

Pacification Cost: Estimate Trade Bloc's Price of De-escalating Tension*

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Abstract

How much should a trade bloc be compensated for due to its role in the de-escalation of tensions? This paper examines the economic impacts that Taiwan joining the Regional Comprehensive Economic Partnership (RCEP) would have on the RCEP trade bloc, the United States, and China. Assuming Taiwan's exclusion is due to political reasons, we use the Computational General Equilibrium (CGE) model and Global Trade Analysis Project (GTAP) database to simulate the economic shock of Taiwan joining the RCEP. First, we identify and aggregate Taiwan's major trading partners, including China, the United States, and the RCEP countries. Then, we use the auxiliary program RunGTAP to simulate policy shocks that affect import tariffs. By analyzing the counterfactual economic impact of trade liberalization, we estimate the potential loss of the RCEP and the economic rationale for Taiwan's exclusion. The conclusion we arrive at shows the opportunity cost of the trade bloc's political compromise and could be generalized to other conflicted regions around the world.

Keywords: Economic Integration, Trade Forecasting and Simulation

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Latest version: <https://jeffjkuo.github.io/CGE1>

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1 Introduction

Engaging in a preferential trade agreement (PTA) has always been a challenge for governments. This is because governments must balance the effects of trade creation on economic welfare and the potential redistribution of trade diversion (Lipsey, 1957). However, PTAs have broader impacts than simply affecting a country's economy and that of the trade block. PTAs can also change the diplomatic dynamics between countries. Vice versa, the decision to allow a country to join a trade block or PTA does not solely depend on economic incentives. Instead, it depends more on the diplomatic relationship and the political climate. But do political concessions have a price? Or how much does it cost for a trade block to exclude a influential trade counterpart from joining the block? These are the main questions this paper seeks to answer.

Economic integration is influenced by political tensions among the countries involved. Literature has highlighted that it is challenging for governments to sign trade agreements when they are experiencing escalating tensions (Acemoglu and Yared, 2010; Martin et al., 2008). However, there is scant literature on the estimation of the potential welfare losses of expulsion for tensions between states of this type. The case between Taiwan, China, and Southeast Asian countries is a suitable example. We believe we can at least get a ballpark idea of how much the political tensions are worth using the well-developed Computational General Equilibrium (CGE) model by running the counterfactual policy experiment. Rather than analyzing an already-implemented policy, we present simulations of experimental trade shock policies for Taiwan's joining the Regional Comprehensive Economic Partnership (RCEP).¹

Why is Taiwan, China, and the RCEP an interesting case? From an economic perspective, both Taiwan and the RCEP countries know and have an incentive to cooperate. Taiwan is the third largest trading partner for Southeast Asian countries after China and the U.S., and its capital-intensive technological export industries would be a complement to the relatively labor-intensive manufacturing sectors in

¹Regional Cooperation Economic Partnership (RCEP), a multinational trade agreement chartered by The Association of Southeast Asian Nations (ASEAN) and the five new members of the developed countries, including Australia, China, Japan, South Korea, and New Zealand. For more institutional details of RCEP, please refer to the official website of RCEP, <https://rcepsec.org/>

the RCEP countries. On the other hand, the current Taiwanese administration has advocated “New Southbound Policy (NSP)” since taking office in 2016’s general election. The fact that Taiwan is not currently part of the RCEP is obviously not optimal for economic equilibrium. But what are the causes?

There has been a wave of economic integration via signing PTAs among Asian countries since the formation of the Association of Southeast Asian Nations (ASEAN) (Baysan et al., 2006; Hashmi and Lee, 2008). Southeast Asia’s economic integration is ardent due to its geographical proximity and interwoven history. It is not uncommon to see emerging markets rely heavily on trade with the world (Reyes-Heroles et al., 2020). On the other hand, China, with approximately 1.4 billion population, naturally becomes the most significant market that other countries want to approach. However, after three decades since the beginning of trade liberalization, China has maintained its unique authoritarian political regime, and there is still no truce between the “People’s Republic of China (PRC)” and “Taiwan (Republic of China, ROC)”. Since ideological transformation is not occurring as the Chinese economy grows, the rest of the world begins to evaluate political concessions while sharing the market with China. Foreign firms and governments face economic coercion in China as a result of clashes between the Chinese government and foreign companies. Taiwan had a unique dilemma when choosing between the economic market or jeopardizing its sovereignty in this regard.

We are interested in Taiwan’s role in economic integration during the escalating U.S.-China tensions. Applying the Computable General Equilibrium (CGE) model and the GTAP database, we estimate the impact of Taiwan joining RCEP. The motivations are as follows. First, the administration in Taiwan has advocated the New Southbound Policy (NSP) since 2016, as the primary goal of NSP aims to reduce Taiwan’s economic reliability to China.² To achieve this goal of having more trade exposure to Southeast Asian countries, joining RCEP seems feasible. Secondly, the Taiwan issue has been at the core of the political conflicts between the U.S. and China since the Cold War. The tension between the U.S. and China continues to grow as China has become the most

²To reduce the economic reliability of China, the incumbent Tsai Ing-Wen administration pushed a “New Southbound Policy” as she was elected as Taiwanese President in the general election of 2016. We detail the NSP in Section 2.1.

significant global economic unit. It is unclear whether Taiwan's exclusion from the RCEP was due to politics, economics, or both. Lastly, we are interested in estimating how much the RCEP's political compromise costs. Since Taiwan's exporting industry also plays a vital role in the global value chain, the results of this study have the potential to be a useful benchmark for other high-tension or conflict regions in the world.

Taiwan has been critical of East Asian geopolitics and the US-China competition. Since Taiwan locates on the southeast coast of China, it has unreplaceable geographical and military interests for the U.S.-led democratic alliance to scout the power of growing China. Hence, Taiwan has been the hot spot for geopolitics and the front end of potential conflicts since the Cold War era ([Gray, 2011](#); [Hsieh, 2011](#)). Economically, firms headquartered in Taiwan have made their names in the wave of globalization by exporting consumer electronic goods and computer chips to the rest of the world since the 80s ([Brown and Linden, 2011](#); [Cheng, 2022](#); [Gereffi, 2019](#); [Kaynak and Kuan, 1993](#)). The advanced semiconductor industry in Taiwan has recently also shown its vital role in worldwide consumer electronics and the computer market ([Chen and Leong, 2022](#)). The impacts of the Taiwanese trade policies, especially dealing with China and the U.S., do not merely affect the welfare of the individuals and multinational firms in the Indo-Pacific region. The dynamics of the US-China-Taiwan relationship, the so-called precarious triangle, intertwined with the world instead ([Weidenbaum, 2000](#)).³

Due to the inherent complexity of the linkage between the domestic production sectors and foreign markets, it is not easy to estimate the impact of trade agreements objectively by using the empirical analysis under the partial equilibrium structure ([Plummer et al., 2011](#)). Not to mention if this supposedly economic-oriented decision is upgraded to the political level. Would it be better for the U.S. if Taiwan joined the RCEP and U.S. did not? Would China benefit or lose if Taiwan joined the RCEP? If Taiwan discontinues the FTA with China and enters the RCEP, would China encounter a benefit or loss in the welfare change? In this paper, we hope to use the CGE model

³We detail the U.S.-China-Taiwan relationship, the so-called Precarious Triangle in Section [2.3](#).

to provide a relatively objective and economic view to show the effects on China and the U.S. should Taiwan join the RCEP.

