

**Economic Impacts of President Trump 2.0's
Trade Policies on Southeast Asia:
A Computable General Equilibrium Analysis**

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Economic Impacts of President Trump 2.0's Trade Policies on Southeast Asia: A Computable General Equilibrium Analysis

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2026

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Abstract

This thesis examines how President Trump 2.0's reciprocal tariff policies, announced up to April 2025, affect the economies of Southeast Asia. The study focuses on both macroeconomic outcomes and sector-level changes and also considers how Southeast Asian countries should respond to these new trade measures. To address these questions, the research develops four policy scenarios that reflect different combinations of US reciprocal tariffs, Chinese retaliation, and Southeast Asia's own policy choices.

The analysis uses the standard GTAP computable general equilibrium model, supported by three main datasets: the GTAP version 9 database, updated macroeconomic indicators for 2017 and 2024, and detailed bilateral tariff information. These data are processed and calibrated to create a consistent base for the simulations. The model then evaluates how changes in tariffs influence GDP, consumption, investment, trade flows, welfare and sectoral output across ten regions and twelve sectors.

The results show that Southeast Asia experiences economic losses in the first three scenarios, especially when it retaliates against the United States. These findings confirm that tariff escalation is costly for small, open economies. Sectoral effects are uneven, with most non-service sectors contracting under the first three scenarios. However, the fourth scenario, where Southeast Asia eliminates its own tariffs while receiving a lower reciprocal tariff from the United States, produces a clear improvement. In this case, Southeast Asia records positive GDP growth, stronger investment, and significant gains in key manufacturing sectors such as textiles, light manufacturing, and heavy manufacturing. By contrast, US exports to Southeast Asia fall unexpectedly even when tariffs are removed, showing that general equilibrium effects can lead to unexpected outcomes.

The study concludes that unilateral tariff liberalisation is the most effective strategy for Southeast Asia under the current trade environment, although this outcome does not maximise global welfare. The thesis also highlights several limitations, including the static nature of the model, the degree of regional, sectoral and household aggregation, and the use of past parameters. These limitations point to opportunities for future research using dynamic models, updated parameters, such as trade elasticities, and more detailed sectoral structures.

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Abbreviations

AANZFTA	ASEAN-Australia-New Zealand Free Trade Area
ACFTA	ASEAN–China Free Trade Area
AIFTA	ASEAN–India Free Trade Area
AJFTA	ASEAN-Japan Free Trade Area
AKFTA	ASEAN-Korea Free Trade Area
APEC	Asia-Pacific Economic Cooperation
ASEAN	The Association of Southeast Asian Nations
ATSM	Automatic Trigger Safeguard Mechanism
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
CGE	Computable General Equilibrium
CIF	Cost, insurance, and freight
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
CU(s)	Customs Union(s)
DSM	Dispute Settlement Mechanism
FAO	Food and Agriculture Organization
FTA(s)	Free Trade Agreement(s)
GAMS	General Algebraic Modeling
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GE	General Equilibrium
GEMPACK	General Equilibrium Modelling PACKage
GFC	Global Financial Crisis
GNP	Gross National Product
GTAP	Global Trade Analysis Project
GTAPv7	Standard GTAP model version 7
HS	Harmonized System
IMF	International Monetary Fund
I-O	Input-Output
IOT	Input-Output Table
MFN	Most-Favoured-Nation
NAFTA	North American Free Trade Agreement
NE	Nash Equilibrium
PE	Partial equilibrium
PPML	Poisson Pseudo Maximum Likelihood
PTA(s)	Preferential Trade Agreement(s)
RCEP	The Regional Comprehensive Economic Partnership
RoO	Rules of Origin
RTA(s)	Regional Trade Agreement(s)
SAM	Social Accounting Matrix
SEA	Southeast Asia
SNA	System of National Accounts
SPNE	Subgame Perfect Nash Equilibria

SUT(s)	Supply and Use Table(s)
TPP	Trans-Pacific Partnership
TPSEP	Trans-Pacific Strategic Economic Partnership
TRIPS	Trade-Related Aspects of Intellectual Property Rights
TTB(s)	Temporary Trade Barrier(s)
UNCTE	United Nations Conference on Trade and Employment
USD	United States Dollar
USTR	Office of the United States Trade Representative
WTO	World Trade Organization

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1 Chapter 01: Introduction

1.1 Background

After the end of the World War II in 1945, the global economy needed rebuilding, and the United States took the lead in creating new rules for trade. In 1947, 23 countries signed the General Agreement on Tariffs and Trade (Hereafter referred to as “GATT”) in Geneva, Switzerland, during the United Nations Conference on Trade and Employment (Evans, 1968). GATT aimed to cut tariffs and promote open markets to avoid the protectionism that worsened the Great Depression 1929-1933 (Eichengreen and Irwin, 2010). Over the years, several negotiation rounds followed: the Geneva Round (1947), the Annecy Round (1949), the Torquay Round (1950), The Geneva II Round (1956), the Dillon Round (1960), the Kennedy Round (1964), the Tokyo Round (1973), and the Uruguay Round (1986–1994). The Tokyo Round tackled not just tariffs on industrial goods but also, for the first time, non-tariff barriers like quotas and subsidies (World Bank, 1980). The Uruguay Round, lasting nearly eight years, brought in services, intellectual property, and stronger dispute settlement, paving the way for the World Trade Organization (“WTO”) in 1995 (VanGrasstek, 2013).

The Doha Round, launched in 2001, marked the first major WTO negotiation, but it has stalled ever since over disagreements between developed and developing countries on agriculture and manufacturing access (IMF, 2011). As multilateral progress slowed, countries turned to regional trade deals and the number of such discriminatory agreements grew more than five times from 40 in early 1990s to more than 200 around two decades later (Craig et al, 2014).

Regional agreements grew, including The Association of Southeast Asian Nations (“ASEAN”)'s ties with six other regional partners ¹. The Trans-Pacific Strategic Economic Partnership (“TPSEP”), created in 2006, quickly expanded into the Trans-Pacific Partnership (“TPP”) in 2016 with 12 members, but US President Donald J. Trump pulled the US out in 2017, leading to the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (“CPTPP”) in 2018. The Regional Comprehensive Economic Partnership (“RCEP”), signed in 2020, became the world's largest trade bloc, though India withdrew in 2019 over its trade deficit concerns (Shimizu, 2021). These setbacks, alongside the stalled Doha Round, revealed deep

¹ See Chapter 03 for a complete list

tensions between economic integration goals and domestic political pressures, highlighting how vulnerable large-scale agreements had become to unilateral decisions and protectionist sentiments.

Since the 2016 United States of America's presidential election, there has been a marked increase in trade protectionism and confrontational trade policies between major nations, particularly between the United States and China (Bank of England, 2019; European Central Bank, 2019). The first Trump administration initiated a trade war by imposing tariffs on several neighbouring countries and allies but primarily targeting China. While Section 301² was the main part of President Trump's trade policy during the first term targeting China (Giesecke et al, 2019), President Biden “*has decided to add some, increase others, and maintain the remainder*” (Cogan, 2024). It appears that the United States has increasingly adopted protectionist trade policies, a trend that current indicators suggest is unlikely to be swiftly reversed, especially towards China.

These disruptions, however, created opportunities for other countries, especially in Southeast Asia (“SEA”), to benefit from shifts in global supply chains. Southeast Asia has become increasingly important in the global trade landscape, particularly through ASEAN's central role in forging major regional agreements like RCEP and CPTPP as well as in the Indo-Pacific strategies of many major partners³. Many Southeast Asian nations not only expanded their trade volumes but also attracted the relocation of manufacturing supply chains, promoting economic growth and employment. Vietnam serves as a prominent example, emerging as a manufacturing hub due to its integration into global supply chains and increased exports to the US (Lim and Nguyen, 2024). However, during the second Trump presidency, the trade dynamics changed drastically for Southeast Asia. The reciprocal tariff lists announced by the Trump second administration imposed some of the heaviest tariffs directly on Southeast Asian economies, such as Cambodia faces a 49% tariff, Laos 47%, Vietnam 46%, Thailand 36%, Indonesia 32% while many other countries only face a minimum 10%⁴. This policy shift caught these nations unprepared, forcing them to quickly seek appropriate responses to mitigate the

² The Office of the United States Trade Representative. China Section 301-Tariff Actions and Exclusion Process. Available at: <https://ustr.gov/issue-areas/enforcement/section-301-investigations/tariff-actions>. Accessed on 23-Jul-24.

³ To be discussed in more detail in Chapter 03

⁴ The White House. Regulating Imports with a Reciprocal Tariff to Rectify Trade Practices that Contribute to Large and Persistent Annual United States Goods Trade Deficits. Available at: <https://www.whitehouse.gov/presidential-actions/2025/04/regulating-imports-with-a-reciprocal-tariff-to-rectify-trade-practices-that-contribute-to-large-and-persistent-annual-united-states-goods-trade-deficits/>. Accessed on 14-Oct-25.

economic disruptions caused by tariffs. The tariffs, if implemented, might jeopardise the benefits previously gained from trade diversion and supply chain shifts, creating short and even long-term dislocation and economic uncertainty.

Textbook economic theories, especially those from Neoclassical and Classical schools, suggest that tariffs and protectionism lead to overall welfare losses and do not benefit any country. From this perspective, the continuation and intensification of tariffs under the Trump administration might seem irrational. However, such textbook models often rely on assumptions that may not fully capture the complexity of the current geopolitical and geoeconomic landscape (Chang, 2014). Smaller nations, such as those in Southeast Asia, lack the bargaining power of global economic giants and face new challenges in this evolving trade environment. Given the complexities of increasing geopolitical and geoeconomic tensions across the globe, as well as the novelty of President Trump's reciprocal tariff announcement in April 2025, it is imperative for Southeast Asian nations to undertake a rigorous analysis of the specific economic implications resulting from the recent tariff policies and to proactively develop a suite of relevant policy responses.

1.2 Research Aim, Objectives and Research Questions

The recent escalation in trade tensions, exemplified by the announcement and implementation of sweeping reciprocal tariffs by the United States following President Trump's re-election, has created a pressing need to rigorously evaluate the far-reaching economic impacts of these measures.

This doctoral thesis aims to contribute to a better understanding of the macroeconomic and sector-level impacts that might follow due to President Trump's recent tariff announcement up to April 2025, as well as how SEA should respond strategically and optimally to such new trade policies.

This research sets out three objectives:

1. To conduct an analysis of the macroeconomic consequences of President Trump's tariff policies on Southeast Asia and its nine key trading partners, including the United States.
2. To conduct an analysis of the microeconomic or sector-level consequences of President Trump's tariff policies on Southeast Asia's twelve aggregated sectors

3. To formulate policy recommendations concerning the optimal response strategies for Southeast Asian nations in light of President Trump's tariff policies.

To achieve the aim and objectives set out above, the research will answer three questions:

1. What is the projected impact of President Trump's tariff policies on key macroeconomic aggregates, specifically the resulting changes in real economic growth, consumption, investment, export volumes, import volumes, sectoral production output and welfare?
2. What is the differential sectoral impact of President Trump's tariff policies on the aggregated economy of Southeast Asia, specifically the absolute and relative gains and losses across key sectors and industries?
3. What is the most likely optimal economic response for Southeast Asian nations, specifically concerning retaliation versus restraint, to mitigate the adverse economic effects of President Trump's reciprocal tariff policies?

1.3 Original Contributions

This thesis makes three main contributions to the academic literature and to current policy debates.

First, it provides the first Computable General Equilibrium (“CGE”) -based assessment of the new reciprocal tariff proposals announced by President Trump in 2025. While many CGE studies examine the 2018–2020 trade war, none models the tariff structure proposed for a second Trump term or analyse how these new measures could affect Southeast Asia. By building forward-looking scenarios based on these new measures, this study fills a gap in both academic and policy discussions and offers practical insights for those assessing the consequences of future U.S.–Asia trade wars.

Second, the thesis brings together two areas of work that tend to be kept separately: CGE modelling and the idea of ASEAN centrality. Most studies on ASEAN’s role in the Indo-Pacific are qualitative and generally belong to the international politics domain and do not use formal economic modelling. At the same time, economic models often ignore the region’s strategic choices. This thesis links the two by showing how different policy responses from Southeast Asia can strengthen or weaken its economic position in the world.

Third, the thesis offers a practical policy contribution by identifying which strategic response is likely to give Southeast Asia the best economic outcome under Trump's proposed reciprocal tariff regime. The results show that retaliation leads to the largest losses, while tariff liberalisation produces better macroeconomic and selectively improved sector-level outcomes. This finding provides practical guidance for policymakers and business leaders who must decide how to respond to renewed US protectionism.

Putting together, these above contributions not only add new knowledge to the literature but also offer tools and evidence that stakeholders can practically use in shaping effective responses to new trade policies.

1.4 Overview of Research Methodology

This study adopts the positivist approach, grounded in the tradition of neoclassical economics, which emphasises objective analysis (minimising personal bias), empirical validation, and the use of formal modelling to examine economic relationships. Under the positivist paradigm, reality is viewed as measurable and observable through quantifiable indicators, allowing for hypothesis testing and reproducible results (Pretorius, 2024). This philosophical orientation is consistent with the key principles of neoclassical theory, which relies on rational behaviour, market equilibrium, and quantifiable interactions among economic agents (Chang, 2014).

Accordingly, the thesis employs a quantitative research methodology, centred on the application of a Computable General Equilibrium model. Specifically, the standard GTAP model version 7 is used to simulate and evaluate the multi-sector, multi-region impacts of various policy interventions. The CGE approach enables the rigorous quantification of key economic changes, such as economic growth, consumption, investment, welfare, trade flows, and production adjustments, across the entire economy. These outcomes align with the positivist aim of objective measurement and model-based inference.

The decision not to adopt an interpretivist or qualitative research approach stems from the nature of the research questions. The study seeks to estimate the measurable economic effects of trade and tariff policies announced by President Trump across multiple sectors and countries, rather than to explore subjective experiences, perceptions, or institutional narratives (Pretorius, 2024). Though qualitative approaches are valuable for understanding behavioural and

contextual dimensions, they lack the capacity for general equilibrium analysis and numerical policy simulation necessary for this inquiry.

Consistent with the quantitative design, the empirical foundation of the analysis draws upon several authoritative global datasets, including the World Bank, CEPII, FAO, official national statistics, the GTAP database version 9, and the MacMap database. The dataset also incorporates extensive official lists of Harmonized System (“HS”) codes facing tariff changes since 2017, announced by both the United States and China, comprising tens of thousands of product lines.

All these data sources are systematically harmonised and processed as inputs into the standard GTAP model version 7. The model then supports the simulation of four distinct policy scenarios made by Southeast Asia, enabling a comprehensive and policy-relevant evaluation of trade disruptions and economic adjustments within the global framework.

1.5 Outline of the Study

This thesis is organised into nine chapters, including the Introduction. Each chapter has been carefully designed to build upon the previous one, systematically guiding the reader from a comprehensive contextual background through rigorous analytical modelling, and finally to the interpretation of results and broader implications. The following outline details the content and focusses of each chapter that follows the introduction, demonstrating the depth and scope of the analysis undertaken.

