whether the district is high-exposed to tourists. X_i is the assigning variable, the driving time or distance to the airport or tourist attractions. W_i is the unobserved endogenous variable, which could be considered the real tourist numbers, which is assumed to affect the result of election Y_i. c is the cutoff of driving distance or time, which we use as the sample mean.[16]

$$Y_i = D_i\tau + W_i\delta_1 + U_i \tag{3.4}$$

[16]In the first model we run, we pin c = 290 minutes as this is the average time that people spend on the highway traveling from the capital to the south. One day trip from Taipei (north region) to Kaohsiung (south area) is 4 hours and 50 minutes.

$$D_i = 1[X_i \geq c]$$

$$X_i = W_i\delta_2 + V_i$$

Since districts can not precisely control W_i via X_i, the external validity of the RD holds. On the other hand, it is not always the case that the longer travel time from the airport brings fewer tourists; the districts have no complete control to be tourism hot spots or not. Then, to robust our analysis, we calculate the treatment effect based on the different local polynomial functions in the RD model. Here, we consider the first four degrees of the power in the RD model. The RD model with the linear local polynomial function is as following, the τ_1 is the estimated variable that we are interested in.

$$Y_i = \tau_1[X_i > c] + \delta_1(X_i - c) + U_i \tag{RD1}$$

The quadratic one,

$$Y_i = \tau_1[X_i > c] + \delta_1(X_i - c) + \delta_2(X_i - c)^2 + U_i \tag{RD2}$$

The cubic one,

$$Y_i = \tau_1[X_i > c] + \delta_1(X_i - c) + \delta_2(X_i - c)^2 + \delta_3(X_i - c)^3 + U_i \tag{RD3}$$

And with the power of fourth local polynomial function, the RD model becomes

$$Y_i = \tau_1[X_i > c] + \delta_1(X_i - c) + \delta_2(X_i - c)^2 + \delta_3(X_i - c)^3 + \delta_4(X_i - c)^4 + U_i \tag{RD4}$$

And finally, after calculating the treatment effects from the different

elections year, we then test the stationarity of the series of treatment effects and run a time-series regression of those treatment effects on the numbers of the incoming Chinese visitors. Such as,

$$\text{Treatment Effects}_t = \beta_0 + \beta_1 \text{Chinese Tourist}_t + \varepsilon_t \tag{3.5}$$

3.5.3 Alogorithm

To wrap up this section, I conclude this section by listing the algorithm we use in this study.

1. Calculate the distance between the municipalities and the tourists attractions.
2. Calculate the mean of distances, set the municipalities into control and treatment group.
3. Set the mean of the distance as the cutoff to the close and away regions.
4. Run the regression discontinuity using the 2004, 2008, 2012, 2016, 2020 presidential electoral data.
5. Compare the treatment effects across the different elections.
6. Regression of those treatment effects on the importing number of the Chinese tourists.

3.6 Results

The following figures are the series of RD results based on the 2016 presidential elections and use the largest airport in Taiwan, Taipei International airports are the tourist concentration point. As indicated in the

series of graphs, either kind of the local polynomial functions of the RD model shows a significant difference at the cutoff point between the high and low tourist-exposed areas.

3.7 Conclusion

"Distance is the Soul of Beauty" was quoted by Simone Weil. The French scholar, philosopher, and political activist uses her words to describe humans' social interactions and behaviors. This witty quote appreciates the merits of the distance between individuals; one might find it easier to get along with others should they be unfamiliar, whereas familiarity often leads to more friction. It does not feel out of place if we put this quote into the context of global politics and economics in modern history. Countries are prone to have tensions and conflicts with their neighbors. Asian countries are no exception. Besides the prolonged cross-straits tensions between China and Taiwan, the 2020–2021 China–India skirmishes with borders resulted from long-time Sino-Indian disputes on the proclaimed territories. The consistent political tensions on the Korean Peninsula are due to the ideological distinctions between the two political identities.[17] Not to mention another well-known case in the Middle East, Israel continues to have military clashes with her neighbor Arabic states, which has caused the image of instability in its neighboring regions for decades. As noted above, although there are various reasons to cause countries to engage in conflicts and tensions, a shouting distance between counterparts seems to be a common trait shared.[18]

[17] Of course, the potential risks of North Korea using nuclear weapons contribute to the current tension, but it is probably hard to argue that other nations did not play a role in this context.

[18] Visit the website of Peace Insight for more detailed statistics and graphs of the conflicted regions around the world. Peace Insight is powered by Peace Direct, a Non-government

The tangled relationship between China and Taiwan is another case in point. Either physically or psychologically, China and Taiwan are not far apart. The island of Taiwan is geographically separated from China's southeast coast by the short stretch of Taiwan Strait, which ranges from 220 km at its widest point to 130 km at its narrowest. Meanwhile, ethnically, both China and Taiwan shared the primary composition of Han ethnicity and the inheritance of the Chinese culture. Following the previous argument, the political tensions have sustained since the day that two China were built.[19]

The political gridlock resulting from the unending Chinese Civil War and the spillover of Cold War had shut down the communications and commercial cooperation at both ends during the post-war era. Although there has been no physical military engagement across the straits since the end of the Second Taiwan Strait Crisis in 1979, neither side could solve this political gridlock unilaterally. Until now, each side, either side still claims their legitimacy of China's representation in the international community and denies another.