RCEP magnifies the imperativeness of Taiwan, as the Taiwan issue has once again become the primary platform for the U.S.-China political and economic competition. Hence, documenting the economic impacts of Taiwanese participation in the Regional Trade Agreement motivates this research. We focus on simulation of the results and analyzing the counterfactual policy impacts on China and the U.S. if Taiwan chooses to participate in RCEP, from which Taiwan is currently excluded. According to our results, the exclusion of Taiwan in the RCEP is not purely political; instead, there is an economic rationale behind it. We categorize the countries into five groups, i.e., China, the U.S., Taiwan, RCEP, and the Rest of the World, under the standard CGE model in the GTAP, which includes 56 sectors and 121 countries. Also, we utilize the latest version, version 10, of the GTAP database, setting 2014 as the reference year. Then, we simulate the experimental policy shock using the RunGTAP program to simulate the trade shocks and analyze welfare change and the economic impacts on the U.S. and China.⁴

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.⁵ CPTPP, the once-U.S.-led regional trade agreement, was formerly known as the Trans-Pacific Partnership Agreement (TPP).⁶ The potential impact on the world of Taiwan's decision

⁴GTAP is formulated and solved using GEMPACK, a flexible system for solving Applied General Equilibrium (AGE) models. RunGTAP is a visual interface to various GEMPACK programs. RunGTAP allows the user to run simulations interactively in a Windows environment using the GTAP general equilibrium model.

⁵The CPTPP is a free trade agreement (FTA) between Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, Peru, New Zealand, Singapore, and Vietnam. The 11 countries signed the CPTPP on 8 March 2018 in Santiago, Chile. This agreement is a separate treaty that incorporates, by reference, the provisions of the TPP, a precedent treaty that was signed but not yet in force, except for a limited set of suspended conditions. The 11 countries have a shared vision of the CPTPP as a platform open to others to join if they can meet its high standards. In section 2.2, we detail the institutional background and the development of the RCEP and TPP.

⁶U.S. President Obama announced in November 2009 the plan of the Trans-Pacific Partnership. The United States intends to participate in the Trans-Pacific Partnership (TPP) negotiations to conclude an ambitious, next-generation Asia-Pacific trade agreement that reflects U.S. economic priorities and values. Through this agreement, the Obama Administration seeks to boost U.S. economic growth and support the creation and retention of high-quality American jobs by increasing exports in a region that includes some of the world's most robust economies and represents nearly 40 percent of global GDP. Please refers to the official website of TPP for more details, <https://ustr.gov/tpp/overview-of-the-TPP>

to join either trade agreement is enormous. However, only limited literature discusses the implications or analyzes counterfactuals. There is not much literature targeting Taiwan's impact using the CGE model, and none of them targeted the potential outcome in the U.S. and China. We focus on the effect on the U.S. and China should Taiwan join RCEP in this paper and leave the discussion of the CPTPP to the next project.

This paper is organized as follows. The following section reviews three critical institutional terms mentioned: the New Southbound Policy (NSP), the RCEP, and the Precarious Triangle. We document them and review the related literature. Subsection 2.2 will introduce the origin and the development of the RCEP. Then, Subsection 2.3 discusses a brief history of Taiwan's role in China-U.S. competition as we discuss the string of literature focusing on the so-called "Precarious Triangle," the U.S.-China-Taiwan relationship. Section 3.1 discusses the development background and the related literature on the CGE model and GTAP. Section 5 documents how the GTAP network updates the Input-Output Table from the countries worldwide. Using Taiwanese trade data as an example of how the GTAP database was constructed, we review the literature on how Taiwanese trade data was collected in GTAP. Section 4 discusses aggregation methods in the GTAP database and then introduces the experimental shock we apply in the RunGTAP model. We organize the experimental results in Section 6. Finally, in the last section, Section 7, we identify the results from graphs, conclude our findings, and discuss the possible extension and policy implications to wrap up the paper.

2 Policy Background

In Section 2, we review the details of three critical terminologies centering on this paper. Our goal is to provide a comprehensive overview of Taiwan's concurrent significant foreign policies and how they could potentially affect the political-economic equilibrium between the U.S. and China. The following Subsection 2.1 introduces New Southbound Policy (NSP). Then, in Subsection 2.2, we review the institutional

background of RCEP. Finally, Subsection 2.3 describes the Precarious Triangle, a term created in the 2000s to describe the relationship between the United States, China, and Taiwan.

2.1 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 in the South of Taiwan, starting with her first term as Taiwanese President. The targeted nations are ten ASEAN countries and six states in South Asia, Australia, and New Zealand.⁷ This policy was introduced after Tsai led the Pro-Taiwanese-Independence Party, the Democratic Progressive Party (DPP), to victory in the presidential election in 2016. The NSP not only targets the economic and trade perspective but is also designed to increase the impacts of Taiwan's influence in Asia and enhance Taiwan's regional integration (Glaser et al., 2018). According to the official announcement of the NSP, the purpose of the NSP seeks to leverage Taiwan's cultural, educational, agricultural, and economic assets while maintaining a stable cross-Strait relationship with China.

Interestingly, NSP is not the first policy in Taiwanese history to explore opportunities with the Southeastern Asian countries. It follows similarly named guidelines in the 1990s, Southbound Policy, which operated under the previous administration between 1996-2008. The goal of the Southbound Policy was clear: counterstrike the wave of investment and trade in China during the late 90s and early 2000s. Under the Lee Tung-Hui region, just like the NSP, the Southbound Policy aimed to diversify Taiwan's economic reliability to Mainland China and divert them towards the South East 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

⁷The 19th ASEAN Summit, under the Chairmanship's theme of "ASEAN Community in a Global Community of Nations," held in Bali on 17 November 2011, was chaired by the President of the Republic of Indonesia, Dr. Susilo Bambang Yudhoyono, as the Chair of ASEAN in 2011.

Trade Organization in 2001, the old Southbound policies did not achieve much. China has been the trade counterpart that Taiwan mainly relied on since then.

As Tsai indicates in her inaugural speech, the NSP's goal is to reinvigorate and diversify Taiwan's economy to the booming Southeast and South Asian markets. The 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 to set up a "southbound center" financing platform for Taiwanese businesses in need of capital injections. On the other hand, the government encourages multinational companies with a strong tie with Taiwan, including those headquartered in Mainland China, to relocate to Southeast or South Asia to take advantage of lower operating costs.

This paper aims to estimate the results if Taiwan joins RCEP. As of now, Taiwan is working closely with the Southeastern countries, and we want to know the economic impact on Taiwan's foremost trade counterparts if Taiwan is invited to join RCEP at any chance. Since this is a complete counterfactual policy analysis, we rely on the comprehensive model, GTAP, to run our policy experiments. We start to set the trade shock by reducing the tariffs uniformly on the importing goods from RCEP countries to Taiwan, and in this experiment, we do the same policy shock in the reverse direction too. Section [3.1](#) introduces the GTAP system and its economic model. We also review the development of the GTAP and the setting in this project for both model and data. Then, after configuring the environment in the GTAP model and database, we can calculate the potential welfare change and economic shocks toward China, the US, Taiwan, and the whole RCEP, if Taiwan becomes a member.