Chapter 02: Literature review

This chapter reviews the foundational and modern theoretical perspectives on tariffs and trade, beginning with mercantilist and classical views that support and oppose protectionism respectively, and continuing with the neoclassical, optimum tariff theories and ending with game theory. It then explores analytical frameworks, starting with partial equilibrium approaches that often rely on econometric techniques, before progressing to gravity models, initially as intuitive partial equilibrium tools and subsequently as structural gravity models grounded in general equilibrium. While these frameworks offer valuable insights, each has inherent limitations, particularly in capturing the broad general equilibrium interactions and

feedback crucial for assessing tariff impacts fully. The review highlights that a general equilibrium approach is essential to comprehensively analyse tariffs in a globalised economy, setting the stage for the subsequent chapter.

Chapter 03: Computable General Equilibrium: Theoretical Foundations and Empirical Applications

This chapter reviews the development of the General Equilibrium approach both theoretically and empirically. The chapter then transitions into a comprehensive review of the evolving literature on trade liberalisation and later trade wars as well as the use of CGE modelling, culminating in an exploration of recent empirical and theoretical contributions surrounding President Trump's first trade war during 2016–2020. Key findings from contemporary papers are integrated to clarify what is already known, where debates remain unresolved, and what gaps this thesis seeks to fill, especially regarding the Southeast Asian context. The chapter underscores the unique contribution of a regionally focused, CGE-based analysis of reciprocal tariffs, given the scarcity of such research to date.

Chapter 04: Methodology - CGE Model Structure and Main Equations

Chapter 4 explains how the study is carried out and why a Computable General Equilibrium (CGE) model is the most suitable method for analysing Trump's proposed tariff policies. It begins by outlining the research philosophy, which follows a positivist and quantitative approach, and links this directly to the use of formal modelling. The chapter then sets out the overall research design, including the data sources, the regional and sectoral aggregation choices, and the steps taken to prepare the GTAP database for simulation. It also describes how the four policy scenarios are constructed using a game-theoretic framework and explains how the tariff shocks are implemented in the GTAP model. The chapter also concludes with a discussion of the model's key assumptions, the closure used and limitations of the study. Together, these elements form the methodological foundation for the simulation results presented in later chapters.

Chapter 05: Data – The Main Database

The operation of a CGE model necessitates the input of various complex datasets. This research dedicates Chapters 05, 06, and 07 to an in-depth discussion of three primary data sources. Specifically, Chapter 05 will focus on the main database derived from the Global Trade Analysis Project (“GTAP”). Given its critical role, it is essential to provide a comprehensive analysis of the theoretical foundation and methodological processes underpinning the development of this core database. Chapter 05 will provide a survey and critical assessment of the principal national accounting systems, examining the relationships between these systems and the subsequent accounts and matrices, including the Input-Output tables and Social Accounting Matrices, that are fundamentally derived from them.

Chapter 06: Data – Projections for baseline scenarios: Southeast Asian economies and their partners from 2011 to 2024

For this research, ten aggregated regions and twelve aggregated sectors have been strategically defined. The central task involves updating the existing database, which currently holds a reference year of 2011, using key macroeconomic data. This essential data includes metrics such as Gross Domestic Product (GDP), population, labour force, physical capital, and arable land. To maximise the analytical utility of the compiled dataset, all collected macroeconomic statistics will be processed and computed to characterise the eleven Southeast Asian nations under study, alongside their nine aggregated trading partners. This systematic data presentation is intended to provide the reader with a comprehensive baseline overview of the economic structure, developmental status, and inherent nature of all entities included in the model.

Chapter 07: Data - Tariff Rates

This chapter marks the final phase of data preparation for the CGE analysis by focusing on the critical task of updating bilateral tariff rates. While earlier chapters have detailed the revision of the GTAP v09 database and macroeconomic aggregates for the 2017 and 2024 base years, accurately revising tariff data is essential to reflect the dramatic changes in global trade barriers over the past fifteen years. This period encompasses both the significant tariff hikes during President Trump’s first term, particularly against China, as well as a prevailing long-term trend of gradual tariff reductions worldwide. Relying solely on the outdated GTAP v09 tariff

structure would risk systemic bias in the baseline model, necessitating a sophisticated approach to gather, process, and computationally convert recent tariff information into a model-compatible format. This chapter therefore elaborates on the data sources, methods, and R-based computational techniques used to produce a rigorously calibrated tariff dataset, which is fundamental for accurate base-year calibration ahead of the policy simulations outlined in Chapter 01.

Chapter 08: Simulation Results

Chapter 08 is the empirical heart of the thesis, reporting and interpreting the results of simulating the four distinct policy scenarios.

- **Scenario 1 (S1):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners and other trading partners do not retaliate.
- **Scenario 2 (S2):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners (S1) and only China retaliates with an equivalent tariff of 34%.
- **Scenario 3 (S3):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners (S1) and China retaliates with an equivalent tariff of 34% (S2). Southeast Asia (SEA) also retaliates the US with an equivalent tariff of 34.44%
- **Scenario 4 (S4):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners (S1), apart from SEA and only China retaliates with an equivalent tariff of 34% (S2). SEA reduces all non-service tariffs to 0% in exchange for 2.3 times reduction from 34.44% to 14.97%.

Building on the methodological foundation laid out in Chapter 04, this chapter presents the simulation results alongside a comparative analysis. The chapter aims to visually and analytically demonstrate the economic impacts of the reciprocal tariffs, focusing on macroeconomic gains and losses across nations and sectoral effects across four different scenarios listed above. Due to the extensive volume of sectoral output data, the discussion will concentrate on key outcomes for the United States, China, and Southeast Asia, highlighting the regions and sectors that stand to gain or suffer most from the analysed scenarios. The outcomes are also be tested against the hypotheses set out in Chapter 04.

Chapter 09: Conclusion and Policy Implications

The thesis concludes with a synthesis of the main insights, drawing together global context, methodological innovations, and scenario results to offer clear answers to the research questions. Chapter 09 distils key findings, such as which economies and sectors are most vulnerable or resilient, how unexpected outcomes emerge from systemic interactions, and what policy measures could mitigate adverse effects or leverage new opportunities.

Limitations as well as future research directions are outlined, emphasising gaps highlighted by the analysis. The chapter also suggests how the findings can inform national policymaking, regional cooperation, and wider academic debate on trade policy under geopolitical uncertainty.

All additional empirical tables and graphs, extended methodology details, data documentation, and model code are housed in the Appendix, ensuring transparency and enabling replication of results by other scholars.

2 Chapter 02 - Literature review

2.1 Introduction

Trade policy has consistently remained a pivotal and salient focal point within the field of international economics. Tariffs, in particular, stir up strong views. Some see them as tools to protect jobs and build industries at home. Others argue they just raise prices and hurt everyone in the end. With President Trump's return to the White House in 2025 and his talk of new tariff rounds, particularly the reciprocal tariffs, it is worth digging into what the literature says about these measures.

This chapter lays out the key ideas and tools that help make sense of tariffs and their effects. Section 2.2 starts with the basics: what tariffs are and the main types in use today. From there, Section 2.3 moves to the big theories, from mercantilism's push for protection through to neoclassical warnings about deadweight losses and optimal tariff theory's explanation for why countries might still impose tariffs despite the risks of retaliation. Game theory, on the other hand, focuses on retaliation as a tool to maintain cooperation. Finally, Section 2.4 looks at analytical frameworks such as partial equilibrium, gravity models, and the general equilibrium approaches that point toward the Computable General Equilibrium method used later in this thesis. Along the way, the discussion ties back to Trump-era policies to show where theory meets real-world choices.

2.2 Types of tariffs

According to the World Trade Organisation ("WTO"), which prides itself as the sole global organisation dedicated to governing the rules of trade between nations ⁵, a tariff is defined as "*customs duties on merchandise imports*". There are many different types of tariffs, and they can be categorised into two main groups, namely (1) Classification by Application Status and (2) Classification by Calculation Method.

⁵ WTO. The WTO. Available at: https://www.wto.org/english/thewto_e/thewto_e.htm. Accessed on 21-Apr-2025.

2.2.1 Classification by Application Status

2.2.1.1 Most-Favoured Nation Tariffs

The Most-Favoured-Nation (“MFN”) principle is the bedrock of the multilateral trading system, serving as the first core tenet of the WTO, and the vast majority (83%) of global trade was conducted under the MFN scheme by the end of 2022 (WTO et al, 2025). Such a treatment also appears in the first article of the WTO’s predecessor, the General Agreement on Tariffs and Trade (“GATT”), which came into force in 1947 ⁶. Other major agreements, such as the General Agreement on Trade in Services (“GATS”) ⁷ and the Agreement on Trade-Related Aspects of Intellectual Property Rights (“TRIPS”) ⁸, which entered into force in 1995, also contain such a clause for the MFN (Saggi, 2004).

According to the WTO, “*most-favoured*” means “*non-discrimination*”. Under this rule, a WTO member nation commits to treating all other members equally, meaning any special favour or lower tariff granted to one trading partner must “*immediately and unconditionally*” be extended to all others. The MFN tariff rate is therefore the standard, non-discriminatory rate applied to a product originating from any other WTO member, barring a specific discriminating or preferential agreement. This principle ensures predictability and fairness in international commerce, preventing countries from arbitrarily setting different tax rates on imports based on their origin (WTO et al, 2025).

However, the rise of preferential tariffs, which offer lower duties to selected countries, has created a complex trade environment where tariff preferences vary widely, and discrimination occurs among trade partners. This fragmentation undermines the multilateral trading system’s uniformity and may increase trade diversion effects, prompting a re-evaluation of MFN tariffs as well as how trade liberalisation efforts should be structured in both theory and practice (WTO et al, 2025).

⁶ General Agreement on Tariffs and Trade (GATT 1947). Available at: https://www.wto.org/english/docs_e/legal_e/gatt47_e.htm. Accessed on 01-Nov-2025.

⁷ General Agreement on Trade in Services (GATS 1995). Available at: https://www.wto.org/english/docs_e/legal_e/gats_e.htm#ArticleII. Accessed on 01-Nov-2025.

⁸ Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS 1995). Available at: https://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm. Accessed on 01-Nov-2025.

2.2.1.2 Preferential Tariffs

There are two main reasons for the increase in the preferential trade agreements. The first reason is that when worldwide trade talks stall, countries are more encouraged to start one-on-one (bilateral) or smaller group (regional) trade deals instead (Capling and Low, 2010; Bhagwati, 2008). The second factor, often described as the "domino effect", is a direct consequence of the first: once Preferential Trade Agreements ("PTAs") or Free Trade Agreements ("FTAs") are established, other nations become concerned about being disadvantaged, such as losing market share, compelling them to pursue and sign similar agreements (Baldwin and Jaimovich, 2010).

Preferential tariffs are a central instrument in international trade policy, granting selected countries reduced tariff rates compared to MFN benchmarks under specific trade agreements. Preferential tariffs typically arise from regional trade agreements, or customs unions, and are intended to stimulate trade flows between participating nations by lowering trade barriers. Empirical research, such as Espitia et al (2018), shows that these arrangements have expanded the scope of duty-free trade globally, enabling around 70 per cent of countries to reduce trade-weighted average preferential tariffs to less than 5 per cent. However, the degree of preferential liberalisation varies substantially across countries and sectors, with high protection levels persisting in some low-income countries and sensitive industries like agriculture and textiles.

Despite the expansion of preferential tariffs, not all eligible trade takes full advantage of these preferences. Studies find that actual preference utilisation rates, the share of eligible imports that receive preferential treatment in relation to the total imports, are often below potential rates due to restrictive rules of origin (Hayakawa et al, 2018; WTO et al, 2025). Moreover, while preferential tariffs can boost competitiveness and market access for exporters, they may also create inefficiencies through trade diversion. Kuenzel and Sharma (2021) show that a rising share of imports sourced from PTA partners correlates with a simultaneous reduction in a country's MFN tariffs for non-partner countries to avoid "*MFN tariff revenue losses*". Since trade diversion inherently diminishes the importing country's welfare by reducing tariff revenue and lowering productive efficiency, a compensatory reduction of MFN tariffs on third-country imports can partially mitigate these initial losses and offset consumer price increases.

2.2.1.3 Bound tariffs and Applied tariffs

Bound tariffs are formal commitments made by WTO member countries that specify the maximum tariff rate they can impose on particular goods. These are negotiated and agreed upon during trade rounds and are incorporated into each country's trade schedule, serving as binding ceilings that limit what tariffs can be raised to in the future. The core purpose of bound tariffs is to promote stability, predictability, and security in international trade by preventing countries from arbitrarily increasing tariffs beyond agreed levels. If a country attempts to raise tariffs above its bound rate, other member countries can invoke dispute settlement mechanisms and seek remedies such as retaliatory tariffs or compensation, thus ensuring adherence to the commitments (WTO, 2009).

However, in practice, most countries set applied tariffs below their bound levels, allowing some degree of policy flexibility. Empirical studies reveal that the difference between bound tariffs and applied rates varies significantly across countries and sectors. This system aims to strike a balance between offering protection for sensitive sectors and maintaining overall trade liberalisation commitments. Yet, the existence of this flexibility can sometimes facilitate “*strategic*” tariff opportunism, underlining the importance of robust dispute resolution mechanisms within the WTO framework (WTO, 2015; Gibson et al, 2001).

2.2.2 Classification by Calculation Method

2.2.2.1 Ad Valorem Tariff

Ad valorem tariffs are calculated as a percentage of the imported product's cost, insurance, and freight (“CIF”) value, which already includes trade margin expenses. Notably, the importing country's tariff revenue will increase when the CIF value goes up. For instance, applying a 5% ad valorem tariff to an apple with a CIF import value of \$1 raises its final cost to \$1.05. If that apple's CIF import value were to double to \$2, the cost with the tariff included would become \$2.10 (Burfisher, 2021).

A potential drawback of an ad valorem duty is the difficulty in accurately determining the tax amount, as it relies on correctly assessing the value of both imported goods and domestic prices. Because duties based on value must strictly adhere to the rules set out in the World Trade

Organisation's Valuation Agreement, this process is often complex and time-consuming, requiring extensive data and evidence from various involved parties^{9 10}.

2.2.2.2 Specific Tariff

Specific tariffs are calculated as a fixed monetary amount per unit of the imported item (e.g., \$1 per barrel of oil). Under this system, the total tariff payment increases directly with the quantity imported (two units cost \$2, three cost \$3, etc.), but it remains constant regardless of price fluctuations. For example, the importer would pay \$1 per barrel whether the oil is valued at \$25 or \$125. Assuming the imported quantity is constant, specific tariffs provide a guaranteed and predictable revenue stream. This contrasts with ad valorem tariffs, where the revenue generated will fluctuate with changes in the import price (Burfisher, 2021).

Since the impact of Ad Valorem and specific tariffs is not the same on tariff revenue, the implications of their employment during the trade war might also be different. Lockwood and Wong (2000) show that when two countries are engaged in a trade war, and each imposes an optimal tariff, the resulting trade restriction is less stringent if both parties utilise ad valorem tariffs compared to the use of specific tariffs. Furthermore, when countries engaged in a trade war opt to use Ad Valorem tariffs rather than specific tariffs, the outcome suggests that at least one of the participating countries will be better off. The two authors also note that a nation's final decision regarding the type of trade protection it adopts may ultimately be influenced by whether consumer interests or producer interests hold greater political sway in the policy-making process. While consumers prefer Ad Valorem tariffs, producers would lobby for the latter.