However, although there was never an official tie built by the authorities, the underground capital investments, technological transfer, and stratigical cooperation across the straight were increasing as the wave of globalization began. Since China's post-1978 reform period, Taiwanese entrepreneurs and capital, along with outsourcing by Taiwanese firms, have played an important role in seeding coastal China with manufacturing capabilities. Those early investments in China created global production chains stretching from Taiwan's Hsinchu Technology Park to Chinese factories in southeastern

Organization (NGO) supporting local people in the most challenging conflict environments worldwide.

[19]i.e., the People's Republic of China (P.R.C.) controlled and established in mainland China, and the Republic of China (R.O.C.) relocated and settled in Taiwan.

provinces to the retail electronics stores of North America and Europe (Rosen and Wang, 2011). Being aware of the investment and joint venture across the straits, both governments started to take a new route by appreciating the value of business cooperation and trade specialization. The logic behind this follows the belief that trade gains would ease the political tension and ultimately solve the political problems (Pelzman, 2016). The more economies depend upon each other, the more inseparable their citizens' lives become, plummeting the possibility of getting into military conflict. In short, a gradual economic integration could serve as a stepping stone for more advanced political coalitions.

I interpret my results from two main perspectives. First, from the behavioral and microeconomic perspective, my results challenge the contact hypothesis advocated by sociologists (Allport, 1954; Katz, 1991) and experimental economists (Bertrand and Duflo, 2017). According to my results, more intensive interactions between members of the conflict groups neither alleviate the stereotype nor form a new sense of belongingness. Instead, they reinforce the bias, perhaps due to the visitors' self-selection or existing cultural distinctions. Secondly, from the lens of macroeconomics, my results demonstrate a higher degree of economic integration, such as the policy of opening to never-met visitors, does not necessarily lead to a higher degree of political convergence. On the contrary, the districts with higher exposure to Chinese visitors encountered a more significant ideological realignment after the policy shock. Residents living in the towns in northern Taiwan, surrounded by the main tourist attractions, gradually swung their votes to favor the party distancing themselves from China.

Tables

Date	Phase	Cities Residents Allowed Travel to Taiwan	Count Count	Total Total
2011/6/28	Phase 1	Beijing, Shanghai, Xiamen	3	3
2011/7/29	Mini-Three Links[20]	Xiamen, Fuzhou (Fujian), Putian, Quanzhou, Zhangzhou, Longyan, Sanming, Nanping, Ninde	(9)	(9)
2012/4/28	Phase 2 - Stage 1	Tianjin, Chongqing, Nanjing, Hangzhou, Guangzhou, Chengdu	6	9
2012/8/28	Phase 2 - Stage 2	Jinan, Xian, Fuzhou (Jiangxi), Shenzhen	4	13
2012/8/28	Mini-Three Links[20]	Wenzhou, Quzhou, Lishui, Ganzhou, Fuzhou, Shangrao, Yingtan, Meizhou, Chaozhou, Shantou, Jieyang	(11)	(20)
2013/6/28	Phase 3 - Stage 1	Shenyang, Zhengzhou, Wuhan, Suzhou, Ningbo, Qingdao	6	19
2013/6/28	Phase 3 - Stage 2	Shijiazhuang, Changchun, Hefei, Changsha, Nanning, Kunming, Quanzhou	7	26
2014/7/18	Phase 4	Harbin, Taiyuan, Nanchang, Guiyang, Dalian, Wuxi, Wenzhou, Zhongshan, Yantai, Zhangzhou	10	36
2015/3/18	Phase 5	Haikou, Hohhot, Lanzhou, Yinchuan, Changzhou, Zhoushan, Huizhou, Weihai, Longyan, Guilin, Xuzhou	11	47
2019/7/31	Tourism to Taiwan was Suspended		-	0
2019/9/20	The policy of “Mini-Three Links” reinstated		(20)	(20)

Table 3.1: Timetable of Open Up Tourism to Taiwan for the Residences in Mainland Cities
Source: Mainland Affairs Council, Republic of China (Taiwan). The author organizes the table.

[20]Mini-Three Link: The citizens residing in these cities were allowed to do tourism only in Jingmen, Mazhu, and Penghu, the remote island of Taiwan.