2.2 Regional Comprehensive Economic Partnership (RCEP)

RCEP was initially built on the Association of Southeastern Asian Nations (ASEAN) proposal to add more Asian states. It was known as "ASEAN + 3" with the invitation of China, Japan, and South Korea, and "ASEAN + 5" counting Australia and New Zealand. As a regular preferential trade agreement, RCEP is an economic contract to govern the policy tools of the international trades among their member states. They are cutting

trade barriers, such as tariffs, subsidies, and technical trade barriers. As indicated in its bylaws, the goal of RCEP is to boost the trade flows among the member states so that the firms and the residents can take advantage of the less costly and more diversified goods ([Shimizu, 2021](#)).

In November 2011, at the 19th Association of Southeast Asian Nations (ASEAN) Annual Meeting held in Bali, Indonesia, the idea of Regional Comprehensive Economic Partnership (RCEP) was first introduced.⁸ The 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.

The RCEP is a proposed preferential and regional trade agreement between the member states of the ASEAN and their free trade agreement (FTA) partners. Include Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Vietnam, China, Japan, India, South Korea, Australia, and New Zealand. Altogether, the sixteen countries negotiating the RCEP account for a third of the world's GDP and almost half the world's population, with the combined GDPs of China and India alone making up more than half of that.

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

RCEP is not the only sizeable regional integration project in Asia-Pacific. The US-led Trans-Pacific Partnership Agreement (TPP) was also brewing in progress in the 2010s, proposed by Barack Obama's administration. According to the announcement of the White House at that time, TPP is a trade agreement targeting eleven other Asian-Pacific countries, including Canada and Mexico, to eliminate over 18,000 taxes that

⁸The 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.

those countries put on U.S.-made products. However, the TPP does not include the most significant trade partner of the U.S., China, due to political reasons. Hence, it is well-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 up its trading blocks.

However, U.S. President Donald Trump discontinued the Obama administration's policy and withdrew from the TPP on January 30, 2017.⁹ The remaining countries in the original TPP negotiated a new trade agreement called Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), which incorporated most of the provisions of the TPP and entered into force on December 30, 2018. The progress and the future of CPTPP were not clear since then.

2.3 Precarious Triangle

Dittmer (1981) is the first study using the term “strategic triangle” in the literature. Instead of describing the U.S.-China-Taiwan relationship, the author applies it to the U.S.-China-U.S.S.R. relationship. This paper also provides the game-theoretic perspective of the political competitions between three countries. The concept of a “strategic triangle” is helpful in an analysis of the internal logic of the relationship between the United States, the Soviet Union, and China. The preconditions for a triangular relationship are that each player recognizes the strategic salience of the three principles. The relationship between any two will be affected by each player's connection to the third. Dittmer (1981) defines three distinct pattern dynamics in the triangle: the menage a trois, consisting of mutually positive relationships among all three; the stable marriage, consisting of a bilateral relationship excluding the third. And the romantic triangle consists of one pivot player playing off two suitors. Each of these pattern dynamics has specific rules of rational play. The shift from one pattern dynamic to another is a function of the players' attempts to freeze a given configuration through a commitment to a treaty or a common ideology. In this paper,

⁹The letter indicating the United States officially withdraws from the Trans-Pacific Partnership Agreement. [Link to the Official Letter of U.S. Trade Representative](#)

we argue the “strategic triangle” could also be applied to the situation between Taiwan, China, and the U.S when it comes to regional integration.

The US-China-Taiwan relationship is inherently complex ([Zagoria, 2011](#)); hence, it was named Precarious Triangle ([Weidenbaum, 2000](#)). Since World War II, Taiwan has been a regional security hot spot due to its unique location and historical inheritance between powerful countries such as the U.S. and China. Jue ([2016](#)) summarizes the diplomatic history and U.S.’s China strategy after the end of the Chinese Civil War. The authors used his experiences as a U.S. foreign delegate to Taiwan starting from Mao Zedong’s era and Zhou Enlai’s “One China” policy proposal.

In the post-war era, the U.S. had treated the island as an ally against Chinese communism at the frontline, and it was the U.S. ([Hsieh, 2020](#)). Navy fleets that secured the infant times of the R.O.C. were established in Taiwan. However, this bilateral relationship was not all smooth. The Chiang family and Kuomintang-led authoritarian regimes once distanced the island from the U.S. The U.S. leaned on China since a solid ally to balance the Soviet Union was eagerly needed in the far east during the Cold War ([Baldwin et al., 1995](#)).

On the flip side, the China-Taiwan relationship also has a long and complex history. In short, until today, China has deemed Taiwan a renegade province since the Chinese Civil War broke out, even though Taiwan has the essential components of being a sovereign country and gradually transformed into a mature democracy since the 90s.¹⁰

Through the lens of international trade, both U.S. and China play crucial roles 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 mainland China, increasing from around 91.8 billion U.S. dollars in the previous year.

¹⁰For 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 back by its central bank.

3 Methodology

We use the CGE Model as the primary methodology to conduct the policy experiment and calculate the shock of the economic impact. Both database and the standard CGE model under the Global Trade Analysis Project (GTAP) played a critical role in this paper. Hence, in Section 3.1, we review the literature relating to the GTAP and the CGE model ecosystem. We conclude this section by providing an overview graph of the GTAP system. In Section 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.

3.1 Global Trade Analysis Project (GTAP)

The Global Trade Analysis Project (GTAP) is a system combining updated trade data and an economic model. The entire system was initially invented and documented in Hertel (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 the counterfactual analysis of simulating the outcome of regional integration. The standard GTAP model included a multi-region, multi-sector CGE model written in the GEMPACK programming language. In GTAP 10, there are 65 sectors and 141 regions. GTAP also had an up-to-date global trade database maintained by the GTAP users worldwide. And the RunGTAP program is the Graphical User Interface (GUI) for the GTAP system. RunGTAP helps the users to collect the data, operate the experiment shocks, preview the results of post-shock equilibrium, and view the code in GEMPACK.

We show an overview of the GTAP environment in Figure 1. As we see in Figure 1, to simulate the outcome of Taiwan joining RCEP as part of the Newly-imposed Southbound Policies, we need to acquire three main components in the system: Data, Model, and Experiment. In this paper, we first use the GTAP 10 database as our primary data resource, based on the Input-Output Tables published by governments worldwide. Secondly, 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. 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 importing tariffs of the goods between Taiwan and 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. As it concludes, GTAP is a comprehensive static, global, and general equilibrium model resting on an input-output accounting framework. Moreover, GTAP is also a database that includes international economic activities worldwide. We rely on the RunGTAP to run the policy experiment, which is the virtual interface for the users to use the GTAP more easily. Pearson et al. (2018) gives several examples of hands-on computing that the users can carry out to familiarize themselves with the RunGTAP and GEMPACK software.¹¹

Young and Huff (1996) uses the GTAP database and RunGTAP shock simulating program to analyze the initiative trade agreement in the Pacific Rim dated back to the 1980s, the Asia Pacific Economic Cooperation (APEC) group. The 12 member states founded the APEC with the goal of is to promote multilateral trade reform and facilitating 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's 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. GTAP 10 database underlies most applied global general equilibrium models.

In this paper, we apply the CGE model to focus on Taiwan-China-U.S. economic co-competition, regional integration, and potentially building up the new preferential trade

¹¹For 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>

agreement. There is abundant literature on regional integration in the East Asian regions, 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 U.S. 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 and skill-intensive manufactured goods, thus further improving industrial countries' terms of trade.