When both Ad Valorem tariffs and specific tariffs are jointly used, this is now called a **compound tariff**. However, when both types of tariffs are used together, but the choice of

⁹ UK Government (2023). Trade Remedies Authority: Know your tariff: getting to grips with the different forms of trade remedy measures. Available at: <https://traderemedies.blog.gov.uk/2023/10/16/know-your-tariff-getting-to-grips-with-the-different-forms-of-trade-remedy-measures/>. Accessed on 01-Nov-2025.

¹⁰ WTO. Technical Information on Customs Valuation. Available at: https://www.wto.org/english/tratop_e/cusval_e/cusval_info_e.htm. Accessed on 01-Nov-2025.

which one applies depends on specific trigger thresholds, this mechanism is classified as a **mixed tariff**^{11 12}.

For the purposes of this thesis, President Trump’s “reciprocal” tariffs announced in April 2025 are best treated as ad valorem import tariffs, applied as additional percentage charges on the customs value of imported goods, rather than as specific (US Dollar per unit) duties. In practice, the policy combines a broadly applied across-the-board ad valorem surcharge (the 10 per cent baseline tariff on most imports) with extra, higher ad valorem rates targeted at selected trading partners with large bilateral deficits, which can be read as discriminatory layers on top of existing MFN structures. President Trump’s reciprocal tariffs will be discussed in more detail in Chapter 07.

It is crucial to note that the use of tariffs is not a recent phenomenon but has existed for hundreds of years. This next section will examine various economic schools, traditions, theories and empirical approaches to understand how they perceive the role of tariffs and how the impacts of tariffs are analysed.

2.3 Review of the main economic theories on tariffs and trade wars

2.3.1 Mercantilist

Mercantilist economic thought, dominant from the 16th to mid-18th centuries, firmly regarded tariffs as a fundamental policy tool for national prosperity and security. According to Chang (2014), Mercantilism is typically demonstrated nowadays as primarily focusing on “*generating trade surplus*”. In other words, Mercantilists wanted a nation to try to export as much as possible while restricting imports. While others, such as Blink and Dorton (2020), might have mistakenly portrayed mercantilism as aiming solely to increase a nation’s wealth by gaining more gold and silver through trade, which should have been referred to as bullionism, a subset of mercantilism. Such negative demonstrations of mercantilism might mislead non-specialist readers, as Chang (2014) believes that many of the early mercantilists were more eager to

¹¹ World Bank. Forms of Import Tariffs. Available at: https://wits.worldbank.org/wits/wits/witshelp/content/data_retrieval/p/intro/C2.Forms_of_Import_Tariffs.htm. Accessed on 01-Nov-2025.

¹² WTO. Jargon buster. Available at: https://www.wto.org/english/tratop_e/dda_e/status_e/jargon_e.htm. Accessed on 01-Nov-2025.

promote highly productive sectors, which could have failed to materialise under a free market, such as competition from more well-established sectors from other countries. Such promotions were generally done via policy interventions.

Mercantilist writers contended that state intervention in trade, especially via import tariffs and export subsidies, was essential for preserving domestic employment, stimulating industrial growth, and amassing national wealth in the form of bullion. Prominent figures such as Giovanni Botero (1589)¹³ and Antonio Serra (1613)¹⁴ in today's Italy, Thomas Mun (1624)¹⁵ in England and Jean-Baptiste Colbert¹⁶ in France represented such a way of thinking. These influential works underline the promotion of manufacturing and industrial development, export promotion and a favourable trade balance and the use of tariffs and other protectionist policies. The mercantilist view also became a dominant view among the United States of America's founders, for example, through the "*Report on the Subject of Manufactures*", which was presented to the US Congress in 1791 by Alexander Hamilton, the first US Treasury Secretary¹⁷. Hamilton (1791) is considered the first to introduce an argument for "*infant industry*" protection.

While many researchers might regard mercantilism as a standalone doctrine, Chang (2014) categorised mercantilism within a broader tradition of developmentalism. This perspective rationalises tariffs as tools to correct market failures in dynamic trade settings, where free trade might lock countries into low-productivity specialisation. Hirschman (1958) and Myrdal (1957) later extended these ideas to advocate unbalanced growth strategies in developing economies. Empirically, such logic underpins contemporary strategic trade policies, where large countries impose tariffs to capture rents in oligopolistic sectors (Brander and Spencer, 1984; Colacicco, 2024).

Several researchers regarded President Trump's trade policies during his first term as mercantilist or neo-mercantilist (Nelson, 2019; Helleiner, 2019). Yet mercantilism's zero-sum view of trade neglects comparative advantage and general equilibrium (economy-wide)

¹³ Italian title: *Della Ragion di Stato* (Translate: The Reason of State)

¹⁴ Italian title: *Breve trattato delle cause che possono far abbondare li regni d'oro et argento dove non sono miniere* (Translate: A Short Treatise on the Causes that Can Make Gold and Silver Abundant in Kingdoms Where There Are No Mines)

¹⁵ *England's Treasure by Foreign Trade, Or The Balance of Our Foreign Trade Is The Rule Of Our Treasure*

¹⁶ A French statesman and King Louis XIV's finance minister, Jean-Baptiste Colbert. Although Colbert never produced a formal treatise, his collected memoranda, letters, and legislative policies collectively define and embody French mercantilism, commonly referred to as "Colbertisme". (Chang, 2002 & 2014)

¹⁷ National Archives. Alexander Hamilton's Final Version of the Report on the Subject of Manufactures, available at: <https://founders.archives.gov/documents/Hamilton/01-10-02-0001-0007>. Accessed on 09-Oct-2025.

feedback, assuming fixed global demand rather than mutual gains from specialisation, a limitation starkly exposed by Classical economists.

2.3.2 Classical

Classical economic theory, pioneered by Adam Smith and further developed by David Ricardo, fundamentally challenged the mercantilist endorsement of tariffs by emphasising the benefits of free trade (a positive-sum endeavour rather than a zero-sum game) grounded in absolute and comparative advantage principles. Smith, in his seminal work *The Nature and Causes of the Wealth of Nations* (1776), criticised mercantilism's zero-sum view of trade and argued instead that nations prospered by specialising in activities where they held an absolute efficiency ("*absolute advantage*") over others, thereby increasing overall wealth and productivity globally. He maintained that tariffs and trade restrictions distorted market efficiencies and ultimately harmed consumers through higher prices and reduced product availability (Smith, 1776/2012). This marked a pivotal shift from the mercantilist and bullionist view of wealth as stockpiles of precious metals to understanding it as the total output and production capabilities of a nation. Also, according to Smith (1776/2012), labour is the fundamental measure of value and wealth creation, and the labour theory of value is also the foundation for Smith's arguments, as well as for the Classical school ¹⁸.

Building on Smith's framework, Ricardo introduced the concept of "*comparative advantage*" in his influential 1817 book *On the Principles of Political Economy and Taxation*, which reinforced free trade even further by demonstrating that countries benefit from specialising in goods for which they have a lower opportunity cost, regardless of whether they hold an absolute advantage. Ricardo's example of the cloth and wine trade between England and Portugal ¹⁹ mathematically illustrates the inefficiencies imposed by tariffs or any other trade restrictions,

¹⁸ "... It was not by gold or by silver; but by labour, that all the wealth of the world was originally purchased; and its value, to those who possess it, and who want to exchange it for some new productions, is precisely equal to the quantity of labour which it can enable them to purchase or command." Available at: <http://gesd.free.fr/smith76bis.pdf>. Accessed on 14-Oct-25.

¹⁹ "To produce the wine in Portugal, might require only the labour of 80 men for one year; and to produce the cloth in the same country, might require the labour of 90 men for the same time. It would therefore be advantageous for her to export wine in exchange for cloth. This exchange might even take place, notwithstanding that the commodity imported by Portugal could be produced there with less labour than in England. Though she could make the cloth with the labour of 90 men, she would import it from a country where it required the labour of 100 men to produce it, because it would be advantageous to her rather to employ her capital in the production of wine, for which she would obtain more cloth from England, than she could produce by diverting a portion of her capital from the cultivation of vines to the manufacture of cloth." Available at: https://oll-resources.s3.us-east-2.amazonaws.com/oll3/store/titles/113/Ricardo_0687-01_EBk_v6.0.pdf. Accessed on 14-Oct-25.

showing that barriers to trade prevent countries from realising gains derived from a more efficient global allocation of resources, for example, the specialisation of labour (Ricardo, 1817). This analytical breakthrough provided a powerful normative argument against tariffs, illustrating that protectionist policies often reduce economic welfare not only abroad but also domestically, a fundamental challenge to the mercantilist doctrine. While Ricardo's theory is not a dynamic one (e.g., unchanged technologies), Chang (2014) regards this as “*still one of the best theories of international trade*”. This framework underpinned post-WWII trade liberalisation, with GATT/WTO rounds empirically validating Ricardo's predictions (Powell, B (Ed., 2018) ²⁰.

However, classical economics relies on certain assumptions, such as perfect labour mobility and flexible prices, which Keynes (1936) rejected as he pointed out different types of unemployment, including “*involuntary unemployment*”. Its successors, the Neoclassical school, have also dismissed the classical economics' labour theory of value, which will be presented in the next section. For Trump 2.0's tariffs, classical logic anticipates aggregate welfare losses from distorted specialisation but overlooks large-country terms-of-trade gains addressed in optimal-tariff theory (to be discussed in the later section).

2.3.3 Neoclassical

The Neoclassical school of economic thought emerged in the 1870s, rooted in the foundational contributions of key figures such as William Jevons (1835–82) and Léon Walras (1834–1910). This school was solidified and gained widespread acceptance following the 1890 publication of Alfred Marshall's influential work, *Principles of Economics*.

Neoclassical economic theory builds upon classical foundations by incorporating more rigorous mathematical modelling and believes in laissez-faire or free markets and free trade. Unlike the Classical school, Neoclassical emphasises demand and consumption rather than supply and production. As a result, the way value is measured is also different between the two schools. Value or price, according to Neoclassical economists, depends on how much the consumers are willing to pay for an additional unit. This approach gave rise to the “marginal” revolution (Chang, 2014). Unlike mercantilism's focus on protectionism and the accumulation

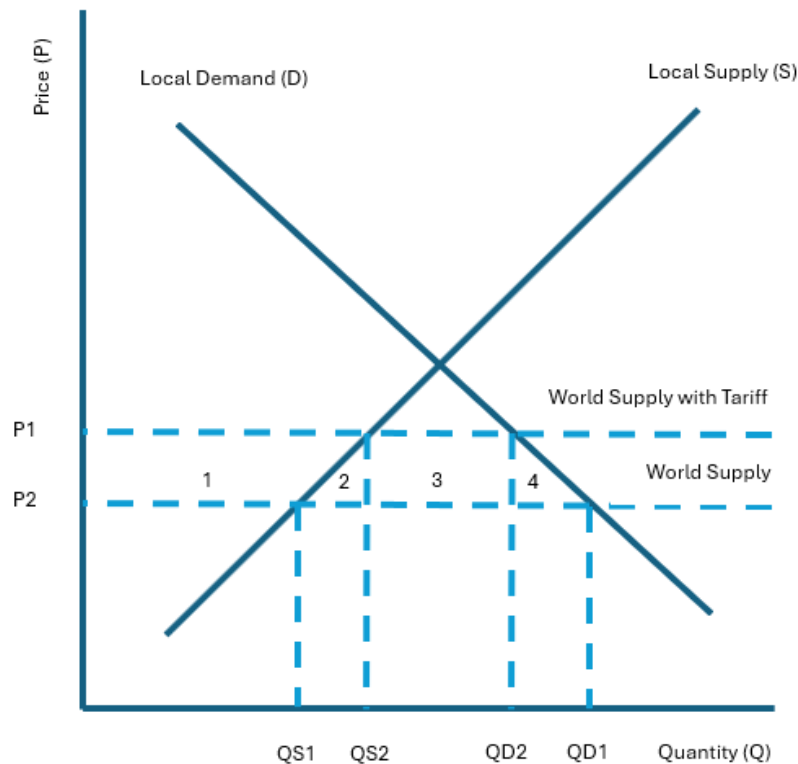
²⁰ Powell, B. (Ed.). (2018). *Economic Freedom and Prosperity: The Origins and Maintenance of Liberalization* (1st ed.). Routledge. <https://doi.org/10.4324/9780429443817> (Chapter The case for free trade since David Ricardo)

of wealth through trade restrictions, neoclassical economists emphasise that tariffs generate welfare losses by distorting prices and consumption patterns (Viner, 1950).

A key neoclassical contribution is Viner's (1950) analysis of customs unions, which introduces the concepts of trade creation and trade diversion as tools for evaluating the welfare effects of preferential liberalisation. Trade creation occurs when tariff reduction shifts demand from high-cost domestic production to lower-cost partner imports, thereby raising welfare. In contrast, trade diversion occurs when preferences shift imports from an efficient non-member to a higher-cost member, reducing welfare despite higher intra-bloc trade. This distinction showed that tariff changes cannot be assessed purely by their impact on trade volumes; their welfare implications depend on how they reallocate production across sources with different costs.

The familiar partial-equilibrium tariff diagram, with a downward-sloping demand, an upward-sloping domestic supply, and a horizontal world-supply schedule, illustrates these neoclassical insights in a single market. The graph below, and other similar ones, which are included in many economics textbooks such as Blink and Dorton (2020) and trade research papers such as Piermartini and Teh (2005) from the WTO, illustrate the effects of a tariff (tax on imports) and its removal on a local market's supply, demand, and pricing structure. The horizontal axis represents quantity (Q), while the vertical axis shows price (P). Two world supply curves are indicated: "World Supply" (the global price) and "World Supply with Tax" (the world price plus tariff), along with local supply and demand curves. The vertical distance between the two world supply curves demonstrates the level of a tariff (tax) per unit.

Initially, with the tariff in place, the domestic price for consumers is at P_1 (World Supply with Tax). At this price, domestic producers supply up to QS_2 and domestic consumers demand up to QD_2 , with the gap between QS_2 and QD_2 being met by imports. The tariff benefits local suppliers as it allows them to sell a higher quantity at a higher price than if goods were freely importable at the world price. It also leads to government tariff revenue (typically the area between QS_2 and QD_2 at the difference between P_1 and P_2 or area 3), but it reduces total consumption and raises costs for consumers.



Graph 02.01: Trade Creation (Author's own graph)

Upon the removal of the tariff, the relevant supply curve shifts from “World Supply with Tax” (P_1) down to “World Supply” (P_2). The price paid by consumers falls to P_2 , increasing total quantity demanded to QD_1 and decreasing domestic supply to QS_1 as cheaper imports satisfy a larger part of market demand. Local suppliers now face more competition and are able to sell less at a lower price. Domestic consumers benefit from lower prices and increased variety, while import volumes rise. Areas 2 and 4, which were previously deadweight losses due to relatively less efficient, more expensive production carried out by local producers and loss of consumer surplus, respectively, under the tariff imposition scenario, have now become sources of gains for the tax-removing country.

The above graph, under the neoclassical framework, highlights classic outcomes of tariff removal: lower consumer prices, greater market efficiency, reduced protection for local producers, increased imports, and the disappearance of tariff revenue for the government. Overall, the market moves toward greater integration with the world economy, benefiting consumers but challenging less competitive local industries. The theoretical frameworks established by the Classical and Neoclassical schools of economic thought provided the

foundational intellectual justification for the global movement toward trade liberalisation and the comprehensive reduction or removal of tariffs.