Date	Regulations Governing the Permission for Mainland Personnel to Come to Taiwan for Tourism Activities
2006.8.27	The Taiwan Strait Tourism Association was established.
2008.6.13	Signed the "Agreement on Mainland Residents Traveling to Taiwan on Both Sides of the Taiwan Straits."
2008.7.4	The first cross-strait voyage, the first tour group of mainland tourists arrived in Taiwan.
2008.7.18	Mainland visitors to Taiwan are officially opened for sightseeing, with a daily quota of 3,000 visitors to Taiwan.
2009.7.18	The Taiwan Travel Association and the Association For Tourism Exchange Across The Taiwan Straits (hereinafter referred to as the Two Little Associations) jointly established a regular cross-strait tourism consultation. The two sides jointly held the first cross-strait tourism exchange roundtable in Beijing.
2010.8.14	For the second anniversary of the opening of cross-strait tourism, a cross-strait tourism round table was held at the Ambassador Hotel Hsinchu.
2011.1.1	The daily quota for tourists to Taiwan was increased to 4,000.
2011.6.28	The first batch of mainland tourists who traveled freely came to Taiwan, with a daily quota of 500 people.
2012.4.28	The quota limit for free traveling to Taiwan of the mainlanders was adjusted to 1,000 per day.
2013.4.1	The daily quota for Mainland Chinese Tourism Group was adjusted to 5,000, and the quota for free travel was adjusted to 2,000.
2013.5.1	The Tourism Bureau of the Ministry of Communications implements high-quality tour groups for land passengers and is subject to a daily quota of group guests.
2013.10.1	China implemented a new travel law, strictly regulated shopping itineraries, and banned commissions.
2013.12.1	The daily quota for free travel by Mainland travelers to Taiwan was adjusted to 3,000.
2014.4.16	The daily quota for free travel by Mainland travelers to Taiwan was adjusted to 4,000.
2014.11.28	The "In-depth Tour of Indigenous Tribes" was opened without daily quota restrictions.
2015.5.1	Opened the "Mainland Chinese Tourists High-end Quality Tour" without daily quota restrictions.
2015.9.21	The daily quota for free travel by land travelers to Taiwan was adjusted to 5,000.

Table 3.2: Timetable of Policy Relating to Mainland Chinese Tourists. Resource: Webpage of Tourism Bureau, Ministry of Transportation and Communication. https://admin.taiwan.net.tw/timetable