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

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

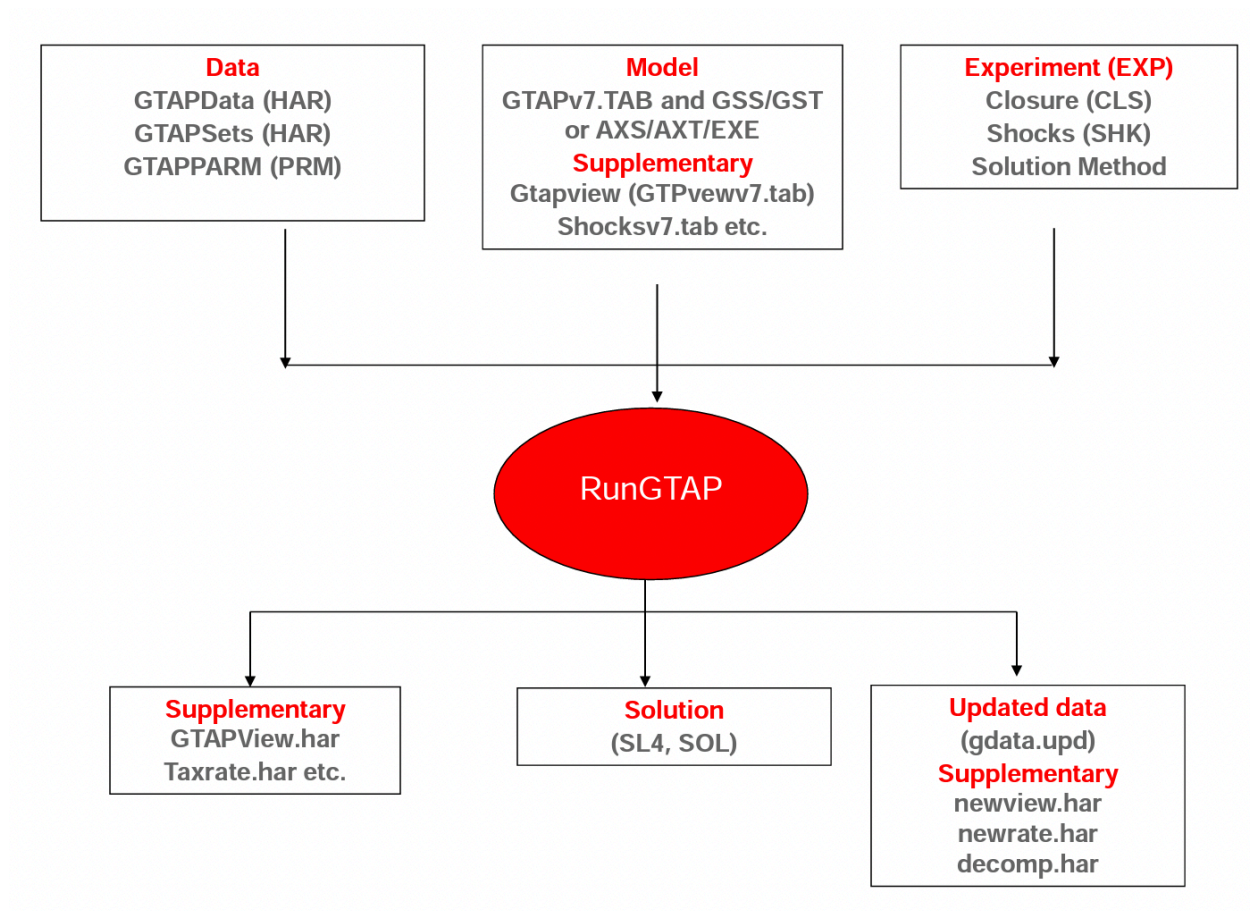


Figure 1: GTAP System

3.2 Global Accounting

Following Brockmeier (2001), we use a graph to illustrate the structure of the default model in the GTAP. Figure 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 linkage between the sectors captures the default general equilibrium model within an open economy.

We start by assuming a regional household is associated with each country or composite region of GTAP. This regional household collects all incomes generated in the economy and spending on the d. The *per capita* utility function of this household follows the Cobb-Douglas format, and this representative household exhausted all its incomes into three forms of final demand, which include *Private Household Expenditures* (PRIVEXP), *Government Expenditures* (GOVEXP), and *Savings* (SAVE). The *Value of Output at Agent's prices* (VOA) is paid by producers to use endowment commodities for the regional household. The domestic consumption made by the Private Household is denoted by the *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 Constant Difference of Elasticity (CDE) implicit 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 by using data on income and own-price elasticities of demand.

Government domestic purchases are denoted as *Value of Domestic Government purchases* (VDGA), evaluated at the Agent's prices. A Cobb-Douglas sub-utility function is employed in GTAP so that the expenditure shares are constant across all commodities. The model also assumes the savings are completely exhausted on the investment (NETINV).

Then, we focus on the economy's production side and explore the accounting relationship of the firms in GTAP. The firms and the regional household, together with its three final goods, now become a simple model of a closed economy. The producers

receive payments for selling consumer goods to the private households (VDPA) and the government (VDGA), intermediate inputs to other producers (*Value of Domestic Firm Purchases, evaluated at Agents' prices* , VDFA), and investment goods to the saving sectors (NETINV). By zero profit assumption, the revenues must be exhausted on expenditures for intermediate inputs (VDFA) and primary factors of production (VOA).

In addition to the consumers and producers, GTAP also includes the role of the government in the model. TAXES flow from the private household, firms, and government to the regional household. 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 subsidy correspondingly.

Then, we focus on the bottom of Figure 2. We could model the open economy by adding a new sector called “Rest of World,” and the value flows relating to these agents. The producers in the open economy not only sell the goods to the domestic market, but they also sell the goods to the “Rest of the World.” VXMD denotes these exports. Moreover, under the open-economy framework, the producers spend their revenues not only on buying the domestically produced intermediate inputs but also on imported intermediate inputs, VIFA. The firms in the open economy have to pay the tax on imported inputs to the regional household.

The GTAP model assumes the Armington assumptions hold. This means that the economic agents could distinguish imported goods by their origin and explains intra-industry trade of similar products. The 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. Under the open economy, the firms decide first on sourcing 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” gets payments for selling their goods for private consumption, government, and firms. These revenues will be

spent on commodities exported from one region to the “Rest of the World,” denoted as VXMD, and on import taxes, MTAX, and exporting taxes XTAX paid to the regional household.

3.3 Trade Policy Tools

Figure 2 can also show the interventions on exports of commodity i 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 GTAP. The power of the export tax can be calculated as the ratio of the *Value of exports of commodity i from region r to regions, valued at the exporter's domestic market, by destination price* (VXMD(i, r, s)) to the *Value of exports of commodity i from region r to regions, valued at the world prices, by destination* (VSWD(i, r, s)). In equation,

$$TXS(i, r, s) = \frac{VXMD(i, r, s)}{VSWD(i, r, s)}$$

If TXS is smaller than one, it means there exists an export tax. Hence, the domestic price (PM) and fob(PFOB) price of goods could solidify the following linkage.

$$PM = \frac{PFOB}{TXS}$$

Likewise, 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 the *Value of Imports of commodity i from region s to region r , at Market prices, by Source* (VIMS(i, s, r)) to the *Value of Imports of commodity i from region s to region r , Word prices, by Source price* (VIWS(i, s, r)). That is,

$$TMS(i, r, s) = \frac{VIMS(i, s, r)}{VIWS(i, s, r)}$$

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

$$\text{PMS} = \frac{\text{PCIF}}{\text{TMS}}$$

This paper focuses on how joining the regional agreement would affect. So we relied heavily on adjusting the import tax (TMS) on the goods.