However, the limitations of this framework are as important as its elegance. The standard model assumes perfect competition (as seen in a horizontal supply curve), constant returns to scale, and exogenous technologies, so it cannot capture strategic behaviour, scale economies, or dynamic learning that might justify temporary protection. It is also intrinsically partial-equilibrium, meaning changes in one sector's tariff are analysed holding other markets and macro variables constant, ignoring general-equilibrium feedback through factor markets, exchange rates, and inter-industry linkages. These assumptions are particularly problematic for evaluating large-country trade wars or package tariffs such as those announced under President Trump's second term, where retaliation, cross-sector spillovers and macroeconomic adjustments are central.

2.3.4 Optimum tariff

Optimal-tariff theory deepens and partly overturns the neoclassical presumption that tariffs are always welfare-reducing by allowing for market power in world trade.

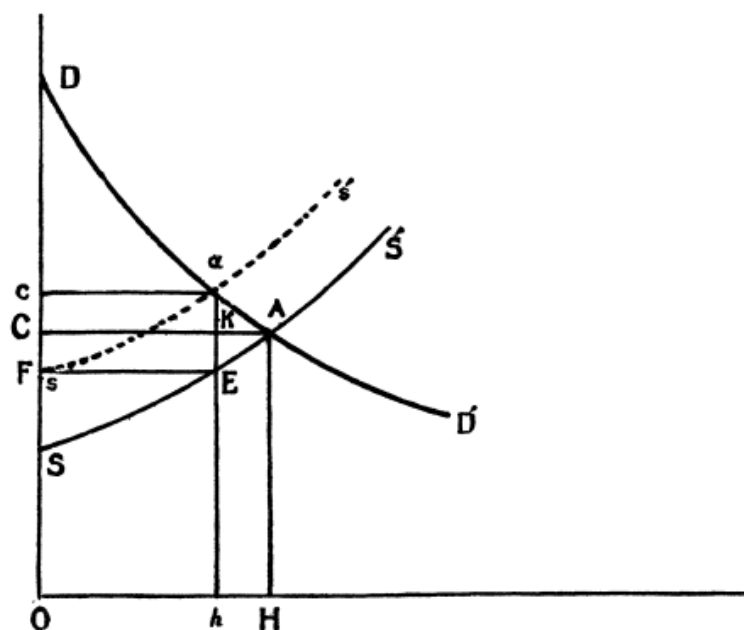
The literature review of the Optimum tariff theory is well documented by Humphrey (1987). Despite the common misconception that this theory emerged in the 1940s, following the key works, as referred in Humphrey (1987), of Kaldor (1940) and Lerner (1944), the concept was, in fact, originally proposed more than a century earlier. The optimum tariff theory, with foundational roots in the early nineteenth century, offers a nuanced perspective on the use of tariffs by nations possessing market power. Contrary to the conventional free-trade argument that unrestricted commerce benefits all parties, early economists such as John Stuart Mill (1829-30) and Robert Torrens (1844), Alfred Marshall (1870s), Henry Sidgwick (1880s), Francis Edgeworth (1894) along with later formalisations by Charles Bickerdike (1906), demonstrated that a country could enhance its welfare by imposing a tariff that improves its terms of trade, which is defined as the relative price of exports to imports, if the tariff is carefully calibrated and foreign retaliation is limited. The core insight is that by reducing its demand for imported goods, a country can lower the world price of those goods, effectively extracting economic rents from foreign suppliers. It is important to note that, unlike the neoclassical graph above showing price-taking and a relatively small country, the key

assumption for any country to employ such a strategy and to win the trade war is that it needs to be relatively large to influence the world price level and the world supply curve (Naito, 2019).

Charles Bickerdike's contributions in the early 1900s advanced optimum tariff theory by framing the tariff-setting country as a monopolist exploiting its power to influence import prices. Bickerdike formalised the conditions under which a tariff produces net welfare gains, emphasising that these depend on the elasticities of export supply and import demand. His welfare analysis demonstrated that small, well-targeted tariffs could generate government revenue while improving terms of trade. However, he also cautioned that excessive tariffs or retaliation would negate these benefits.

Despite encouraging theoretical results, the literature acknowledges several practical challenges of applying optimum tariff theory. The inability to precisely identify the optimum tariff rate, the risk of retaliatory trade wars, and the moral and global welfare implications of protectionism limit its real-world application. While Humphrey (1987) noted that most of the above economists assumed no retaliatory scenario, Johnson (1953) showed that a tariff-imposing country could still gain even when other countries retaliate.

Bickerdike (1906, p.533)'s simple model below, which relies on the neoclassical framework, illustrates how a tariff-imposing country could benefit from the net gain.



Graph 02.02: Optimal Tariff (Bickerdike, 1906, p.533)

This graph depicts the classic optimum tariff scenario in which a country with market power imposes a tariff on imports, thereby influencing both supply and price. The original (free) market equilibrium is established at the intersection of the demand curve DD' and the initial supply curve SS' , resulting in equilibrium at point A. When a tariff is introduced, the effective supply curve shifts leftward to ss' , raising the domestic price from C to c. This contraction in supply, caused by the tariff (Assuming the vertical distance between SS' and ss'), leads to multiple redistributive and welfare effects within the domestic market. Consumers experience a loss in surplus equivalent to the area $cCAa$, as they either pay a higher price for the good or are priced out of the market entirely. The government, however, collects tariff revenue represented by the area $cFEa$, the product of the tariff per unit and the new volume of imports. Comparing these areas, the net welfare effect of the tariff for the country is determined by examining the difference between $CFEK$ (the government's gain from improved terms of trade, the ability to purchase imports at a lower cost F) and AKa (the deadweight loss from distorted consumption and production). If $CFEK$ is larger than AKa , which this diagram shows, then the country realises a net gain from imposing the tariff.

Nevertheless, the final magnitude and even the sign of the welfare effect depend critically on the relative elasticities of the supply and demand curves. Greater elasticity in either supply or demand reduces the ability of the tariff-imposing country to manipulate world prices and increases the scope for trade diversion or substitution, thereby shrinking the optimal gain. If foreign supply is highly elastic, the terms of trade gain for the importing country falls, and the deadweight losses may outweigh the benefits. Conversely, with more inelastic foreign supply and domestic demand, the imposing country can capture a larger share of the welfare gains. Thus, this graphic powerfully illustrates not just the mechanics of the optimum tariff argument but also its dependence on underlying market elasticities.

In the context of President Trump's reciprocal tariffs, the optimal-tariff theory helps explain the underlying intuition that a large country, in this case the US, seeks to exploit its tariff weapon to extract concessions or improve its own terms of trade at the expense of other smaller countries, many of which are in Southeast Asia. This should be seen in the context of a one-shot game without facing retaliation from others.

However, when other large countries or groups retaliate, the situation may become more complicated. Therefore, apart from considering changes in terms of trade, retaliatory scenarios

should also be taken into account to reflect a more realistically complex world. Game theory is well-suited to help understand such tariff “games” between trade partners.

2.3.5 Game theory

2.3.5.1 From Unilateral Optimality to Strategic Interaction

Game theory provides the bridge between unilateral optimal-tariff logic and the strategic reality of “reciprocal” or retaliatory trade wars.

The analysis of the **optimal tariff**, derived from the classic work of Johnson (1953/54) as mentioned in the previous section, serves as a crucial point of departure for understanding the application of game theory to international trade policy. The optimal tariff framework demonstrates that a large country can unilaterally maximise its national welfare by imposing a tariff that exploits its market power, driving down the price of imports and improving its terms of trade.

However, once other governments are allowed to respond and deviate from the trade agreement, tariff setting becomes a non-cooperative game, which means that each large country has an incentive to tax imports (or exports) to exploit market power, and this unilateral optimisation and then subsequent counterbalance from each country or government leads directly to a Prisoner's Dilemma structure (Bagwell and Staiger, 2003; Latina et al, 2011). The theoretical foundation of modern non-cooperative game theory is the Nash Equilibrium (“NE”), formalised by Nash (1951), which posits that an outcome is stable if no single player can unilaterally deviate to improve their payoff, given the strategies of all other players. In other words, it could be understood that the Nash Equilibrium shows the best response by one party against the best response of the other party. The Prisoner’s Dilemma was first formulated by Merrill Flood and Melvin Dresher and later given its now standard story and label by Albert W. Tucker. Within game theory, it is distinctive because it captures a sharp tension between what is best for the group and what is individually rational. In other words, the outcome that maximises total payoffs (a Pareto-efficient cooperative choice) differs from the outcome that is stable when each player acts in their own self-interest (the Nash equilibrium) (Apt & Grädel, 2011). While the Pareto-optimal outcome for all trading nations appears to be free trade (analogous to mutual cooperation), the unilaterally optimal policy (imposing the tariff/defection) is the dominant strategy for each country, resulting in a Nash Equilibrium

characterised by a mutually destructive tariff war (mutually higher tariffs and lower welfare). This non-cooperative NE, where all countries impose high tariffs, yields a lower payoff for every participant compared to the free trade outcome.

This structural dilemma suggests abandoning static one-shot optimisation models in favour of dynamic, non-cooperative game theory to explain how the globally efficient outcome (free trade) can be sustained despite the perennial temptation to deviate (imposing the optimal tariff).

2.3.5.2 Repeated Games and the Enforcement of Cooperative Trade Outcomes

As discussed above, the trade war equilibrium is inefficient, given that a relatively large player or country has the incentive to unilaterally impose positive and increased optimal tariffs to enhance its own economic welfare at the expense of the other countries, as well as of the aggregate social welfare. To minimise such inefficiency and to account for the stability of cooperative outcomes, a trade agreement appears as a solution.

To ensure compliance from all parties, the trade agreement must contain self-enforcing mechanisms without requiring external monitoring or enforcement. As a result, the literature shifts focus to repeated games. Repeated-game models extend the static analysis by showing how international cooperation (for example, low tariffs and free trade) can be sustained indefinitely, even though the incentive to impose a unilateral optimal tariff exists in every period (The Prisoner's Dilemma). In an infinitely repeated setting, the Folk Theorem (Fudenberg & Maskin, 1986) demonstrates that if all agents are sufficiently patient (i.e., have a high discount factor "*tend[ing] to one*"), a wide range of cooperative outcomes²¹ can be supported as Subgame Perfect Nash Equilibria ("SPNE"). This is achieved through trigger strategies, where current adherence to agreed-upon low tariffs is rewarded, but any deviation (imposing a higher, unilateral optimal tariff) is punished by retaliation with higher and reciprocal tariffs (trigger strategy) from other countries. The creation of GATT's (and later WTO's) dispute settlement procedures could be seen as an international attempt to mutually guarantee the "*cooperative equilibrium outcome*". Aggressive unilateral tariff increases, such as those implemented during the Trump administration's first and second terms, are therefore viewed in game-theoretic models as a deviation from the agreed-upon cooperative path. This

²¹ While the authors did not specifically address trade issues, the cooperative outcomes in international economics could include reciprocal tariff reductions and bindings consistent with GATT/WTO rules.

deviation risks activating the punishment phase and retaliation from other partners, resulting to lower welfare for all players predicted by the static Nash Equilibrium. A typical trigger strategy involves an agreement to maintain free trade until one country deviates (imposes the optimal tariff), at which point all other countries immediately revert to the mutually punitive tariff war (the NE) forever. The credibility of the threat, the punishment being the NE of the stage game, is the mechanism by which the repeated game theory provides a foundation for the stability of international trade agreements (Bagwell & Staiger, 2003).

Trigger strategies and folk-theorem results are useful for thinking about long-run cooperation, but they rely on assumptions that are hard to match with real trade policy. Standard repeated-game models typically assume very patient players, almost perfect monitoring (all players' actions are observable by everyone else), and punishment rules (like grim trigger) that can be carried out without political or economic cost (Fudenberg and Maskin, 1986; Fudenberg and Tirole, 1991). Governments do not look like these players. They face elections, lobbying pressures, and uncertainty about trading partners' actions. Because of this, the folk theorem's message, that almost any cooperative outcome can be sustained if players are patient enough, is better interpreted as an upper bound on what strategic interaction might achieve, not as a literal prediction (Mailath and Samuelson, 2006; Hörner et al., 2011). Once we allow for switching costs, imperfect monitoring, or limited-memory strategies, the set of sustainable equilibria becomes much smaller, and harsh punishments like grim trigger often stop being credible.

In addition, as mentioned above, in repeated-game models of trade agreements, the self-enforcing assumption means that cooperation is sustained not by an external enforcer but by the parties' own future-oriented incentives, when the future costs of retaliation outweigh the short-term gains from deviation. In other words, these models do not assume any world or supranational government that enforces tariffs. In the contemporary international political system, where nation-states are the dominant form, the fundamental difference between international and domestic politics lies in the fact that, on the international stage, political entities must operate and coexist without the presence of a superior, "*overarching authority*" or supernational entity (Baylis et al, 2017). It is important to make clear that the WTO is not a supernational organisation that could overrule national decisions or possesses authority to "*directly enforce agreements*" (Maggi, 1999); rather, the WTO regards itself as "*a negotiating forum*". When it comes to disputes among member states, its "*unique contribution*" is "*dispute settlement*" and while "*much of the procedure does resemble a court or tribunal*", "*the priority*

is to settle disputes” and “*not to pass judgement*”²². Having carefully reviewed some of the functions as well as personnel within the panellists and Appellate Body of the WTO, Pauwelyn and Pelc (2022) concluded that the WTO’s Dispute Settlement Mechanism (“DSM”) is more accurately characterised as “*a sui generis administrative review process*” rather than being viewed as a “*World Trade Court*”. The Latin phrase “*sui generis*” refers to “*of its own kind*”, meaning that the WTO’s DSM is a unique type of procedure that does not fit neatly into standard categories such as an international court. Taken together, these institutional features reinforce the self-enforcing nature of trade agreements while also highlighting why real-world enforcement is more procedural, political, and constrained than the stylised mechanisms assumed in repeated-game models.

These institutional features matter because they shape how governments actually respond to deviations from trade commitments. The absence of automatic enforcement and the procedural nature of the WTO’s DSM mean that real-world punishment strategies might depend heavily on domestic politics, administrative capacity, and the strategic environment. A clearer view of how institutional and political constraints shape enforcement comes from examining recent U.S. tariff actions. When the United States imposed steel, aluminium, and China-related tariffs during President Trump’s first term, major trading partners did respond, but their actions were far more selective and delayed than the immediate, symmetric punishments predicted by simple repeated-game models. WTO dispute records, such as cases DS544 (China’s Complaint of the US’s measures on Steel and Aluminium Products)²³ and DS548 (The EU’s Complaint of the US’s measures on Steel and Aluminium Products)²⁴, show that many governments first turned to formal litigation rather than immediate retaliation, reflecting the legal and procedural requirements embedded in the multilateral system. The European Union adopted proportionate countermeasures under WTO rules and explicitly stated that its objective was to avoid escalation (European Commission, 2018)²⁵. Countries with strong security or economic ties to the United States, such as South Korea, often opted for (re)negotiation or limited responses instead of full retaliation against President Trump’s tariffs. According to the Office of the United States Trade Representative as well as the US Customs and Border Protection, South

²² WTO. A unique contribution. Available at: https://www.wto.org/english/thewto_e/whatis_e/tif_e/displ_e.htm. Accessed on 16-Oct-2025.