Figures

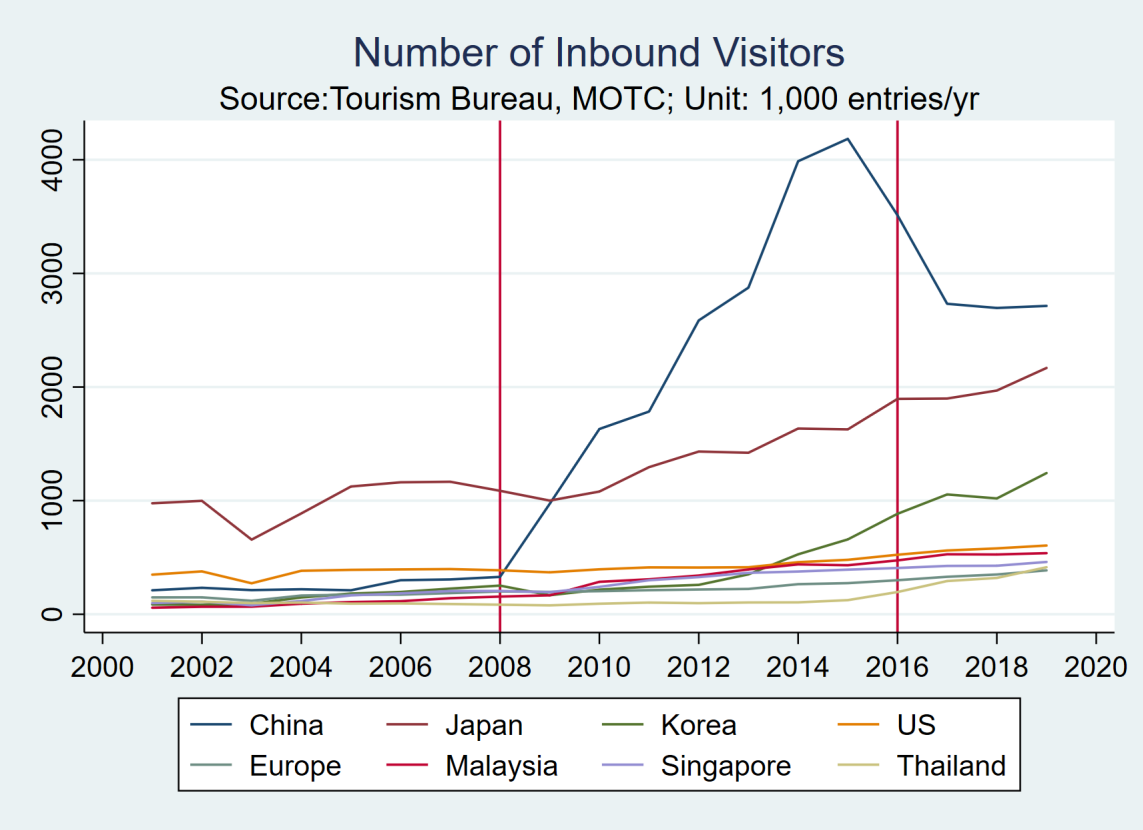


Figure 3.1: Inbound Visitors to Taiwan, 2001-2020

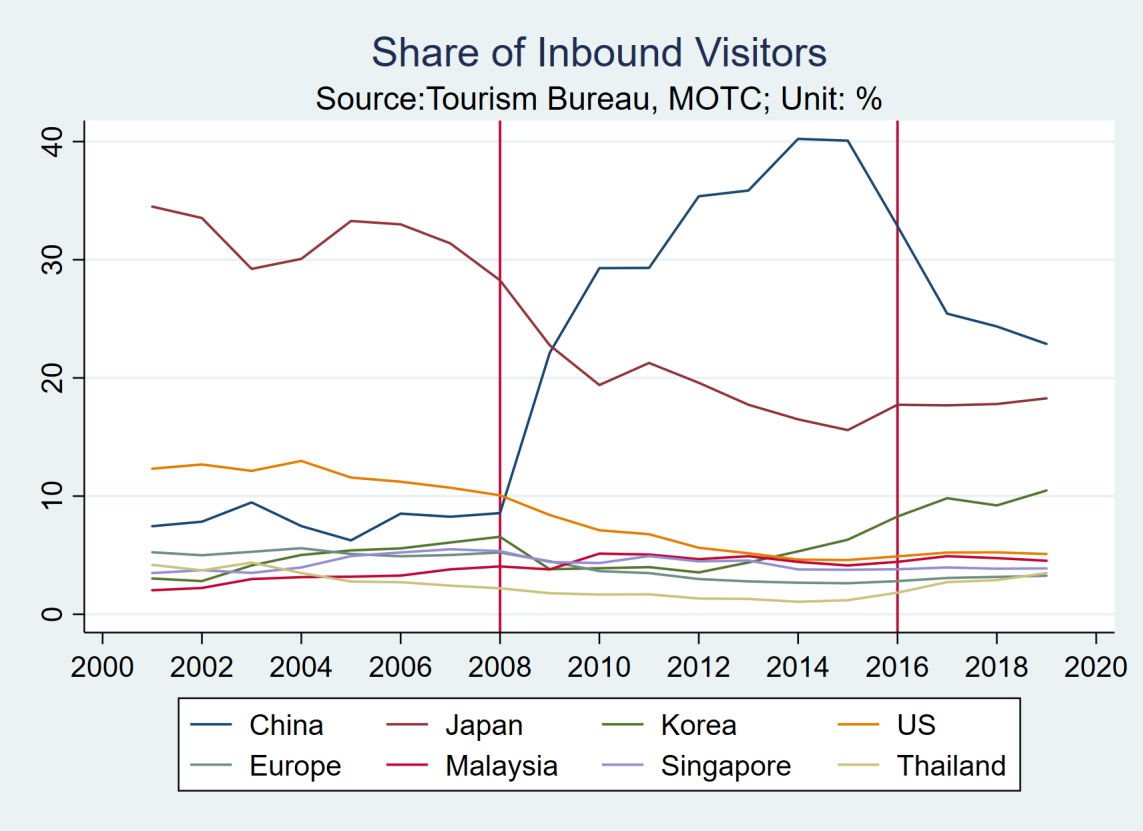


Figure 3.2: Share of Inbound Visitors to Taiwan, 2001-2020

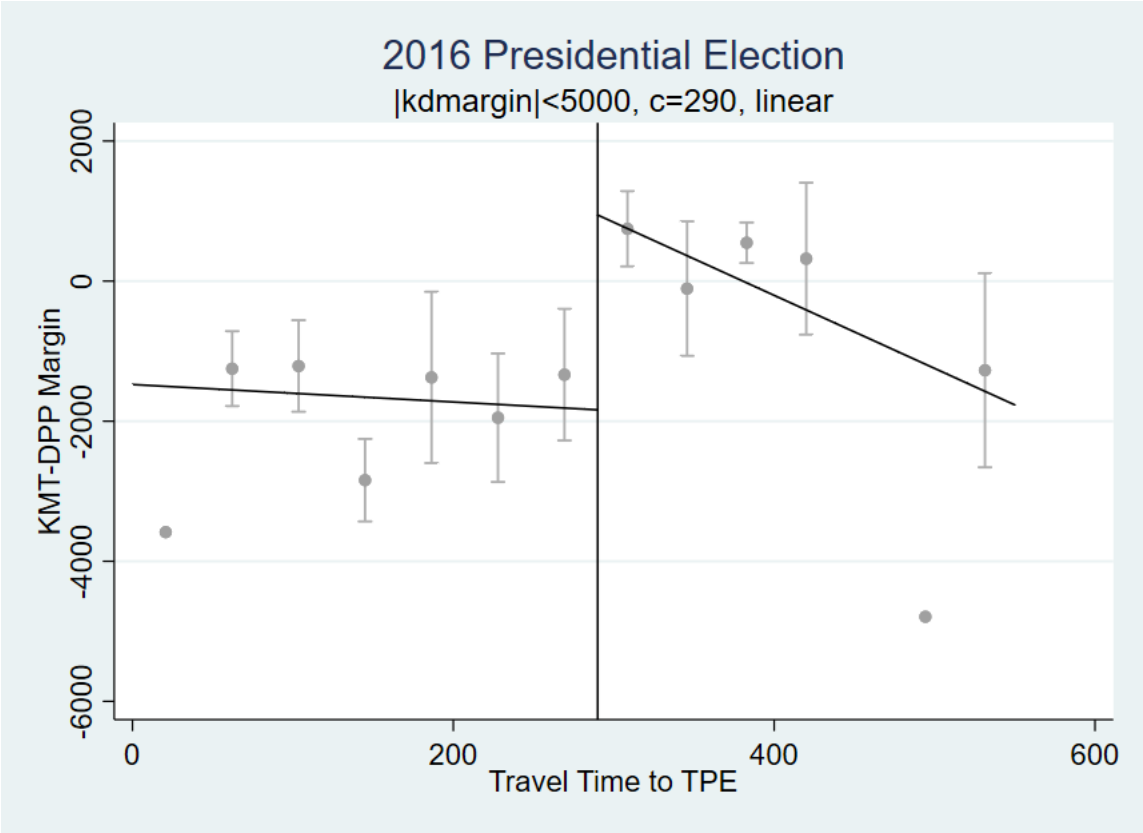


Figure 3.3: 2016 Election, Linear Model, Taipei Airport (t=2016, d=1, j=TPE, c=290)