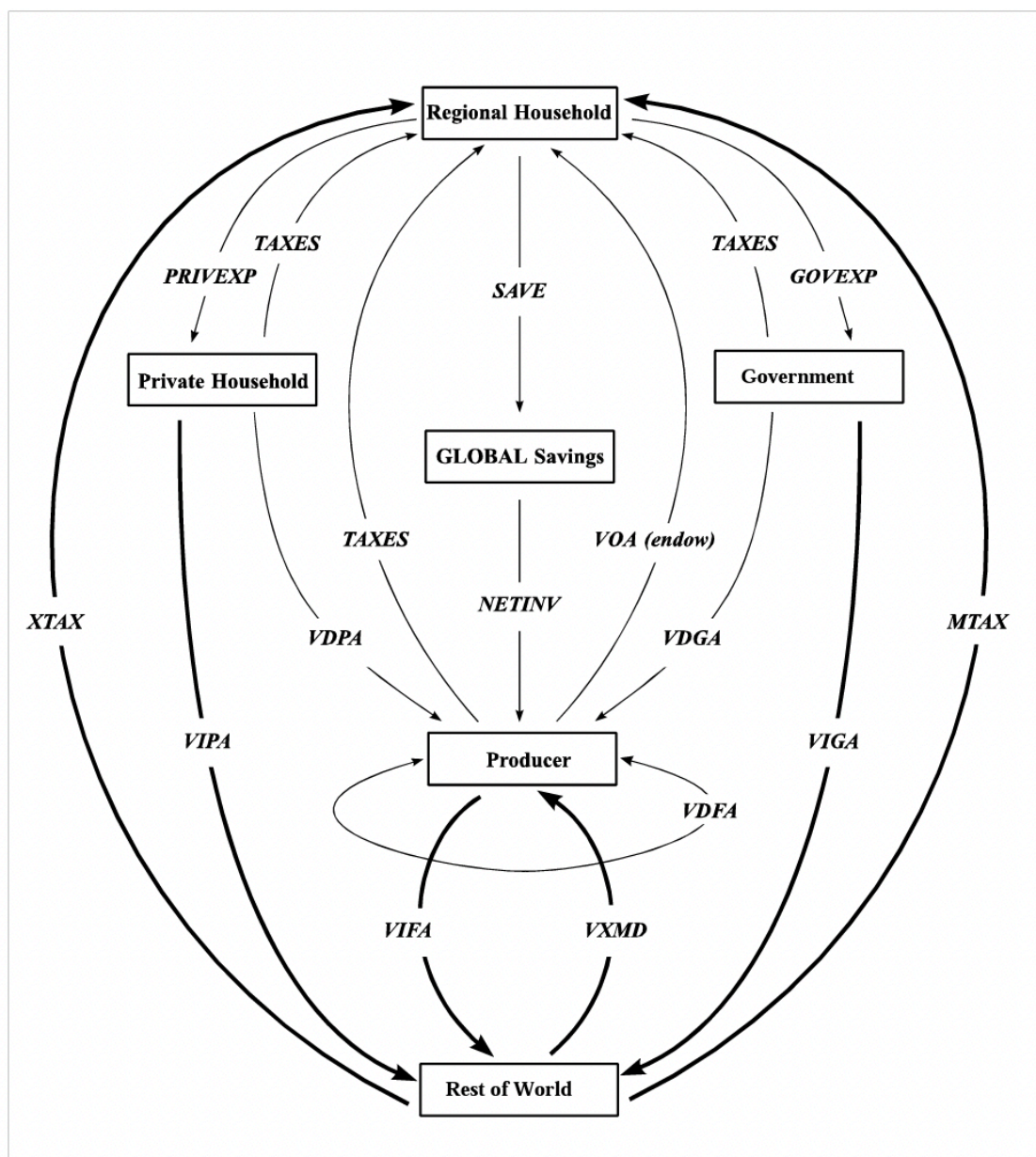


Figure 2: Multi Region Open Economy Model, Brockmeier (1996)

4 Simulation Setup

4.1 Regional Aggregation

Since we focus on analyzing the outcome of the U.S. and China if Taiwan joins RCEP in this study, we separate the U.S., China, and Taiwan in the regional aggregation in the GTAP model. By singling out Taiwan, we could analyze the policy shock of Taiwan's government's intention and how it would happen if joining RCEP became a reality. By doing so, we could explore the shock, particularly from the standpoint of Taiwan. And from the perspective of the Taiwanese government, participating in the RCEP or other regional agreements is always a good option. Until July 2022, RCEP has been ratified by twelve countries, i.e., 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 U.S., and the Rest of the World becomes the five main groups in the setting. China includes the two Special Administrative Regions, Hong Kong and Macau. Table 1 summarizes the aggregation mapping of the GTAP regions code used in this paper. The GTAP code of the countries can be found in Appendix.

4.2 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's license holder. Hence, we categorize the industries into ten larger sectors and tally them in the table, Table 2. The ten large sectors are Grains and Corps, Livestock and Met Products, Mining and Extraction, Processed Food, Textile 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 2, shows the industrial groups we have, which is the default aggregation that runs in the GTAP model. Though 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 next stage of the project. The Appendix details more about the mapping and the description of the sectors.

Table 1: Mapping of Regional Aggregation

No.	New.Code	Region.Description	Comprising.old.regions
1	USA	United States of America	usa
2	China	China and Hong Kong	chn hkg
3	Taiwan	Taiwan	tw
4	RCEP	RCEP Members w/o 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 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

4.3 Policy Experiment

The main shock we are looking into is the import tariffs. The exogenous variable we control is “tms,” which is the “importing tax of goods” label in the GTAP system. Though 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. Hence, lowering the import tariff of the goods imported from the trade counterpart is a viable policy experiment. Reciprocally, exporting goods 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 setting of the CLOSURE tab in RunGTAP. We will leave the heterogeneous shock to a specific sector in the next project.

We targeted the “importing tax of the goods” in the SHOCK setting in the GTAP to lower the current importing tax rates on the goods from the potential trade counterpart. So if the RCEP accepted Taiwan, the tariffs the importing goods from the RCEP member states would drop, and on the other hand, the exporting Taiwanese goods to the RCEP member countries would be required to be eliminated the importing 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 importing goods 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 this paper, China, Taiwan, and the US.

5 Data

GTAP not only defines the General Equilibrium model but also is an extensive global database based on the input-output table published regularly by the governments. In the previous section 3.1, we reviewed the model and accounting relationship between sectors, which led to building up a multi-sector, multi-regions, General Equilibrium model. In Section 4, we explained the setting of the aggregation scenario. Now, we focus on the data side in the GTAP and review the data resources based on our regional and sectoral aggregation. In this Section 5, we introduced the data resource and the trade data relating to Taiwan that we could extract from GTAP. We use them to explain how GTAP combined the General Equilibrium model with the global trade data. Appendix A.2 shows all the regions included in the GTAP database 10, which currently consists of 141 regions and 65 sectors, based on the reference year 2014.

5.1 Input-Output Table

According to Lin and Hsu (2015), Taiwan's initial input-output (I-O) table is derived from the "Input-Output Table of Taiwan" provided by the Directorate-General of Budget, Accounting, and Statistics (DGBAS).¹²

DGBAS is the bureau governed by the Executive Yuan of Taiwan, the principal agency responsible for collecting and organizing economic data. The original 2006 input-output table in the GTAP 9 database includes 554 by 166 sectors, valued in millions of New Taiwan Dollars, at the current producer's prices.