²³ WTO. Case DS544: United States — Certain Measures on Steel and Aluminium Products. Available at: [WTO | dispute settlement - the disputes - DS544](#). Accessed on 31-Dec-2025.

²⁴ WTO. Case DS548: United States — Certain Measures on Steel and Aluminium Products. Available at: [WTO | dispute settlement - the disputes - DS548](#). Accessed on 31-Dec-2025.

²⁵ European Commission (2018). EU adopts rebalancing measures in reaction to US steel and aluminium tariffs. Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_18_4220. Accessed on 31-Dec-2025.

Korea benefited from a tariff-free import quota for steel in exchange for a revived trade agreement between the two countries, the KORUS, signed in 2012, which provided more benefits to the US ^{26 27}. These patterns show that governments operate within institutional and political constraints that make harsh trigger-style punishments neither credible nor desirable. As a result, repeated-game theory remains useful for identifying incentives and potential strategic pressures, but it cannot fully capture the legal, administrative, and domestic political factors that shape real-world trade policy.

2.4 Review of key analytical frameworks for trade and tariff analysis

2.4.1 Partial equilibrium

Partial equilibrium (“PE”), a concept introduced by Alfred Marshall (1890), focuses on the equilibrium conditions within a specific market or industry while holding all other markets and factors constant. Such a condition or assumption is normally known as *ceteris paribus*. All the graphical models presented in the previous sections, using the supply and demand curves, are regarded as theoretical partial equilibrium models.

The partial equilibrium approach is a widely used methodology in trade and tariff analysis, particularly effective for assessing the effects of trade policies on specific sectors or industries without the complexity of economy-wide feedback. Partial Equilibrium trade models are frameworks of equations, derived from economic theory, that account for the various factors affecting the price and sale of both imported and domestically produced goods. These models are designed to estimate the economic consequences of changes in trade barriers (like tariffs and non-tariff measures) on variables such as domestic production and trade volumes. In some PE models, the analysis is extended to calculate changes in equilibrium prices and welfare. Some of the PE trade models used by the UK Government’s Department for Business and Trade include the UK Partial Equilibrium Trade model (PETRA) and the PE Demand model (PE-D) (Department for Business and Trade, 2025).

²⁶ Office of the United States Trade Representative (2018). Fact Sheet on U.S.-Korea Free Trade Agreement Outcomes. Available at: <https://ustr.gov/about-us/policy-offices/press-office/fact-sheets/2018/september/fact-sheet-us-korea-free-trade>. Accessed on 31-Dec-2025.

²⁷ US Customs and Border Protection (2018). QB 18-123 Announcement for Steel Mill Articles: South Korea. Available at: <https://www.cbp.gov/trade/quota/bulletins/qb-18-123-announcement-steel-mill-articles-south-korea>. Accessed on 31-Dec-2025.

Econometric methods play a crucial role in enhancing the precision of partial equilibrium analyses, particularly in the context of tariff policy evaluation. By leveraging econometrics, researchers can estimate critical parameters such as price elasticities of demand and supply, substitution elasticities between domestic and imported goods, and the responsiveness of trade volumes to tariff changes. These parameters are essential inputs for PE models, enabling them to simulate how industries adjust to tariff modifications with greater empirical rigour. For instance, Hallren and Riker (2017) highlight how econometric techniques underpin the calibration of industry-specific PE models, ensuring that results reflect realistic consumer behaviour patterns and market responses, which in turn improve the reliability of ex-ante and ex-post policy evaluations. PE also requires fewer data inputs compared to CGE models

High-quality econometric estimation also addresses some key limitations of PE models by introducing data-driven robustness and the ability to test model sensitivity to parameter variations. Techniques such as regression analysis, instrumental variables, and maximum likelihood estimation have been widely used to extract elasticities and other behavioural parameters from trade data. Moreover, econometric frameworks facilitate the incorporation of micro-level data, allowing analyses of heterogeneous impacts across sectors and products. This empirical grounding enhances the explanatory power of PE models in capturing welfare changes, trade diversion, and trade creation effects arising from tariff implementation or removal. Recent advancements in econometrics also allow for dynamic partial equilibrium modelling, where time-series and panel data techniques enable the tracking of trade responses over time, accounting for lagged effects and evolving market structures (Gujarari & Porter, 2010).

Despite these strengths, there are notable limitations linked to both PE approaches and their econometric underpinnings. PE models inherently focus on isolated sectors or markets and ignore general equilibrium feedback. Unlike PE, the general equilibrium approach, which will be discussed in the following chapters and also the main method to be used in this research, allows all sectors and key (endogenous) variables to alter simultaneously beyond the sector analysed. Consequently, while econometrics enhances the estimation of parameters within the model's scope, this scope remains limited as many unobserved but important influences are only captured in the error terms (Gujarari & Porter, 2010). Numerous scholars have highlighted that such models can underestimate the full economic impact of tariffs because they do not capture indirect linkages and macroeconomic adjustments (Boer and Rieth, 2024) or “*does a poor job*” with post-shock prediction (Narayanan et al, 2010). Furthermore, the accuracy of

econometric estimates, as well as other types of models, including general equilibrium models, depends heavily on data quality and the validity of identifying assumptions, such as exogeneity and stable functional forms, which are occasionally problematic in trade policy contexts with evolving market conditions and policy regimes.

2.4.2 Gravity Model

Since its introduction by Tinbergen in 1962, the gravity model has remained one of the most well-known and successful empirical models in economics. The model, inspired by Newton's gravity model for the natural world, describes the pull and push factors in bilateral international trade. Under Tinbergen (1962)'s model, trade volume between two countries is expected to be positively correlated with the economic mass of trade partners measured in “*gross national product*” (“GNP”), but in fact Gross Domestic Product (“GDP”) has been more widely used ever since (Chaney, 2018), and reversely influenced by distance and trade costs between the two nations. The trade costs normally take into account geographical distance, currency, regional trade agreements, historical ties, shared / common language, shared border, etc. Deriving from this assumption, larger countries are expected to trade more with each other while faraway countries trade less among themselves.

$$Trade_{i,j} = \frac{(GDP_i)^\alpha (GDP_j)^\beta}{(Distance_{ij})^\zeta}$$

In its most basic form, the above gravity model can be written or transformed into a log-linear econometric model as follows (Shepherd et al, 2019):

$$\log X_{ij} = c + b_1 \log GDP_i + b_2 \log GDP_j + b_3 \log \tau_{ij} + e_{ij}$$

$$\log \tau_{ij} = \log (distance_{ij})$$

where X_{ij} indicates exports from country i to country j , GDP is each country's gross domestic product, τ_{ij} represents trade costs between the two countries, distance is the geographical

distance between them, as an observable proxy for trade costs, and e_{ij} is a random error term. The c term is a regression constant, and the b terms are coefficients to be estimated.

According to Shepherd et al (2019), there are several problems with this intuitive model. Firstly, this intuitive model is static and cannot account for changes in the trade costs. For example, between three countries, namely i , j , and k , if i and k happen to sign the trade agreement, such an agreement would have no impact on any other trade routes because $\frac{\partial \log X_{ij}}{\partial \log \tau_{ik}} = 0$. The second problem is that uniform changes in trade costs across all routes, despite leaving the relative prices constant, could still illogically alter trade across all routes. As a result, a new theoretically grounded model is needed.

The Structural Gravity Model has become a cornerstone in contemporary trade policy analysis, offering an empirically robust and theoretically sound framework for quantifying tariff impacts. Building on Anderson and van Wincoop (2003) paper, the structural gravity approach advances beyond traditional gravity models by incorporating the inward and outward “*multilateral resistance*” terms, which measure how tariffs and other trade barriers faced by a pair of countries compare to those facing alternative trade partners. The inward multilateral resistance reflects unobserved trade costs relative to a reference importer. If the inward resistance is less than zero, this implies less resistance to access that importing market relative to the reference importer. On the other hand, unobserved trade costs relative to a reference exporter are captured by the outward multilateral resistance term. If the outward multilateral resistance term is greater than zero, this implies more resistance to exports from that country relative to the reference exporter. The traditional gravity equation would generate biased results if the two terms are not included, as doing so “*overstates bilateral trade elasticities*” (Behar & Nelson, 2012). This innovation ensures that bilateral trade is modelled not in isolation, but within the broader context of global trade networks, capturing the fact that exporters and importers adjust their sourcing and market strategies in response to relative price and policy changes throughout the world (Anderson & van Wincoop, 2003).

Anderson and van Wincoop (2003)’s gravity model takes this multiplicative form, which is basically a demand function:

$$X_{ij}^k = \frac{Y_i^k E_j^k}{Y^k} \left\{ \frac{\tau_{ij}^k}{\Pi_i^k P_i^k} \right\}^{1-\sigma_k}$$

where:

$$\Pi_i^k = \sum_{j=1}^C \left\{ \frac{\tau_{ij}^k}{P_j^k} \right\}^{1-\sigma_k} \frac{E_j^k}{Y^k}$$

$$P_j^k = \sum_{i=1}^C \left\{ \frac{\tau_{ij}^k}{\Pi_i^k} \right\}^{1-\sigma_k} \frac{E_i^k}{Y^k}$$

The two multilateral resistance terms, Π_i^k and P_i^k , are “*unobservable*” because they do not correspond to any price indices collected by national statistical agencies. And by linearising the above multiplicative form, we have:

$$\log X_{ij}^k = \log Y_i^k + \log E_j^k - \log Y^k + (1 - \sigma_k)(\log \tau_{ij}^k - \log \Pi_i^k - \log P_i^k)$$

To overcome the unobservability of the two resistance terms, several methods have been used, such as fixed effects estimation. This technique basically creates a dummy variable for each country in the dataset to capture country-specific unobservable factors. However, gravity models, which use this method and incorporate a large (disaggregated) number of economic sectors rather than a single aggregated one, rapidly become impractical or difficult to manage because of the sheer volume of parameters that must be estimated and handled (Shepherd et al, 2019). Additionally, all trade flows with zero values also need to be dropped as the natural logarithm function, $\ln(x)$, is only defined for positive values of x greater than 0. Alternatively, the structural gravity model can use the Poisson Pseudo Maximum Likelihood (“PPML”) techniques to address heteroskedasticity and zero trade flows in the data (Santos Silva & Tenreyro, 2006; Head & Mayer, 2014).

Unlike the traditional or intuitive gravity model which appears to be a partial equilibrium model, the structural gravity models are particularly valuable because they allow for general equilibrium simulations (Anderson & van Wincoop, 2003), meaning researchers can capture the effects of tariff changes not just on directly affected industries but also on the entire trading system, including welfare effects, trade creation, and trade diversion outcomes (Yotov et al., 2016). When applied to tariff analysis, these models consistently demonstrate that tariffs reduce trade flows, can cause costly trade diversion, and frequently result in a net welfare loss for both the imposing and targeted countries (Anderson et al., 2018).

However, this general equilibrium approach, which uses econometric techniques with only one regression equation (or two), such as that of Anderson & van Wincoop (2003) and (Yotov et al., 2016), means that it becomes more difficult to trace and understand fully the impact of tariffs as the *ceteris paribus* no longer holds. Furthermore, many of the effects caused by an economic shock (e.g., tariff hikes) can only be captured in the coefficients of the dummy variables, making it hard to comprehend the hidden chain of economic reactions across the entire economy. This new theoretically grounded approach also makes the structural gravity models “much more complex to estimate” (Poissonnier, 2016) and requires a different approach to general equilibrium analysis.

2.4.3 Game Theory

Game-theoretic approaches provide a useful way to interpret tariff escalation and retaliation, highlighting how governments weigh strategic choices, credible threats, and long-term incentives. In contrast to (structural) gravity models, which estimate how trade volumes respond to given tariff changes, or econometric (or reduced-form) methods that track outcomes after the fact or post-event, game theory treats policy choices themselves as arising from interaction between players. Theoretical studies of trade agreements and punishment, as discussed above, therefore shed light on why countries might hold back, pick specific targets, or time their responses carefully, and what makes tough retaliation credible in practice.

For the historical US’s tariffs and trade wars, empirical work drawing on game theory tends to be more modest in scope. Researchers often borrow game-theoretic ideas to frame questions about targeting, delays, and negotiation, then test them using simpler econometric tools. Drawing on data covering 1997 to 2006, the econometric findings by Bown and Crowley (2013) suggest that these US tariffs align with heightened incentives to raise 'cooperative' tariff levels, much like the mechanism described in Bagwell and Staiger's (1990) game-theoretical model of self-enforcing trade agreements. Game theory thus helps make sense of the patterns observed and suggests realistic retaliation cases, though it rarely gives hard numbers on welfare costs or sectoral shifts.

That leaves computable general equilibrium models to fill the gap for quantitative work. By capturing links between industries, factor switching, and price changes (including tariffs) across the whole economy for example, CGE lets us trace how tariffs ripple through supply

chains and impact output, jobs, and welfare under different retaliation setups. This thesis draws on both: game theory to shape plausible tariff and retaliation scenarios based on strategic logic, and CGE to measure their full effects in each scenarios given changes in sectoral tariff levels.

2.5 Conclusion

This review pulls together a wide range of views on tariffs, from early mercantilist calls for protection to modern game-theoretic takes on strategic tariff wars. What stands out is the tension between short-term gains for specific groups such as higher prices for producers, better terms of trade for large countries, and the longer-term costs that hit consumers, distort production, and risk escalation. The frameworks surveyed, from partial equilibrium diagrams to structural gravity, offer useful starting points, but they fall short when it comes to tracing economy-wide effects, especially under retaliation.

President Trump's tariffs bring these tensions into sharp focus. His approach appears to lean on optimal-tariff logic and strategic pressure, yet the muted or targeted responses from partners during his first term highlight limits to simple game-theoretic predictions.

Because partial equilibrium, gravity models, and game theory cannot capture economy-wide spillovers, and because President Trump's reciprocal tariffs affect multiple sectors and trading partners simultaneously, a general equilibrium approach is required. This motivates the next chapter, which reviews the CGE literature.

3 Chapter 03: Literature on Computable General Equilibrium and Trade Negotiations

3.1 Introduction

Economists employ a diverse array of analytical approaches to examine trade policies, necessitated by the inherent complexity and interconnectedness of contemporary economic systems. In this context, the construction of robust economic models becomes indispensable. Economic models serve as abstracted and simplified representations of reality, encapsulating the myriad interactions among economic agents, such as consumers, producers, and government entities. These models provide a structured framework within which economists, policymakers, and business leaders can both generate and assess policy-relevant insights, subjecting their prior beliefs and intuitive judgements to systematic empirical scrutiny via simulation exercises (Piermartini and Teh, 2005).

Nevertheless, it is crucial to acknowledge that the notion of a “*correct understanding*” of economic phenomena, as articulated in Piermartini and The’s (2005) report, largely reflects the prevailing theoretical and methodological orthodoxy of the era. Since the late 19th century, neoclassical economics has constituted the dominant paradigm, and this intellectual dominance not only shapes the way models are constructed but also constrains the interpretive lens through which modelling outcomes are evaluated (Chang, 2014).