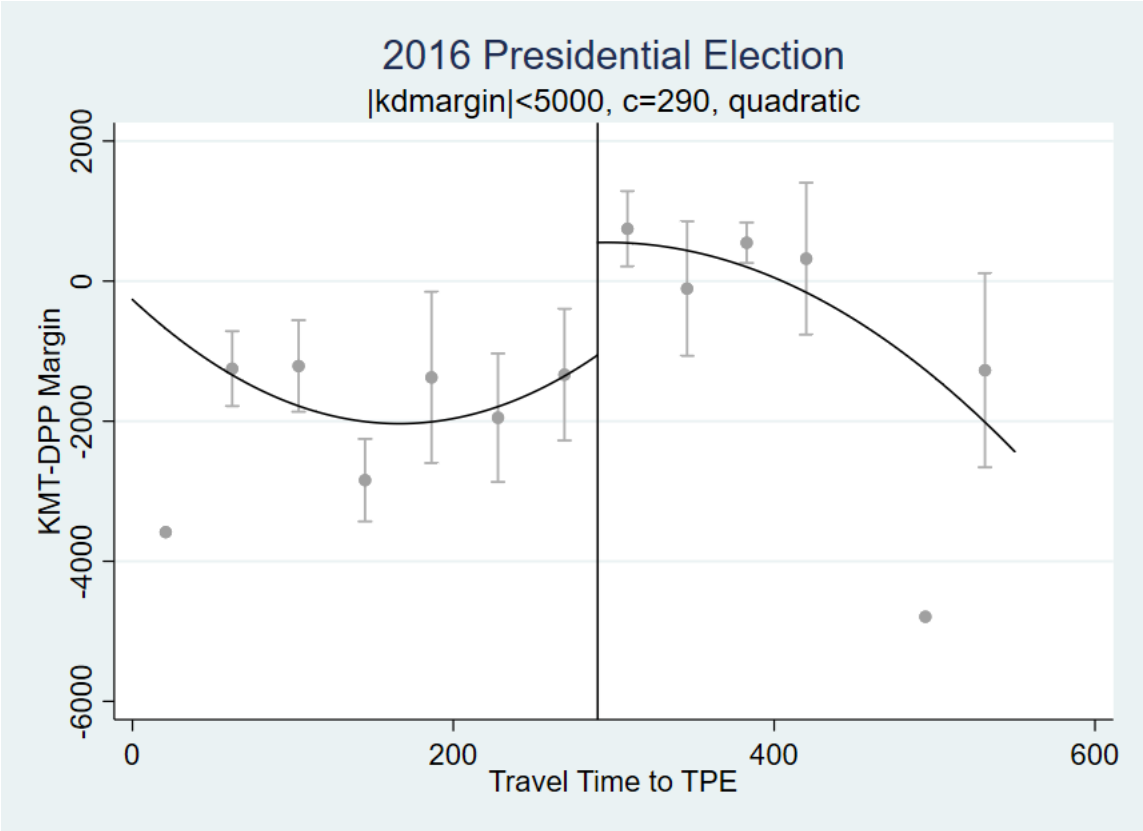


Figure 3.4: 2016 Election, Quadratic Model, Taipei Airport (t=2016, d=2, j=TPE)