According to the DGBAS database, two tables are available: a transactions table for domestic goods and services and a transactions table for imported goods and

¹²The 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 Organization Act of the Executive Yuan's Directorate General of Budget, Accounting, and Statistics was revised. It came into force in November 1973 and was revised in May 1983. In line with the Executive Yuan's restructuring policy, the DGBAS was reorganized on February 6, 2012. The functions of the departments have been reviewed, and one affiliated institute (Electronic Data Processing Center) was merged.

services. The final demand matrix in the transactions table of domestic products and imports includes private consumption expenditure, government consumption expenditure, gross private fixed capital formation, change 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. Depreciation of fixed capital was added to the operating surplus to obtain a vector of capital utilization.

The GTAP Data Base is a consistent representation of the world economy for a pre-determined reference year. Underlying the database, there 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, and thus for achieving consistency, substantial efforts are made to make the disparate sources comparable. For these reasons, the objective of the GTAP Data Base 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 that at their own risk and are assumed to understand the limitations imposed by the database construction process.

The GTAP Data Base is not a relational database of economic variables ([Aguiar et al., 2019](#)). Users interested in macroeconomic and trade 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 Data Base accurately depicts the magnitudes of economic variables, but they are presented in terms of the aggregates that serve Computable General Equilibrium (CGE) modeling.

5.2 Trade Data

Several trade data centered on Taiwan are presented in this subsection to describe the characteristics of Taiwan's market and its dependence on trade. The variables we highlight here are the trade commodities valued by local prices, the exporting value $VXMD_{i,r,s}$, and importing value $VIMS_{i,r,s}$. Then are the trade flows value, exporting and importing, valued by the world market price, $VXWD_{i,r,s}$, and $VIMS_{i,r,s}$. From all the data tables listed here, we can see that China, the U.S., and RCEP are Taiwan's three largest trade partners.

$VXMD_{i,r,s}$ represents the value of exports of a tradable commodity i from source r to destination s , evaluated at exporter's market prices. In the model, the representation is as follows,

$$VXMD_{i,r,s} = PM_{i,r} * QXS_{i,r,s}$$

where $i = \text{TRAD_COMM}$; $r = \text{REG}$; $s = \text{REG}$, $PM_{i,r}$ is the market price of non-saving commodity i in region r , and $QXS_{i,r,s}$ is the quantity of exports of tradable commodity i from source r to destination s . Table 6 shows the data in GTAP.

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

$$VIMS_{i,r,s} = PMS_{i,r} * QXS_{i,r,s}$$

where $i = \text{TRAD_COMM}$; $r = \text{REG}$; $s = \text{REG}$. $PMS_{i,r}$ is the market price by the source of tradable commodity i imported from source r to destination s , and $QXS_{i,r,s}$ is the quantity of exports of tradable commodity i from source r to destination s . Table 4 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, $VXWD_{i,r,s}$ values exports of tradable commodity i from source r to

destination s , evaluated at world (FOB) prices, and VIWS _{i} values imports of tradable commodity i from source r to destination s , measured at world (CIF) prices. That is,

$$VXWD_{i,r,s} = PFOB_{i,r,s} * QXS_{i,r,s}$$

$$VIWS_{i,r,s} = PCIF_{i,r,s} * QXS_{i,r,s}$$

Table 3: Value of Exports from Taiwan at Destination Prices (VXMD[i, Taiwan, d])

VXMD	USA	China	Taiwan	RCEP	Rest of World
1 GrainsCrops	85.45	132.35	0	174.36	85.28
2 MeatLstk	30.84	70.55	0	271.35	34.98
3 Extraction	9.11	273.81	0	231.73	73.86
4 ProcFood	396.36	816.83	0	1538.37	449.30
5 TextWapp	1109.80	3584.23	0	4702.37	3272.98
6 LightMnfc	8605.41	4549.87	0	7238.38	12889.85
7 HeavyMnfc	25010.71	132049.44	0	77231.91	40242.29
8 Util_Cons	192.48	118.06	0	113.00	438.62
9 TransComm	2395.28	1469.41	0	1406.42	5456.56
10 OthServices	3500.85	2147.63	0	2055.57	7975.10

Table 4: Value of Imports to Taiwan at Source Prices (VIMS[i, s, Taiwan])

VIMS	USA	China	Taiwan	RCEP	Rest of World
1 GrainsCrops	2241.28	238.23	0	723.61	1805.02
2 MeatLstk	721.80	139.81	0	674.64	410.53
3 Extraction	84.78	587.17	0	14373.76	38062.09
4 ProcFood	931.13	434.12	0	3306.19	2480.65
5 TextWapp	110.25	1810.12	0	1039.18	706.93
6 LightMnfc	3295.80	4785.22	0	8288.82	7532.43
7 HeavyMnfc	17263.22	44582.05	0	70617.99	35077.88
8 Util_Cons	249.51	122.58	0	123.53	536.01
9 TransComm	2018.69	2473.14	0	1508.65	6045.51
10 OthServices	3833.73	1921.93	0	1913.27	7123.65

Table 5: Value of Export from Taiwan at World Prices (VXWD[i, Taiwan, d])

VXWD	USA	China	Taiwan	RCEP	Rest of World
1 GrainsCrops	2164.68	222.12	0	660.37	1761.85
2 MeatLstk	657.20	138.43	0	635.38	375.67
3 Extraction	82.76	574.83	0	14357.37	38034.42
4 ProcFood	836.26	378.86	0	2934.07	2307.08
5 TextWapp	104.09	1662.24	0	963.54	653.22
6 LightMnfc	3214.06	4613.74	0	7794.95	7002.08
7 HeavyMnfc	17053.13	44156.29	0	69645.52	34551.72
8 Util_Con	249.51	122.58	0	123.53	536.01
9 TransComm	2018.69	2473.14	0	1508.65	6045.51
10 OthServices	3833.73	1921.93	0	1913.27	7123.65

Table 6: Value of Imports to Taiwan at World Prices (VIWS[i, s, Taiwan])

VIWS	USA	China	Taiwan	RCEP	Rest of World
1 GrainsCrops	2164.68	222.12	0	660.37	1761.85
2 MeatLstk	657.20	138.43	0	635.38	375.67
3 Extraction	82.76	574.83	0	14357.37	38034.42
4 ProcFood	836.26	378.86	0	2934.07	2307.08
5 TextWapp	104.09	1662.24	0	963.54	653.22
6 LightMnfc	3214.06	4613.74	0	7794.95	7002.08
7 HeavyMnfc	17053.13	44156.29	0	69645.52	34551.72
8 Util_Con	249.51	122.58	0	123.53	536.01
9 TransComm	2018.69	2473.14	0	1508.65	6045.51
10 OthServices	3833.73	1921.93	0	1913.27	7123.65

6 Simulation Results

In Figure 3 and Figure 4, the main simulation results are presented. The value of the EV and VGDP growth rates presented the welfare of the general equilibrium after the shock. We apply the sensitivity analysis by adjusting the shock's power as we move importing taxes between Taiwan and the RCEP country bilaterally. As an experiment, import tariffs are lowered by 10% across all sectors.

Figure 3 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 ten percent reduction in the bilateral importing tariff between Taiwan and RCEP countries, we add ten percent to the power of the policy shock. The EV unit in Figure 3 is millions in the U.S. dollar. The vertical axis represents the value of EV, and the line represents five groups of countries that we aggregate in this paper.