Among the suite of modelling techniques available, Computable General Equilibrium models have achieved “*widespread*” prominence, particularly due to their neoclassical theoretical underpinnings and their operational versatility. CGE models are routinely applied across a broad spectrum of policy domains, ranging from macroeconomic issues, such as international trade, taxation, energy, and climate change, to more granular analyses that combine CGE frameworks with microsimulation techniques to capture distributional impacts at the household or individual level (Burfisher, 2021; Vos et al., 2004).

3.2 Ex-Ante vs Ex-Post analysis

Trade economics and the evaluation of trade policies can be broadly conceptualised through two principal methodological approaches. The first is the “ex-ante” or “before-event” approach, which involves the analysis of policy interventions in a forward-looking manner,

meaning before their actual implementation. Researchers employing this paradigm seek to simulate potential economic outcomes under hypothetical policy scenarios, such as the four policy scenarios highlighted in Chapter 1, in order to inform decision-making. CGE models, both in their static and dynamic formulations, exemplify this approach, as they enable the projection of policy impacts on a wide array of economic variables before the policies take effect.

In contrast, the “ex-post”, “post-event” or “after-event” methodology is retrospective, relying on empirical analysis of observed data to assess the realised effects of policies that have already been implemented. This tradition is most prominently associated with econometric modelling techniques, such as the intuitive and structural gravity models mentioned in Chapter 2, which have provided the empirical scaffolding for much of contemporary trade analysis. By drawing on actual historical data, ex-post research enables a rigorous evaluation of policy effectiveness and potential causal inference regarding trade outcomes.

3.3 Partial equilibrium and general equilibrium analysis

As the name suggests, the partial equilibrium approach only focuses on one part of the economy or market. PE assumes that changes in a particular sector have negligible or no effects on other parts of the economy and vice versa. PE is widely taught at both college and university levels, and the phrase “*ceteris paribus*” is used to make the above assumption relevant (Blink and Dorton, 2020). For example, President Donald J. Trump imposed a 25 percent tariff on imported steel, including that from China, in 2018²⁸. PE would only concern the steel industry in the US, disregarding other sectors such as construction, which relies heavily on imported steel. Furthermore, PE does not impose several necessary restrictions on macroeconomic variables, such as those between income and expenditure, between investments and savings or endowment constraints (e.g., land, labour, capital, natural resources) (Piermartini and Teh, 2005), making PE itself unsuitable for income determination or welfare decomposition.

In contrast, the general equilibrium (“GE”) approach examines the entire economy and how its sectors and agents interact with one another. GE also establishes constraints on relationships between macroeconomic variables, such as income being equal to expenditure or savings being

²⁸ Proclamation No. 9699, 83 Fed. Reg. 4771, “Adjusting Imports of Steel into the United States,” January 24, 2018. Available at: <https://www.govinfo.gov/content/pkg/DCPD-201800148/pdf/DCPD-201800148.pdf>. Accessed 21-Jun-2025.

equal to investments, as well as constraints on factor endowments. That being said, a GE analysis will extend beyond the single-industry focus of the PE approach to comprehensively evaluate how the initial impact of the imposed tariff spills over and propagates throughout the entire macroeconomic system. In a GE framework where the supply of labour is specified as exogenous (or fixed), a tariff-benefiting and revitalised domestic sector, such as the hypothetical expansion of the US steel industry, would necessarily be expected to reallocate existing labour by drawing it away from other domestic sectors. Consequently, sectors negatively impacted by this labour outflow would experience a reduction in both output and employment. Under the PE analysis with its *ceteris paribus* assumption, the expansion of the US steel industry might indicate an expansion of the US economy. However, the GE approach might yield a contrary conclusion if the contraction in output across other sectors more than offsets the expansion of the steel industry. Having said that, the GE approach provides a more robust and analytically superior framework for studying trade policy, which serves as the primary methodological justification for its adoption in this doctoral research (Burfisher, 2021).

However, there are several limitations when it comes to operationalising GE models such as Computable General Equilibrium models. Firstly, the implementation of a CGE model necessitates the compilation of a significantly more extensive and comprehensive dataset, encompassing the entire global and domestic economies, in contrast to the sector-specific data requirements of the PE approach. The construction of the Input-Output (“I-O”) table and the Social Accounting Matrix (“SAM”), which serve as foundational data inputs for the CGE model (both detailed in Chapter 05), represents a time-consuming and resource-intensive preparatory process. Secondly, the level of aggregation in the CGE dataset might pose a challenge for economists to study and make recommendations when it comes to a very specific sector. For example, highly aggregated data collected for the US manufacturing sector that does not separate the output of the steel and automobile industries would not help economists examine the impact of tariffs on the steel industry; therefore, it is difficult to formulate specific industrial policies to alleviate heavily impacted sectors from any possible trade wars. Thirdly, one cannot completely exclude all PE aspects of the PE approach, even when the GE approach is chosen. The reason is that to understand how GE models operate, several economic theories built for PE models have been used as a foundation to develop the more comprehensive and complex GE models, such as trade creation and trade diversion discussed in Chapter 2. Many of the economic parameters used for the CGE model, such as elasticities, are often estimated using econometrics (Burfisher, 2021). However, Piermartini and Teh (2005) note that while the

databases have been more “*regularly updated*”, the parameters are not, which could undoubtedly impact the accuracy of the outcomes. Furthermore, policy recommendations derived from econometric models must be treated with caution, as the Lucas Critique (Lucas, 1976) warns that the underlying behavioural relationships (the model's fixed parameters) are likely to shift when the policy regime itself changes. In other words, the use of econometrically estimated inputs within the CGE framework raises a direct concern regarding the Lucas Critique, as these backwards-looking parameters may not remain invariant to the policy changes being simulated.

3.4 “Computable” “general” “equilibrium” (CGE) model

3.4.1 Computable

“Computable” refers to the ability of the model to quantify the effects of a shock or several shocks on the economy. Economic theories, such as trade creation, can help economists quickly anticipate that a reduction in tariffs would increase consumer surplus while reducing the surplus of less efficient domestic producers and also reducing government tariff revenue. However, there is a distinct preference among governments, policymakers, business leaders, and economists for quantifying the precise magnitude or the projected quantitative effects that any given economic shock is expected to induce (Burfisher, 2021).

The establishment of the national statistical units as well as many other not-for-profit international organisations to collect statistical data at the national and global levels, such as the Office of National Statistics in the United Kingdom, the U.S. Census Bureau in the United States of America, and the General Statistics Office of Vietnam, WTO, World Bank, IMF helps make data increasingly available for researchers to use in quantitative analysis, such as CGE.

3.4.2 General

Further to section 3.3, which distinguishes the main differences between partial equilibrium and general equilibrium approaches, the GE approach requires an understanding of the Circular flow of income (a more detailed discussion of this topic is reserved for a later chapter).

In a simplified circular flow of income model, there are only two economic agents, namely households (consumers) and producers. Households provide all factors of production, such as labour, capital, land, and natural resources, to producers so that goods and services can be produced for consumption. Producers will then pay households in exchange for these factors of production in terms of wages, interests, rents, and profits, usually known as income. Households or consumers use their incomes to purchase goods and services from producers. The "General" designation implies that the model must comprehensively capture all interdependent interactions and activities occurring within the above modelled economic system.

Additionally, CGE models focus on the “real” economies, meaning that money, the financial markets, as well as changes in the price levels are excluded. This implies that the CGE models only consider physical outputs produced in each market (Burfisher, 2021).

3.4.3 Equilibrium

The phrase “equilibrium” refers to the equalisation of supply and demand at a given price level and that there is no tendency to deviate from such a level. At the equilibrium, under neoclassical assumptions, consumers maximise their total utility or satisfaction while producers maximise their efficiency (Burfisher, 2021).

In the simplified circular flow of income model mentioned above, several constraints are assumed, such as expenditure (E) must equal total income (Y), assuming no leakages or injections. As the model is progressively expanded to reflect a more comprehensive economy, more constraints are introduced: the introduction of savings (S) necessitates that $S = I$ (Investment); the inclusion of the government introduces T (Taxes) which must be balanced by G (Government Spending), yielding $T = G$; and the transition to an open economy necessitates X (Exports) must equal M (Imports). While the model can be dynamically analysed by allowing these individual constraints to be temporarily relaxed (i.e., $S \neq I$ or $T \neq G$), the fundamental macroeconomic equilibrium identity must hold at the aggregated level: $Y + S + T + M = C + I + G + X$. Other market-clearing conditions include all resources being fully employed. In other words, there is no unemployment in the labour market, no unused land, or any idle capital such as machinery.

CGE modellers will introduce changes or shocks, such as changes in tariff levels in this thesis, to the models to create disequilibrium or disequilibria, which will then require all CGE equations to be resolved simultaneously, given the above constraints, to work out the economy's new equilibrium or equilibria.

3.5 Static and dynamic CGE model

3.5.1 Static CGE model

When shocks are introduced into the CGE model, the initial equilibrium changes, and the shocks lead the economy to a new equilibrium. When economists are only concerned about the two equilibria and not the transitioning process of how the final equilibrium is derived from the initial one, we call this a static CGE model (Piermartini and Teh, 2005).

In the analysis of trade policy, a theoretical reduction in tariffs, such as the European Union lowering duties on the US manufacturing sector, is typically expected to stimulate expansion and increased exports in the US manufacturing sector. This expansion then generates inter-sectoral competition for factors, notably labour, which is drawn from other domestic sectors (e.g., services or agriculture). The static CGE framework often abstracts from the complexity of this adjustment by assuming perfect inter-sectoral labour mobility. However, this assumption neglects the real-world frictions of labour transition, which involves significant time and resources dedicated to retraining (Krugman et al., 2012). This same principle applies to specialised capital, such as highly dedicated machinery, which cannot be easily repurposed for alternative production lines. Consequently, the static CGE approach, by omitting these critical adjustment costs and market rigidities, may lead to an overestimation or underestimation of the actual welfare costs and benefits associated with the economy's transition between two distinct equilibrium states (Piermartini and The, 2005).

3.5.2 Dynamic CGE model

In contrast to the static CGE method, the dynamic CGE approach offers a more comprehensive analysis by modelling not only multiple long-run equilibria but also the transition paths between them. This temporal dimension allows the dynamic framework to incorporate costs and benefits that are typically disregarded in a static analysis, particularly by explicitly

considering powerful dynamic factors like endogenous technological change and capital accumulation. These two factors are critical because they are recognised as fundamental drivers of long-term economic growth and overall productivity. Consequently, the ability of dynamic CGE models to capture these mechanisms often results in projections that show significantly larger gains from trade liberalisation, leading to even stronger support for free trade policies. However, the dynamic CGE models are much more complex in nature, both theoretically and technically. Such complexity might lead to difficulty in calculating the final equilibrium as well as interpreting the results (Piermartini and The, 2005).

Given the complexity of the dynamic CGE method as well as the practicality of this Doctoral Degree, the static CGE methodology is chosen for this research.

3.6 The historical evolution of CGE modelling

3.6.1 The theoretical foundation

Marie-Esprit-Léon Walras, normally known as Léon Walras, is regarded by many economists as one of the pioneers of General Equilibrium Theory, as well as marginal utility, through his book “*Éléments d'économie politique pure, ou Théorie de la richesse sociale*” written in French and published in 1874. Unfortunately, it was not until William Jaffé translated the book that a wider economic community was made aware of Walras’s *Elements of Pure Political Economics* in 1954 (Piermartini and The, 2005; Friedman, 1955).

Walras’s work is a system of mathematical formulas that need to be solved simultaneously to derive the market’s equilibria. Walras’s law is an important element in building today’s CGE models. Walras’s law asserts that the total value of excess supply ($D_i - S_i < 0$) needs to equal the total value of excess demand ($D_i - S_i > 0$) in a given economy (Burfisher, 2021). In other words, Walras accepts short-term or temporary disequilibria in two or more markets, but in the long run, all markets must be in equilibrium. This can be partially explained by employing the budget constraint condition, where total expenditures cannot exceed total incomes. In other words, assume that there are m markets in the economy where $m \geq 2$,

$$\sum_{i=1}^m p_i(D_i - S_i) = 0$$

To ensure that a given CGE model has a unique solution, the number of equations needs to equal that of variables. In modern CGE models, modellers only focus on relative prices rather than absolute prices, as the real economy, not nominal, is what economists truly care about. To compute relative prices, one chosen market's price, e.g., the agriculture price, is set to be fixed at the initial or pre-shock level, and such a numeraire equals 1, for example, $p_{agriculture} = 1$ if the agriculture market is designated as the price anchor. Modellers will then determine all relative prices by deflating all other nominal prices using the nominal price of the agriculture sector. However, when one price is fixed as a numeraire, this means that one variable is dropped as the numeraire remains fixed throughout the model. To ensure the uniqueness of the solution as stated above, modellers will need to drop one equation. This method would not impact how the model is solved, as Walras's law implies that the equilibrium of the last market is dependent on the equilibria of all other markets (Burfisher, 2021). However, some have also proved that it is not always the case, such as John Maynard Keynes (1936) in his well-known book "The General Theory of Employment, Interest, and Money" or Robert Clower (1965).

In his 1936 General Theory work, Keynes centred his analysis on the issue of "*involuntary unemployment*", which refers to the circumstances where individuals are prepared to work at prevailing wages yet remain jobless. He demonstrated that persistent unemployment could exist in the labour market even when other markets seem to be in balance, directly challenging Walras's law. Keynes maintained that, particularly within monetary economies, overall economic activity and employment levels are dictated by total demand for goods and services (aggregate demand). He argued that simply reducing wages does not necessarily spur job growth, in contrast to classical theory, because lower wages diminish household income, which in turn suppresses consumption and, ultimately, the demand for products. When aggregate demand is insufficient, there is no self-correcting process to restore full employment, regardless of wage adjustments. While Keynes used unemployment in the labour market as a prominent illustration of his critique, his challenge to Walras's law was more comprehensive. He showed that the mechanism of price and wage adjustments does not inevitably align all markets to full employment. As a result, the entire economy can remain stuck in a state of underemployment, where widespread insufficient demand maintains ongoing unemployment, thereby contradicting the view that all markets must balance simultaneously.

In his influential 1965 article, Robert Clower challenges the universal applicability of Walras's law by distinguishing between what he terms "*notional demand*" and "*effective demand*". Notional demand refers to the quantity of goods and services that economic agents would plan

to purchase at given prices if they faced no constraints. In contrast, effective demand represents the actual amount these agents are able to buy, considering their income limitations and the constraints imposed by market disequilibria. Clower argues that traditional Walrasian theory relies heavily on notional demand, assuming that markets clear accordingly. However, in an actual economy that involves money, especially under conditions such as “involuntary unemployment” as identified by Keynes (1936), effective demand can be substantially lower than notional demand. This divergence arises because agents make two distinct decisions, one about their intended purchases under theoretical full employment conditions, and another about their realised expenditures in an economy where some markets may fail to clear.

Furthermore, Clower (1965) highlights an inherent incompatibility between Walras’s law and Keynesian economics. He asserts that Walras’s law holds true only in an idealised setting of full employment equilibrium. In any scenario with unemployment or market disequilibrium, Walras’s law loses its explanatory power. According to Clower, this means that either Keynes’s insights about demand deficiencies add no new understanding to economic theory if Walras’s law is assumed universally correct, or the law itself is invalid outside full employment. His analysis thus exposes the limitations of the traditional microeconomic foundations upon which Walrasian general equilibrium is built and underscores the need for theoretical frameworks that can accommodate disequilibrium phenomena such as involuntary unemployment, signalling a pivotal shift toward disequilibrium macroeconomics.