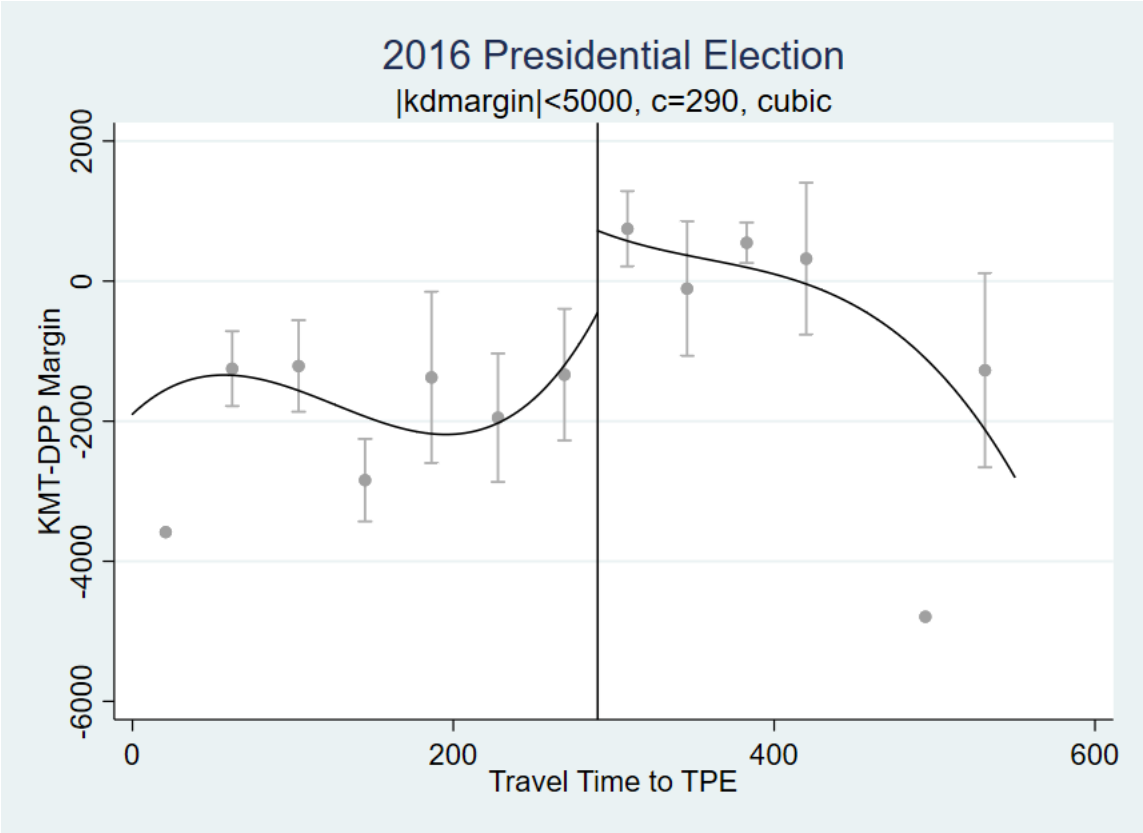


Figure 3.5: 2016 Election, Cubic Model, Taipei Airport (t=2016, d=3, j=TPE)

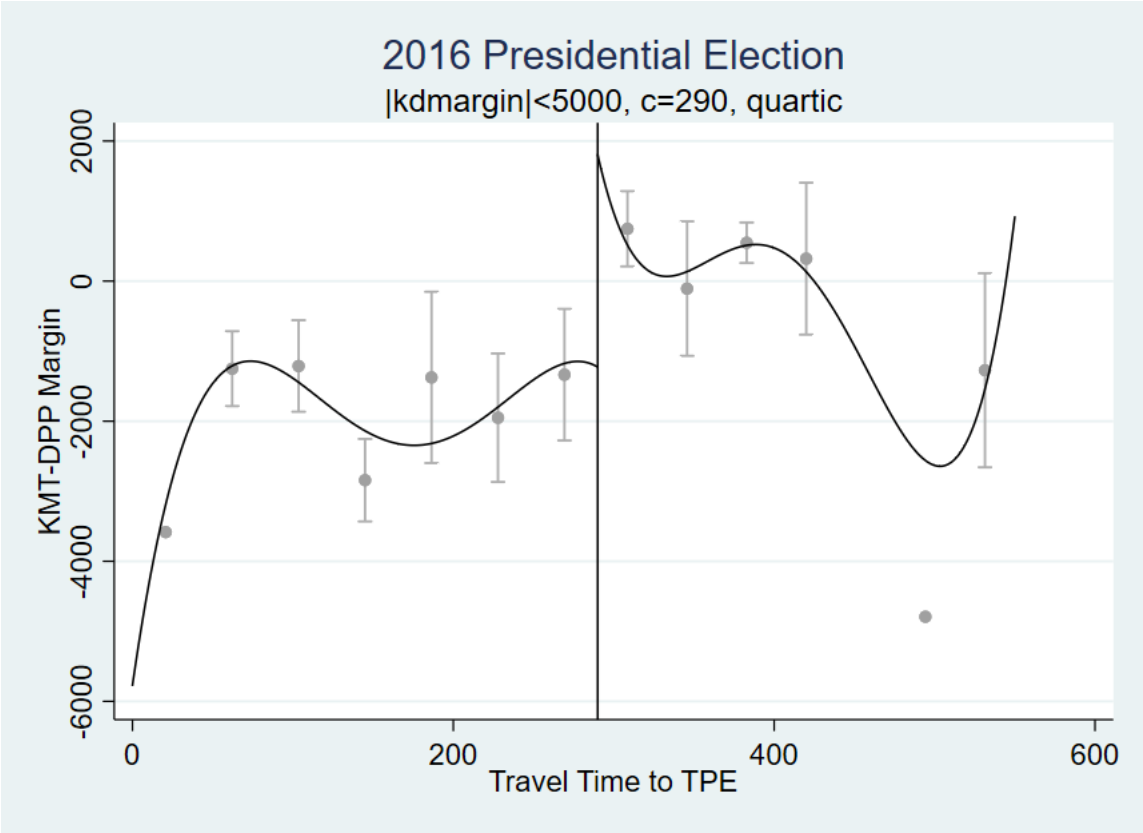


Figure 3.6: 2016 Election, Quartic Model, Taipei Airport (t=2016, d=4, j=TPE)