Several conclusions can be drawn from the graphs. Firstly, if Taiwan is invited to join the RCEP, from the standpoint of gains from trade liberalization, it should accept the offer as soon as possible. Figs 3 and 4 demonstrate that Taiwan benefits the most as the GDP growth rate and the EV increase along with the power of shock. Secondly, the impact of the participation of Taiwan in the RCEP is surprisingly small compared to the combined effect of the RCEP and China. Even though the aggregate trade values of RCEP countries are ranked second among Taiwan's trade counterparts, we are unable to 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 Regional Comprehensive Economic Partnership (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 the final paragraph.

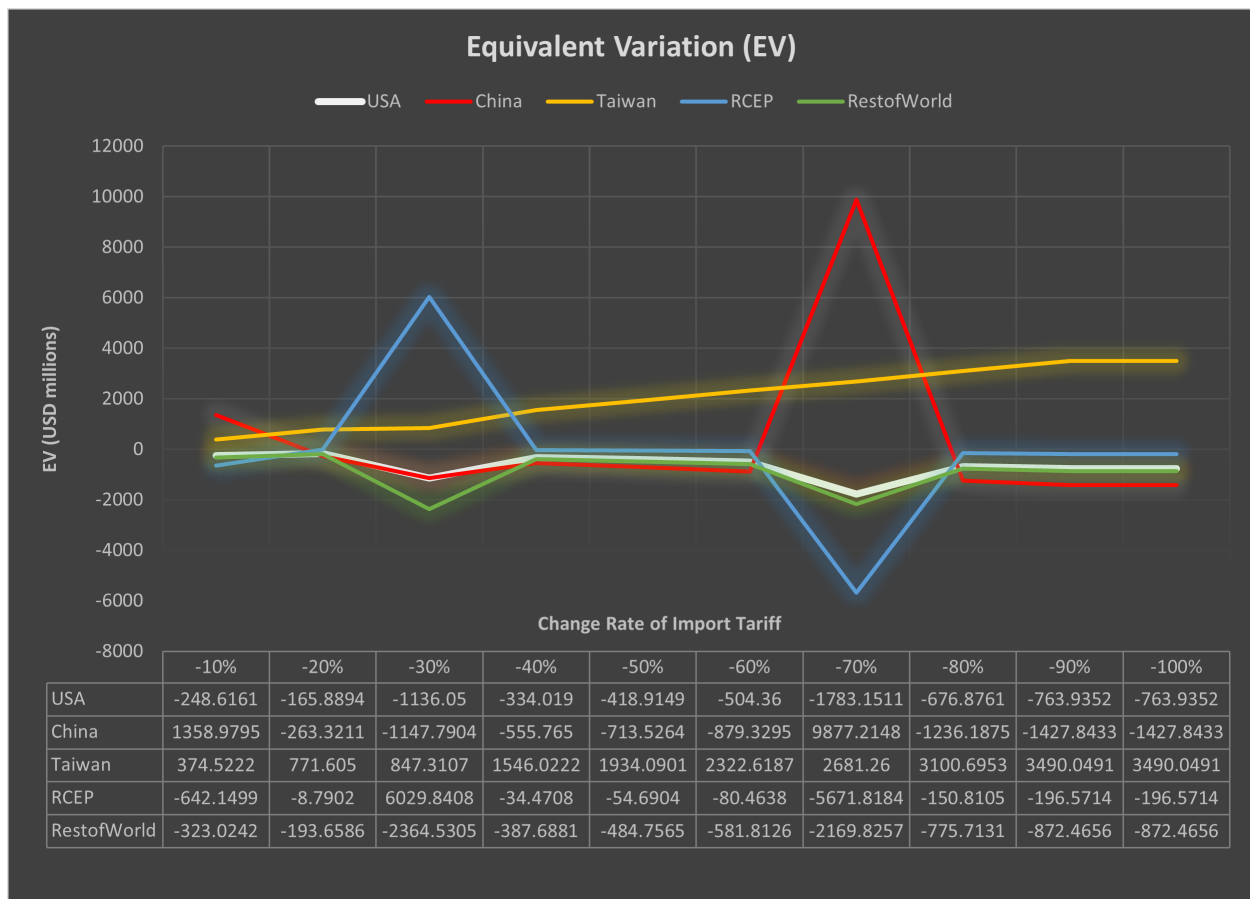


Figure 3: Welfare Change (EV, in USD Millions) as Taiwna Joins RCEP

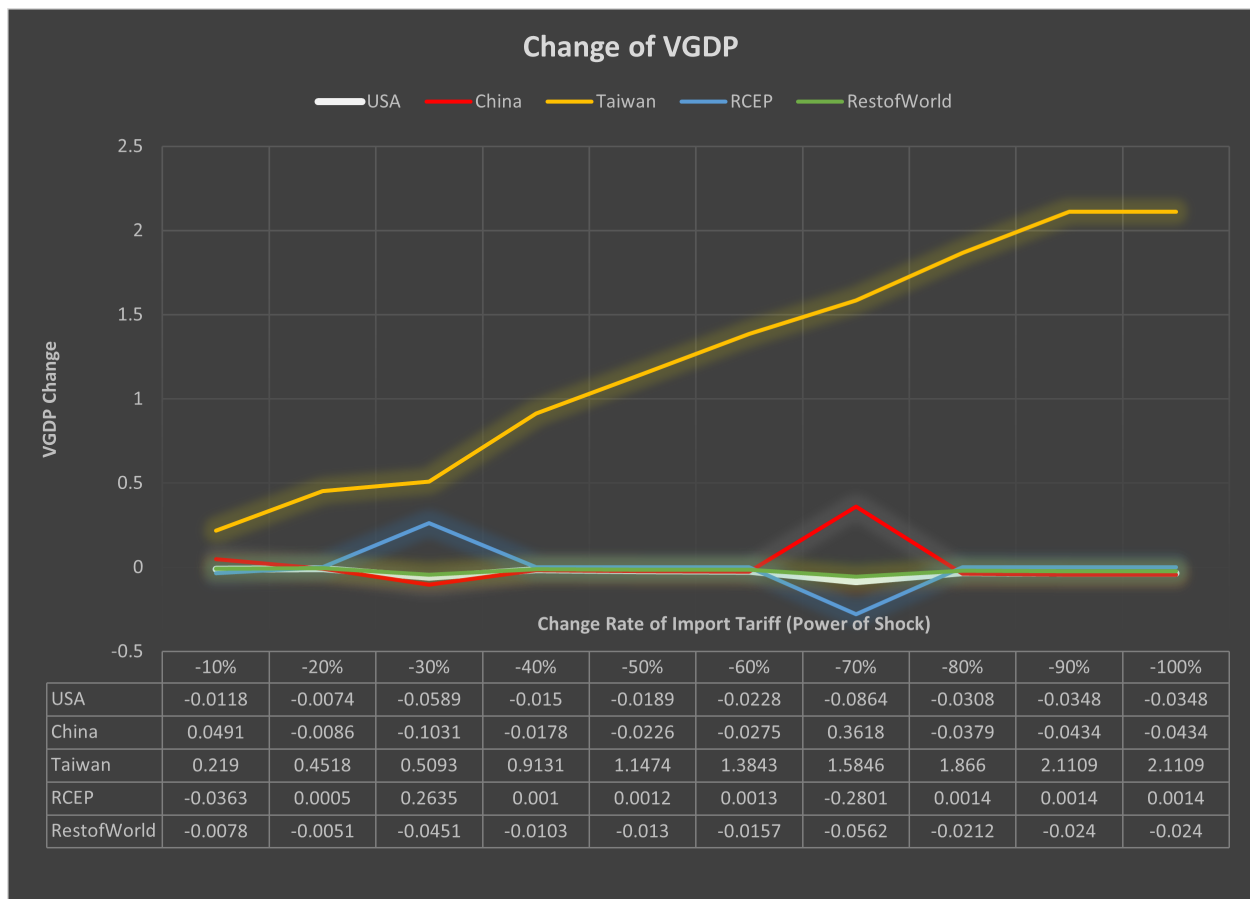


Figure 4: GDP Growth Rate as Taiwan Joins RCEP

7 Conclusion

7.1 Policy Implication

There are three main takeaways from this study. First, from the results, we could see that Taiwan would be an obvious beneficiary if she were invited to become a member. 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 U.S. does not, then the U.S. would be the one that hurts the most. RCEP and China rank first and second in terms of trade volume. Also, due to the proximity of all the counterparts, lowering trade barriers and increasing the diversity of goods should improve the welfare level of a country. 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 RCEP countries to welcome Taiwan are low. The present circumstances of Taiwan's exclusion from RCEP could be explained by economics. It implies, however, 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 had to choose between trade agreements led by the world's two most powerful countries. Taiwan played a unique position in the East Pacific geopolitics due to the competition between the U.S. and China. Taiwan shares the same ancient Chinese culture and history as China. Still, it is divided by modern political ideologies. On the other hand, the U.S. 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 toward the People's Republic of China (PRC, China) has always been a central issue in presidential elections. Throughout

the Cold War era, the Taiwan issue 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, around 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 China 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 the political implications are indirectly shown, Taiwan's administration might be wise to rethink the meaning and strategies of the "New Southbound Policy" and prepare for upcoming proposals that might be raised during the RCEP negotiations.

7.2 Future Work: Interaction with Other PTAs

Except for the RCEP, Taiwan had made a deal with China to cosign a Bilateral Trade Agreement, the Economic Cooperation Framework Agreement (ECFA). Though the ECFA is still in effect, there were few studies to focus on how it would affect the economic outcome of Taiwan joining another PTA, like RCEP. In future studies, as an extension of this paper, we are interested in how the decision to join the RCEP intertwines with the existing free trade agreement. Currently, Taiwan is not a member of the RCEP and does not have an official preferential trade agreement with the current members of the RCEP. However, Taiwan did sign a preferential trade agreement, the Economic Framework Cooperation Agreement (ECFA), with China in 2008.

Due to world politics leaning toward discouraging China from becoming a superpower as the tension between the U.S. and China gets higher, the Taiwanese have begun to question its policies with China, and some pro-independent delegates even advocate the suspension of the pre-existing ECFA with China. Because Taiwan is currently dealing with the existing ECFA and has an incentive to join the RCEP. We run the policies experiments in the following experimental scenario. Considering the