It is worth noting that while Walras constructed a system of simultaneous equations, intending to demonstrate that such an equilibrium price vector exists, he did not provide a complete or rigorous mathematical proof of the existence of general equilibrium in his lifetime²⁹. Such a crucial challenge could only be solved eight decades later by Arrow and Debreu (1954).

The Arrow-Debreu (1954) model is considered a reassessment of Walras’s work. Arrow and Debreu managed to prove that there is a set of prices that can clear all markets simultaneously. The Arrow-Debreu (1954) model is based on a set of assumptions, such as convex preferences, perfect competition, rationality (utility maximisation), and demand independence (of the distribution of income). Arrow and Debreu helped to shed light on two questions asked by Adam Smith, who is regarded as the founder of modern economics, as well as the classical school in economics, as discussed in Chapter 2. The first question concerns whether the free

²⁹ “Walras did not, however, give any conclusive arguments to show that the equations, as given, have a solution”. Arrow, K. J.; Debreu, G. (1954, p.265).

market could coordinate between various consumers and producers through prices better than the government, and the second question is whether a person who “*intends only his own gain*” or pursues self-interest could promote not just the benefits for themselves but also benefit society in the long term. This question is linked to a well-known concept of an “*invisible hand*” by Smith (1776). Arrow-Debreu (1954)’s work contributes to the establishment of two important theorems in economics, namely the First Welfare Theorem and the Second Welfare Theorem.

The First Welfare Theorem establishes that any competitive equilibrium emerging from a decentralised market economy is inherently Pareto-efficient under a defined set of assumptions, such as complete markets, perfect competition, and rational, price-taking behaviour among agents. This means that the price-mediated interactions of self-interested consumers and producers, in externality-free environments, spontaneously coordinate resource allocation in such a way that it is impossible to make any participant better off without reducing the welfare of another. The theorem thus formally connects the concept of market equilibrium with efficiency in resource allocation, highlighting the powerful role of the price mechanism in decentralising complex economic decisions and ensuring aggregate welfare is not left unexploited (Foley, 2010).

The Second Welfare Theorem describes the separability of efficiency and distributive justice in market economies. It posits that, provided certain regularity conditions are met, including “*convex*” preferences and technologies, any Pareto-optimal allocation of resources can, in principle, be realised as a competitive equilibrium following an appropriate redistribution of initial endowments via lump-sum transfers. This result profoundly implies that the objectives of equity and efficiency need not conflict, as the reallocation of initial wealth can achieve any desired ethical or social configuration without disrupting the market’s capacity to generate efficient outcomes. Once this redistribution is implemented, competitive forces alone suffice to achieve the targeted allocation, implying that distributive justice concerns may be addressed independently of market efficiency, at least within the confines of the model’s assumptions (Foley, 2010). However, Arrow-Debreu (1954)’s model has also been questioned by other economists, such as Greenwald and Stiglitz (1987).

Greenwald and Stiglitz’s 1987 paper fundamentally challenged the optimistic conclusions of the Arrow-Debreu model regarding the efficiency of competitive markets. Their central argument was that, once the stringent conditions of Arrow-Debreu, namely, perfect information

and complete markets, are relaxed, competitive equilibria can no longer be assumed to yield efficient or welfare-maximising (allocatively efficient) outcomes. In other words, they demonstrated that the elegant result of markets always allocating resources efficiently only holds in a world where individuals can insure against every conceivable risk and possess full knowledge about all market conditions, assumptions which are rarely, if ever, satisfied in practice. Their main contribution was to establish that, in settings characterised by incomplete markets or asymmetric information, the so-called "invisible hand", as coined by Adam Smith, does not reliably guide the economy to a Pareto-optimal outcome. Greenwald and Stiglitz proved that, under these more realistic circumstances, market failures, where individual actions impose externalities on others that are not reflected by prices, are pervasive rather than exceptional. Consequently, there frequently exist feasible government interventions, such as a tax on alcohol, that can improve upon the market outcome by realigning private incentives with the collective good. However, the two researchers acknowledged that "*successive tax increases*" could exacerbate deadweight loss (p.238).

The implications of their analysis extend well beyond isolated exceptions; Greenwald and Stiglitz effectively reversed the classical presumption of laissez-faire efficiency. They argued that, since imperfect information and incomplete markets are endemic to actual economies, situations in which unregulated markets achieve efficiency are the exception rather than the rule. As a result, their research thus provided a rigorous theoretical foundation for policy activism, justifying appropriate government intervention as a means to correct inefficiencies that naturally arise in almost all real-world markets. In short, the Greenwald–Stiglitz work profoundly shifted the benchmark for economic policy, demonstrating that market failures are typical, not marginal, and that well-designed public policies can often improve social welfare.

3.6.2 The early quantitative foundation

Leontief (1941) is normally regarded as the first person who laid the foundation for the development of quantitative CGE modelling. Leontief introduced the "*comprehensive version*" of the input-output (I-O) model in 1941 in his book, which describes the US economy one decade after the end of the First World War. The model describes how different domestic industries are connected to each other in the modern economy. The goal of the analysis by using the I-O model is to determine how much each economic sector needs to increase its output to meet a targeted rise in demand for consumption, investment, and exports. This increase must

not only meet the final demand but also cover the additional demand for intermediate goods across different production sectors. The I-O model also earned him the Nobel Memorial Prize in Economic Sciences in 1973³⁰.

Johansen (1960)'s study of the multi-sectoral Norwegian economy (also submitted as his doctoral thesis) is seen as the major first attempt to develop the numerical methods for a CGE model (Bjerkholt et al., 2016). The linear computational model has 86 equations and 132 variables. Johansen's model contains an aggregated household sector and disaggregated production sectors of price-taking and cost-minimising twenty-one industries (Bjerkholt et al., 2016). Johansen developed his Leontief-inspired I-O table based on Walrasian GE theory and combined with Solow-type production functions, which exhibit constant returns to scale between labour and capital (such as the Cobb-Douglas production function). Input coefficients across intermediate inputs are fixed (Leontief production function). Imported inputs are either indistinguishable or non-competitive with domestic inputs. Some key variables, such as employment, public spending, net export, and inventory accumulation, are treated as exogenous. However, despite being simple and effective, Johansen's techniques, especially a formula to calculate a matrix with a column vector of 86, are subject to linearisation errors as the formula only approximates the results derived from non-linear equations (Dixon & Rimmer, 2016).

Johansen's model inspired the development of the ORANI model (and later its evolved form - MONASH model), which was designed for the Australian government to study the impacts on manufactured imports due to tariff reductions in 1975 (Bjerkholt et al., 2016). The ORANI model is still widely used today in Australia and has also inspired the development of many other CGE models in other developing countries such as South Africa, Sri Lanka, South Korea, Vietnam, Indonesia, etc (Horridge, 2000)³¹. Johansen's model also laid the foundation for an “*extraordinarily successful project*” called the Global Trade Analysis Project (“GTAP”). The GTAP project was developed based on the SALTER model, which was brought to Purdue University in the USA by its founder, Tom Hertel. Tom Hertel was inspired by the Johansen-style and ORANI-style SALTER model when he visited Monash University in Australia in the early 1990s. GTAP provides not just many well-known and widely-used CGE models but also the biggest global database covering “*bilateral trade patterns, production, consumption, and*

³⁰ Nobel Prize Outreach 2025. Sun. 3 Aug 2025. Available at: <https://www.nobelprize.org/prizes/economic-sciences/1973/press-release/>. Accessed on 22-Mar-2025

³¹ ORANI-G: A CGE of the Australian Economy

intermediate use of commodities and services”³². The database, which relies on the I-O tables from individual countries³³, is widely used around the world. For example, the UK’s Department for Business and Trade (2024) used GTAP’s latest database version 11 (published in 2023) to analyse the “*Impact assessment of the UK’s accession to the CPTPP*” in 2023. Johansen-style models are usually run using the **General Equilibrium Modelling PACKage** (“GEMPACK”) software.

Herbert Scarf (1967) is widely credited with the breakthrough that enabled applied CGE modelling. His crucial contribution was the development of a solution algorithm specifically designed to find equilibrium prices within non-linear models, a capability that was fundamentally lacking in Johansen’s model due to its inherent linearity (Piermartini and Teh, 2005). Scarf’s work was based on Brouwer’s fixed-point theorem (Brouwer, 1911), which essentially states that in any continuous function mapping a compact convex set (such as a closed ball or disk) to itself, there must be at least one point whose position does not change under that function. In simpler terms, it guarantees that if someone transforms a space without tearing or jumping, somewhere within it a point will remain exactly where it started, no matter how someone manipulates or “*stir*” the space. While Scarf did not find a fixed exact point, he developed a numerical algorithm that “*approximates*” equilibrium prices in intricate models through a gradual, geometric process by repeatedly breaking down a multi-dimensional simplex, an abstract shape that extends the idea of a triangle or tetrahedron, into increasingly finer segments, seeking points that are nearly fixed and correspond to prices where supply matches demand. The above process is also known as “*simplicial subdivision*”. However, Scarf’s technique was not the most effective for CGE modelling and gradually gave way to simpler methods from the 1980s (Dixon & Rimmer, 2016). One of the main reasons is that Scarf’s method, though guaranteed to converge under certain conditions, is notably slow and computationally intensive (Sinko, 1992). As CGE models grew more complex and included a large number of sectors or agents, the process of subdividing simplices and checking labels for approximate fixed points became impractically slow compared to alternative algorithms. Intriguingly, Scarf’s background was purely mathematical, having received formal training at both the undergraduate and graduate levels. His seminal 1967 paper, a purely mathematical contribution, was published by the *Society for Industrial and Applied Mathematics*.

³² GTAP Data Base. Available at: <https://www.gtap.agecon.purdue.edu/databases/default.asp>. Accessed on 01-Jul-2024.

³³ GTAP Data Base: Version 11. Available at: <https://jgea.org/ojs/index.php/jgea/article/view/181/221>. Accessed on 01-Jul-2024.

Nonetheless, the work dedicates seven pages to illustrating its implications through an economic example (Scarf, 1967).

Hudson and Jorgenson (1974) were the first to integrate econometrics with I-O analysis to study the US energy market concerning both supply and demand. The paper attempts to project the US economic performance and its energy usage for 25 years from 1975, following the huge surge in oil prices caused by the Arab oil embargo in 1973. Before this paper, Tinbergen-Klein econometric models, according to Hudson and Jorgenson (1974), were useful for studying aggregate demand but had little to say about aggregate supply. Leontief's I-O analysis, on the other hand, is useful for analysing aggregate supply. However, the downside of I-O analysis is that it relies on "*fixed technology at any point of time*", meaning that any price-induced technological changes linked to changes in economic policies cannot be captured. Therefore, a combination of the two aforementioned techniques was needed. The model contains nine industrial sectors, five representing the energy sectors. The authors' innovation is that they treated I-O coefficients endogenously as functions of prices of labour, capital, and imported goods, rather than traditionally as exogenous variables, while prices were treated as functions of I-O coefficients. The second innovation is the integration of supply and demand conditions across various macroeconomic variables, such as labour, capital, consumption, and investment in the non-static growth model.

While most CGE models in the 1960s and 1970s primarily focused on developed countries such as Norway (Johansen, 1960), the US (Leontief, 1941, Hudson and Jorgenson, 1974), developing and Third World countries were under-presented. The works of Adelman and Robinson (1978) and Taylor et al (1980) filled this gap. Both papers were developed to help the World Bank and the International Labour Office address their concern over the poorest population in developing nations (Denslow, 1982). Adelman and Robinson (1978) developed a non-linear and dynamic CGE model exploring numerous policies to increase the income of the poor, especially in the case of Korea, not just in relative terms but also in absolute terms. The key takeaway from this book is that it is the coordination of a set of diverse developmental policies, which influences a large portion of economic activity, could substantially reduce poverty and inequality. Individually implemented policies, even substantial ones, were ineffective in reducing uneven income distribution because the impacts of government intervention diminished gradually. On the other hand, Taylor et al (1980), also known as the Taylor-Lysy model, focused on Brazil from 1959 to 1971 and followed Johansen's linear approach. This model covers 25 sectors and, like many CGE models focusing on the real

economy, excludes the financial market. The authors chose the so-called “*Keynesian closures*” because after having employed plausible values for substitution elasticities and related parameters, the “*neoclassical closure*” is unable to replicate the Brazilian data from 1960 to 1970, chiefly because the model's internally determined volume of real investment is significantly lower than what was actually observed (p.9). The model, however, experienced weaknesses in data collection (Denslow, 1982). Taylor et al (1980) also concluded that “*a large model ... adds little to what one can learn*”, in comparison to small models and from partial equilibrium investigations (pp. 14-15). Hence, the study of distribution should rely on less detailed, less disaggregated models and more attention to be paid to parameters and equations.

3.7 CGE models on trade and tariff

3.7.1 From 1946 to 2000 - Trade liberalisation

The end of the devastating World War II demanded an urgent need for post-war reconstruction. The US attempted to establish multilateral organisations to fulfil such a need, and one of which, the General Agreement on Tariffs and Trade was born in 1947 at the United Nations Conference on Trade and Employment (“UNCTE”) and signed by 23 countries in Geneva, Switzerland (Evans, 1968). There were several rounds of trade negotiations took place since 1947 such as the Geneva Round 1947 in Switzerland, the Annecy Round 1949 in France, the Torquay Round 1950 in the UK, The Geneva II, Dillon and Kennedy Rounds 1956, 1960, 1964 in Switzerland respectively, the Tokyo Round 1973 in Japan, the Uruguay Round 1986 in Uruguay and the latest but inconclusive Round took place in Doha, Qatar in 2001 (VanGrasstek, 2013).

The Tokyo Round 1973 which focused on reducing tariffs on industrial goods, for the first time, “*represents an effort to limit the use and misuse of non-tariff measures*” (Balassa, 1980, p.15) such as import quotas, subsidies, and technical barriers to trade. This Round created a crucial environment for the birth of the Michigan Model, developed by Deardorff and Stern (1986), which is considered as “*The earliest full-blown global trade model of world production and trade*” (Piermartini and The, 2005). This multi-sectoral and multi-regional model covers 34 countries (18 developed and 16 developing) and 29 sectors (22 tradable and 7 non-tradable). Constant Elasticity of Substitution (CES) and imperfect substitution between home and foreign goods were assumed, while export goods across the world were assumed to be homogeneous or perfectly substitutable. Non-tariff barriers were measured as tariff equivalents and assumed

to be endogenous. The model employed the assumption of exogenous wages, which permits the existence of Keynesian unemployment. This assumption, however, has been subject to criticism as this type of unemployment is better suited for modelling the dynamics of the U.S. economy than those of European economies. Aggregate expenditure was assumed exogenous, which means aggregate income might not equal aggregate expenditure (Cuddington, 1988).

The key simulation suggested that, due to small, proposed tariff changes by the Tokyo Round, the overall effects were small. Also, the market share of the world market for each country did not change much, as their vectors of tariff reduction were quite similar. The second simulation suggested that trade expansion between developed and developing countries created jobs, rather than destroyed them, between 1970 to 1976. A few other simulations were also run regarding the exchange rate to reflect a sharp depreciation of the US dollar in the early 1980s. However, this simulation was considered “trivial” when all countries were tested with a 10% uniform depreciation (Winters, 1987).