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Appendix A: Chapter 1

A.1 Code of Sectors in GTAP

Table A.1: Code of Sectors in GTAP

No.	Code	Description
1	pdr	Rice: seed, paddy (not husked)
2	wht	Wheat: seed, other
3	gro	Other Grains: maize (corn), sorghum, barley, rye, oats, millets, other cereals
4	v_f	Veg & Fruit: vegetables, fruit and nuts, edible roots and tubers, pulses
5	osd	Oil Seeds: oil seeds and oleaginous fruit
6	c_b	Cane & Beet: sugar crops
7	pfb	Fibres crops
8	ocr	Other Crops: stimulant; spice and aromatic crops; forage products; plants and parts of plants used primarily in perfumery, pharmacy, or for insecticidal, fungicidal or similar purposes; beet seeds (excluding sugar beet seeds) and seeds of forage plants; natural rubber in primary forms or in plates, sheets or strip, living plants; cut flowers and flower buds; flower seeds, unmanufactured tobacco; other raw vegetable materials nec
9	ctl	Cattle: bovine animals, live, other ruminants, horses and other equines, bovine semen

10	oap	Other Animal Products: swine; poultry; other live animals; eggs of hens or other birds in shell, fresh; reproductive materials of animals; natural honey; snails, fresh, chilled, frozen, dried, salted or in brine, except sea snails; edible products of animal origin n.e.c.; hides, skins and furskins, raw; insect waxes and spermaceti, whether or not refined or coloured
11	rmk	Raw milk
12	wol	Wool: wool, silk, and other raw animal materials used in textile
13	frs	Forestry: forestry, logging and related service activities
14	fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
15	coa	Coal: mining and agglomeration of hard coal, lignite and peat
16	oil	Oil: extraction of crude petroleum, service activities incidental to oil and gas extraction excluding surveying (part)
17	gas	Gas: extraction of natural gas, service activities incidental to oil and gas extraction excluding surveying (part)
18	oxt	Other Mining Extraction (formerly omn): mining of metal ores; other mining and quarrying

19	cmt	Cattle Meat: fresh or chilled; meat of buffalo, fresh or chilled; meat of sheep, fresh or chilled; meat of goat, fresh or chilled; meat of camels and camelids, fresh or chilled; meat of horses and other equines, fresh or chilled; other meat of mammals, fresh or chilled; meat of mammals, frozen; edible offal of mammals, fresh, chilled or frozen
20	omt	Other Meat: meat of pigs, fresh or chilled; meat of rabbits and hares, fresh or chilled; meat of poultry, fresh or chilled; meat of poultry, frozen; edible offal of poultry, fresh, chilled or frozen; other meat and edible offal, fresh, chilled or frozen; preserves and preparations of meat, meat offal or blood; flours, meals and pellets of meat or meat offal, inedible; greaves
21	vol	Vegetable Oils: margarine and similar preparations; cotton linters; oil-cake and other residues resulting from the extraction of vegetable fats or oils; flours and meals of oil seeds or oleaginous fruits, except those of mustard; vegetable waxes, except triglycerides; degras; residues resulting from the treatment of fatty substances or animal or vegetable waxes; animal fats
22	mil	Milk: dairy products
23	pcr	Processed Rice: semi- or wholly milled, or husked
24	sgr	Sugar and molasses

25	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrates; prepared and preserved vegetables, pulses and potatoes; prepared and preserved fruits and nuts; wheat and meslin flour; other cereal flours; groats, meal and pellets of wheat and other cereals; other cereal grain products (including corn flakes); other vegetable flours and meals; mixes and doughs for the preparation of bakers' wares; starches and starch products; sugars and sugar syrups n.e.c.; preparations used in animal feeding; lucerne (alfalfa) meal and pellets; bakery products; cocoa, chocolate and sugar confectionery; macaroni, noodles, couscous and similar farinaceous products; food products n.e.c.
26	b_t	Beverages and Tobacco products
27	tex	Manufacture of textiles
28	wap	Manufacture of wearing apparel
29	lea	Manufacture of leather and related products
30	lum	Lumber: manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
31	ppp	Paper & Paper Products: includes printing and reproduction of recorded media
32	p_c	Petroleum & Coke: manufacture of coke and refined petroleum products
33	chm	Manufacture of chemicals and chemical products

34	bph	Manufacture of pharmaceuticals, medicinal chemical and botanical products
35	rpp	Manufacture of rubber and plastics products
36	nmm	Manufacture of other non-metallic mineral products
37	i_s	Iron & Steel: basic production and casting
38	nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
39	fmp	Manufacture of fabricated metal products, except machinery and equipment
40	ele	Manufacture of computer, electronic and optical products
41	eeq	Manufacture of electrical equipment
42	ome	Manufacture of machinery and equipment n.e.c.
43	mvh	Manufacture of motor vehicles, trailers and semi-trailers
44	otn	Manufacture of other transport equipment
45	omf	Other Manufacturing: includes furniture
46	ely	Electricity; steam and air conditioning supply
47	gdt	Gas manufacture, distribution
48	wtr	Water supply; sewerage, waste management and remediation activities
49	cns	Construction: building houses factories offices and roads
50	trd	Wholesale and retail trade; repair of motor vehicles and motorcycles
51	afs	Accommodation, Food and service activities
52	otp	Land transport and transport via pipelines
53	wtp	Water transport
54	atp	Air transport