Taiwanese government has to choose between terminating or honoring the ECFA, at the same time, 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) ECFA was not terminated and is accepted by RCEP. (2) ECFA was not discontinued and is not recognized by RCEP. (3) ECFA was discontinued and is not recognized by RCEP. (4) 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. In addition, we changed the import tariff for goods from China simultaneously in the previous setting. For example, In scenario 1, we would reduce the import tariffs on the goods between Taiwan and China. In addition, we would reduce the import tax on goods between Taiwan and the RCEP countries. For the results, we chose 10 percent as the increment of the change rate, and we calculated the Equivalent Variation (EV) change as an indicator of the welfare change in the country.

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Appendix

A.1 Detailed List of GTAP Sectors

Table 7: Detailed Sectoral Code of 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; degrass; 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 Codes of GTAP Regions

Table 8: Detailed Sectoral Code of 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	Turkiye
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	Côte 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

A.3 R and R Markdown Code

```
knitr::opts_chunk$set(echo = TRUE)

knitr::include_graphics("gtapflow.png")
knitr::include_graphics("graph/gtapmrgraph.png")
library("kableExtra")
library("readxl")
agg<-read.csv("data/aggregation.csv")
knitr::kable(agg, caption="Mapping of Regional Aggregation", format="latex", longtable = T, bootstrap_options = c("striped", "hover"),
  column_spec(4, width = "25em")
library("kableExtra")
library("readxl")
agg<-read.csv("data/secaggregation.csv")
knitr::kable(agg, caption="Mapping of Secotral Aggregation", format="latex", longtable = T, bootstrap_options = c("striped", "hover"),
  column_spec(4, width = "25em")
library(kableExtra)
VXMD<-read.csv(file = 'data/VXMD.csv')
VXMD<-VXMD[-c(7)]
colnames(VXMD) = c("VXMD", "USA", "China", "Taiwan", "RCEP", "Rest of World")

knitr::kable(VXMD, caption='Value of Exports from Taiwan at Destination Prices (VXMD[i, Taiwan])',
  kable_styling(bootstrap_options = c("striped", "hover"),
    full_width = F,
    font_size = 11,
    position = "left")
library(kableExtra)
VIMS<-read.csv(file = 'data/VIMS.csv')
VIMS<-VIMS[-c(7)]
colnames(VIMS) = c("VIMS", "USA", "China", "Taiwan", "RCEP", "Rest of World")
knitr::kable(VIMS, caption='Value of Imports to Taiwan at Source Prices (VIMS[i, s, Taiwan])',
```

```

kable_styling(bootstrap_options = c("striped", "hover"),
              full_width = F,
              font_size = 11,
              position = "left")

library(kableExtra)

VXWD<-read.csv(file = 'data/VIWS.csv')
VXWD<-VXWD[-c(7)]

colnames(VXWD) = c("VXWD", "USA", "China", "Taiwan","RCEP","Rest of World")

knitr::kable(VXWD, caption='Value of Export from Taiwan at World Prices (VXWD[i, Taiwan, d])',
kable_styling(bootstrap_options = c("striped", "hover"),
              full_width = F,
              font_size = 11,
              position = "left")

library(kableExtra)

VIWS<-read.csv(file = 'data/VIWS.csv')
VIWS<-VIWS[-c(7)]

colnames(VIWS) = c("VIWS", "USA", "China", "Taiwan","RCEP","Rest of World")

knitr::kable(VIWS, caption='Value of Imports to Taiwan at World Prices (VIWS[i, s, Taiwan])',
kable_styling(bootstrap_options = c("striped", "hover"),
              full_width = F,
              font_size = 11,
              position = "left")

library(kableExtra)

library("readxl")

GTAPsector <-read.csv(file = 'data/gtapsectorlist.csv')
GTAPsector2 <- head(GTAPsector, 65)

knitr::kable(GTAPsector2, caption='Detailed Sectoral Code of GTAP', format="latex", longtable =
              column_spec(3, width = "40em")

```

```

#knitr::kable(GTAPsector2, format = "simple") %>% kable_paper(full_width = F) %>%
  #column_spec(1, width = "3em", bold = F) %>%

library(kableExtra)
library("readxl")
GTAPsector <- read.csv(file = 'data/regiongtap.csv')
GTAPsector2 <- head(GTAPsector, 142)
knitr::kable(GTAPsector2, caption='Detailed Sectoral Code of GTAP', format="latex", longtable =
  column_spec(3, width = "40em")

```