55	whs	Warehousing and support activities
56	cmn	Information and communication
57	ofi	Other Financial Intermediation: includes auxiliary activities but not insurance and pension funding
58	ins	Insurance (formerly isr): includes pension funding, except compulsory social security
59	rsa	Real estate activities
60	obs	Other Business Services nec
61	ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activities; private households with employed persons (servants)
62	osg	Other Services (Government): public administration and defense; compulsory social security, activities of membership organizations n.e.c., extra-territorial organizations and bodies
63	edu	Education
64	hht	Human health and social work
65	dwe	Dwellings: ownership of dwellings (imputed rents of houses occupied by owners)

A.2 Code of Regions in GTAP

Table A.2: Detailed Country Code in GTAP

Number	Code	Description
1	AUS	Australia
2	NZL	New Zealand
3	XOC	Rest of Oceania
4	CHN	China
5	HKG	Hong Kong, Special Administrative Region of China
6	JPN	Japan
7	KOR	Korea, Republic of
8	MNG	Mongolia
9	TWN	Taiwan
10	XEA	Rest of East Asia
11	BRN	Brunei Darussalam
12	KHM	Cambodia
13	IDN	Indonesia
14	LAO	Lao PDR
15	MYS	Malaysia
16	PHL	Philippines
17	SGP	Singapore
18	THA	Thailand
19	VNM	Viet Nam
20	XSE	Rest of Southeast Asia
21	BGD	Bangladesh

22	IND	India
23	NPL	Nepal
24	PAK	Pakistan
25	LKA	Sri Lanka
26	XSA	Rest of South Asia
27	CAN	Canada
28	USA	United States of America
29	MEX	Mexico
30	XNA	Rest of North America
31	ARG	Argentina
32	BOL	Bolivia
33	BRA	Brazil
34	CHL	Chile
35	COL	Colombia
36	ECU	Ecuador
37	PRY	Paraguay
38	PER	Peru
39	URY	Uruguay
40	VEN	Venezuela (Bolivarian Republic of)
41	XSM	Rest of South America
42	CRI	Costa Rica
43	GTM	Guatemala
44	HND	Honduras
45	NIC	Nicaragua
46	PAN	Panama
47	SLV	El Salvador

48	XCA	Rest of Central America
49	DOM	Dominican Republic
50	JAM	Jamaica
51	PRI	Puerto Rico
52	TTO	Trinidad and Tobago
53	XCB	Rest of Caribbean
54	AUT	Austria
55	BEL	Belgium
56	BGR	Bulgaria
57	HRV	Croatia
58	CYP	Cyprus
59	CZE	Czech Republic
60	DNK	Denmark
61	EST	Estonia
62	FIN	Finland
63	FRA	France
64	DEU	Germany
65	GRC	Greece
66	HUN	Hungary
67	IRL	Ireland
68	ITA	Italy
69	LVA	Latvia
70	LTU	Lithuania
71	LUX	Luxembourg
72	MLT	Malta
73	NLD	Netherlands

74	POL	Poland
75	PRT	Portugal
76	ROU	Romania
77	SVK	Slovakia
78	SVN	Slovenia
79	ESP	Spain
80	SWE	Sweden
81	GBR	United Kingdom
82	CHE	Switzerland
83	NOR	Norway
84	XEF	Rest of European Free Trade Association
85	ALB	Albania
86	BLR	Belarus
87	RUS	Russian Federation
88	UKR	Ukraine
89	XEE	Rest of Eastern Europe
90	XER	Rest of Europe
91	KAZ	Kazakhstan
92	KGZ	Kyrgyzstan
93	TJK	Tajikistan
94	XSU	Rest of Former Soviet Union
95	ARM	Armenia
96	AZE	Azerbaijan
97	GEO	Georgia
98	BHR	Bahrain
99	IRN	Iran, Islamic Republic of

100	ISR	Israel
101	JOR	Jordan
102	KWT	Kuwait
103	OMN	Oman
104	QAT	Qatar
105	SAU	Saudi Arabia
106	TUR	T<9f>rkiye
107	ARE	United Arab Emirates
108	XWS	Rest of Western Asia
109	EGY	Egypt
110	MAR	Morocco
111	TUN	Tunisia
112	XNF	Rest of North Africa
113	BEN	Benin
114	BFA	Burkina Faso
115	CMR	Cameroon
116	CIV	C<99>te d'Ivoire
117	GHA	Ghana
118	GIN	Guinea
119	NGA	Nigeria
120	SEN	Senegal
121	TGO	Togo
122	XWF	Rest of Western Africa
123	XCF	Rest of Central Africa
124	XAC	South Central Africa
125	ETH	Ethiopia

126	KEN	Kenya
127	MDG	Madagascar
128	MWI	Malawi
129	MUS	Mauritius
130	MOZ	Mozambique
131	RWA	Rwanda
132	TZA	Tanzania, United Republic of
133	UGA	Uganda
134	ZMB	Zambia
135	ZWE	Zimbabwe
136	XEC	Rest of Eastern Africa
137	BWA	Botswana
138	NAM	Namibia
139	ZAF	South Africa
140	XSC	Rest of South African Customs Union
141	XTW	Rest of the World