The complexity inherent in multilateral trade liberalisation is highlighted by the Uruguay Round of negotiations, which required a significant temporal investment, extending for nearly eight years from its inception in September 1986 to its conclusion in April 1994. While the Tokyo Round failed to reach an agreement on agricultural trade, this became a key feature, along with textiles, traditionally highly protected by many countries, especially from the US and the EU, in the Uruguay Round. The Uruguay Round also introduced services, intellectual property, and investment-related measures into the trade agenda and dispute resolution mechanisms for the first time and also gave way for the establishment of the World Trade Organisation to replace GATT and better strengthen the enforcement mechanisms (VanGrasstek, 2013).

Some of the major CGE studies were published one to two years after the conclusion of the Uruguay Round including Brown et al (1996), Francois et al (1996), Goldin and van der Mensbrugghe (1996), Hertel et al (1996) and Harrison et al (1995) and these works were surveyed and summarised by Piermartini and Teh (2005) as below:

Publications	Data / Evaluation	Model Structure	Sectors Liberalized
Brown, Deardoff, Fox and Stern (1996)	data and evaluation in 1990	_Michigan model _29 sectors (1 Ag, 1 proc. food, 1 Prim, 20 Manuf., 6 Services) _8 regions _perfect competition, CRS, Armington elasticities in Ag. Monopolistic competition and IRS in Manuf. _static	_Industrial Tariff cut according to schedule. MFA not covered. _Agriculture tariffs, including NTB-equivalents cut according to commitments _Services: NTBs cut by 25 per cent
Francois, Mc Donald and Nordstrom (1996)	data version 1992	_GTAP model _19 sectors _13 regions _Model1: CRS, perfect competition _Model2: IRS, monopolistic competition _saving-driven investment (i.e. dynamic model)	_Industrial Tariff cuts according to schedules, MFA quotas lifted _agriculture tariff cuts according to commitment, subsidies cut by 36 and 24 per cent in developed and developing countries respectively
Goldin and van der Mensbrugghe (1996)	1985-93 data are used to validate the model. Projections are made for the period 1993-2002	_RUNS model _20 sectors (15 of which agricultural sectors) _22 countries _perfect competition _static	_industrial tariffs cut according to schedules _agricultural reforms: tariffs including NTBs cut according to schedules. Subsidies cut by 36 per cent in OECD and 24 per cent in other countries.

Hertel, Martin, Yanagishima and Dimaranan (1996)	_1992 data, evaluated at 2005 _Using exogenous of regional growth of capital, population and technology the world economy is estimated with and without the Uruguay Round policy change	_GTAP model _10 sectors _15 regions _CRS, perfect competition, Armington trade elasticities	Industrial and agricultural tariffs cut according to schedules. MFA quotas are lifted.
Harrison, Rutherford and Tarr (1995)	1992 data and evaluation	_GTAP model _22 sectors _24 regions _M1: CRT, PC, Armington _M2: IRT, monopolistic competition intraregional, Armington-based trade _M1 both static and dynamic	_Industrial and Agriculture tariff cut according to schedule _Export (domestic) subsidies cut by 36 (20) per cent and 24 (13) per cent in developed and developing countries respectively.

Table 03.01: CGE studies of the Uruguay Round (Piermartini and Teh, 2005)

As we can see from the above summary, Southeast Asia was not at the heart of regions being studied in early CGE research. Instead, early researchers tended to focus on more developed countries and regions.

3.7.2 2001 to Present: The Reversion of Trade Liberalisation?

3.7.2.1 The Doha Round

While the Uruguay Round was seen by many as “*the largest negotiation of any kind in history*”, the challenge of achieving consensus on a comprehensive package covering nearly all current trade issues has led some to believe that negotiations of such scale may no longer be feasible in the future³⁴. This assertion remains valid at the time of writing this thesis, as no new global trade negotiation round has been successfully concluded since the Uruguay Round. The ninth and most recent multilateral trade negotiation round, initiated in Doha, Qatar, in November 2001, and notably the first since the formal establishment of the WTO, remains unresolved, particularly concerning its most politically sensitive and intractable issues. After around seven years of negotiations, talks have stalled because of the disagreements between developed countries and developing countries over tariff reductions and more market access for specific manufactured goods sectors from developed countries, especially the US, in exchange for better access to agricultural products from emerging nations (IMF, 2011).

Piermartini and Teh (2005) selectively summarised key CGE papers that (1) only includes global simulations rather than simulations on a single nation or region, (2) made data sources publicly available, (3) were published in or produced by international organisations, (4) sufficiently cover liberalisation issues being negotiated at the Doha Round such as “*agriculture, non-agricultural goods, services and trade facilitation*” and (5) simulated scenarios need to be closely aligned with any considered alternative options. Regarding point 4, all research utilised GTAP databases ranging from version 4 to version 6. Piermartini and Teh (2005) also pointed out from analysing the GTAP database that around two-thirds of the global merchandise trade was dominated by developed countries, nearly 90% of which were trades in manufactured goods. Due to the nature of the database, and if tariff levels were uniform internationally and across different sectors, developed countries would enjoy around two-thirds of the welfare gains if a uniform tariff reduction were implemented. The same logic can also be applied to

³⁴ WTO. The Uruguay Round. Available at: https://www.wto.org/english/thewto_e/whatis_e/tif_e/fact5_e.htm. Accessed on 15-Jun-2024.

merchandise trade. However, in reality, emerging countries tend to have higher average tariff rates than developed countries do.

Publications & Data	Baseline	Model Description	Measures Liberalized	Simulation Scenarios
Anderson, Martin and van der Mensbrugghe (2005) GTAP Database version 6	2015 –extrapolated from 2001 by first moving to a new 2005 baseline that account for policy reforms already implemented (EU expansion to 25 members, Uruguay Round implementation, including the elimination of quotas on textile and clothing, accession of China and Chinese Taipei to WTO); then, the world economy is projected to 2015 using exogenous population, labour force growth, saving-driven capital	_No. of sectors 25 _No. of regions: 27 _LINKAGE model, a recursive dynamic model (van der Mensbrugghe, 2004) _constant returns to scale and perfect competition	Agriculture - Tariffs - Export subsidies - Domestic subsidies (cut by 28 per cent for the US, 18 per cent for Norway, 16 per cent for the EU and 10 per cent for Australia) Manufacturing goods tariffs	(i) elimination of all merchandise trade barriers over the 2005-2010 period (ii) a progressive reduction formula with a marginal agricultural tariff rate reduction of 45, 70 and 75 per cent cuts for developed countries and 35, 40, 50, and 60 for developing countries for the respective bands. No cut for LDCs. (iii) adds to Scenario (ii) the “Sensitive Products” option allowed for in the July package (2 per cent of agricultural

	accumulation and labour-augmenting technological progress			tariff lines for developed countries and 4 percent for developing countries, subject to just a 15 per cent cut) (iv) adds to Scenario (iii) a tariff cap of 200 percent for agricultural products (v) add to Scenario (ii) liberalization of non-agricultural products (50 per cent cut of bound rates for developed countries and 33 per cent for developing countries) (vi) like (v) but developing countries also cut bound tariffs by 50 percent
Anderson, Dimaranan,	2005 - extrapolated from 1995 using projections of labour force growth, investments in	_No. of sectors: 4 _No. of regions: 19 _Standard GTAP	Agricultural tariffs Manufactured goods tariffs	Elimination of all tariffs in agricultural and manufactured goods

Francois, Hertel, Hoekman and Martin (2003) GTAP version 4	human and physical capital. On the trade policy front, data updated to take Uruguay Round implementation (including the ATC) and China's accession into account. Standard GTAP trade elasticities were doubled given the long-term nature of the simulations.	model with perfect competition and constant returns to scale		
Brown, Deardorff and Stern (2003) GTAP version 5	2005 - extrapolated from 1995. Services barriers are estimated from data on gross operating margins of services firms listed in national stock exchanges.	_No. of sectors: 18 _No. of regions: 20 _Increasing returns and monopolistic competition in manufactures but perfect competition and constant returns in agriculture _Michigan model	Agriculture - Domestic subsidies - Export subsidies - Tariffs Manufactured tariffs Services barriers	(i) 33 percent reduction in agricultural tariffs, production and export subsidies (ii) 33 per cent reduction in manufactured goods tariffs (iii) 33 per cent reduction in services barriers (iv) Scenarios (i)+(ii)+(iii) (v) Global free trade in agricultural and

				industrial goods and services
Cline (2004) GTAP version 5	1997 but agricultural tariff data is updated to 1998	_No. of sectors: 22 _No. of regions: 25 _perfect competition and constant returns _Harrison-Rutherford-Tarr model	Agriculture - Tariffs - Export subsidies - Input subsidies Manufacturing - Tariffs - Textile quotas	Complete elimination of tariffs applied to agriculture and manufactures, export subsidies and input subsidies on agriculture, and textile quotas
Francois, van Meijn and van Tongeren (2003) GTAP version 5.2	1997 Protection data is modified using tariffs in WTO IDB and WITS; takes into account Uruguay Round implementation, China's accession and EU enlargement. Services barriers are estimated using a gravity equation	_No. of sectors: 17 _No. of regions: 16 _Allows for increasing returns and monopolistic competition in manufactures but assumes perfect competition and constant returns in agriculture _Allows for capital accumulation (dynamics)	Agriculture - OECD Domestic subsidies - Export subsidies - Tariffs Manufactured goods tariffs Services barrier Trade facilitation	(i) Linear: 50 per cent reduction in agricultural and manufactured tariffs, export subsidies, OECD domestic support and services barriers. Trading costs are reduced by 1.5 percent (ii) Swiss: reduction in agricultural and manufactured tariffs is based on the Swiss formula with a coefficient of 0.25. 50 percent

				reduction in OECD domestic support, export subsidies and services barriers. Trading costs are reduced by 1.5 percent (iii) Complete liberalization and a reduction in trading costs of 3 percent
OECD (2003) GTAP version 5	1997 but protection data benchmarked to 1998 using data in OECD tariffs database	_No. of sectors: 10 _No. of regions: 10 _Standard GTAP model with perfect competition and constant returns to scale	Agricultural tariffs Manufactured goods tariffs Trade facilitation	(i) Linear tariff reductions by all regions - free trade in agricultural and manufactured goods and trade facilitation - free trade only in manufactured goods & trade facilitation - 50 percent reduction in tariffs on agricultural & manufactured goods and trade facilitation (ii) Differential participation in liberalization

				- Cuts of 100 per cent & 50 per cent respectively in manufactured and agricultural tariffs by developed countries only and trade facilitation - free trade by developed countries; 50 per cent cut by developing countries; trade facilitation (iii) Swiss formula - Swiss formula coefficient of 25 and trade facilitation - Swiss formula coefficient of 15 and trade facilitation - Swiss formula coefficient of 5 and trade facilitation
UNCTAD (2003) GTAP version 5	1997 Modified using TRAINS to take preferences into account	_No. of sectors: 6 _No. of regions: 12 _Standard GTAP	Agriculture - Agricultural tariffs - Export subsidies	(i) 50 per cent reduction in agricultural tariffs (ii) Elimination of export subsidies in

		model with perfect competition and constant returns to scale		agriculture (iii) 50 per cent reduction in processed agriculture tariffs (tariff escalation)
World Bank (2003) GTAP version 4				Agricultural tariff peaks are cut to 10 and 15 per cent respectively in high-income and developing countries. Manufacturing tariff peaks are cut to 5 and 10 per cent respectively in high-income and developing countries. Average agricultural tariffs are cut to 5 and 10 per cent, respectively, for high-income and developing countries. Average manufacturing tariffs are cut

				to 1 and 5 per cent, respectively, for high-income and developing countries. Elimination of export subsidies, tariff rate quotas and anti-dumping. Decoupling of domestic support
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Table 03.02: Basic model structure of CGE simulations of the Doha Round (Piermartini and Teh, 2005)

The table below summarises the simulated gains from the above papers from the reductions of all barriers. Given that the WTO negotiations target the bound rates, the maximum tariff a country can impose, not the applied rates, the actual rates imposed on imports, only OECD paper opted for the former, and this paper also resulted in the lowest total welfare gains in 1997 USD (billions) (Piermartini and Teh, 2005).

STUDY	AGRICULTURE	NON-AGRICULTURE	SERVICES	TRADE FACILITATION	TOTAL
ADFHHM	✓	✓			263.5
AMV	✓	✓	✓		264.8
BDS	✓	✓	✓		2,154.5
Cline	✓	✓			227.8
FMT	✓	✓	✓	✓	367.3
OECD	✓	✓		✓	173.6

Table 03.03: Overall welfare gains from the removal of all barriers (Piermartini and Teh, 2005)

While OECD and World Bank papers projected substantial gains for developing countries of around 50%, others, such as AMV, BDS, and FMT showed only small gains. The reasons could be attributed to increasing returns to scale assumptions in the manufacturing sectors and dynamics (BDS and FMT) or preference erosion (AMV). The latter signals welfare loss after trade liberalisation.

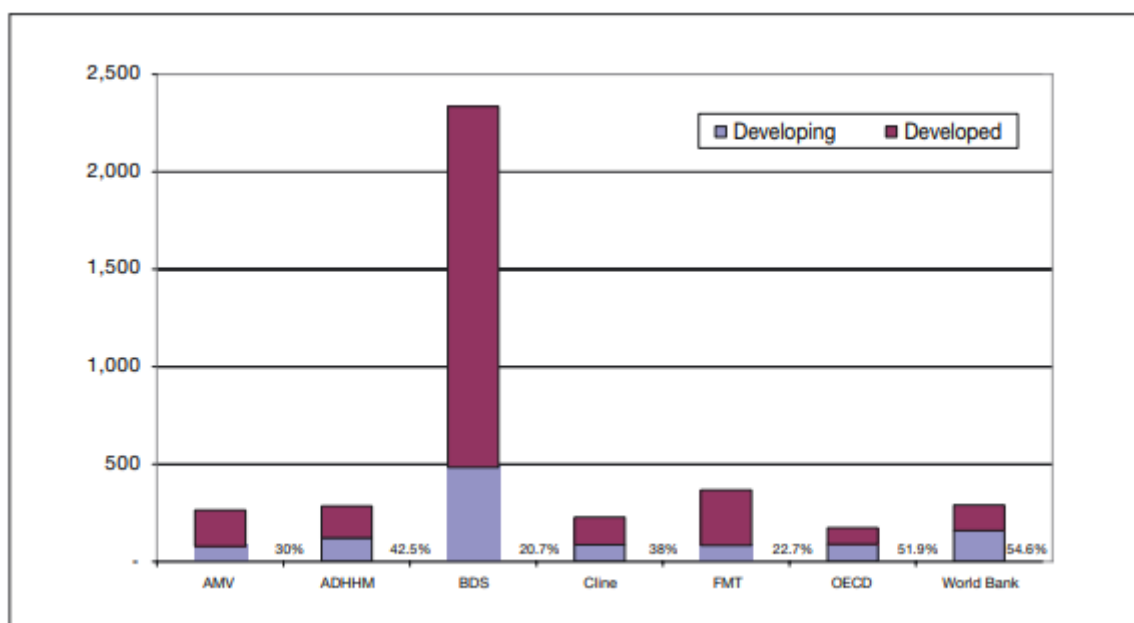


Figure 03.01: Overall welfare gains from multilateral liberalisation (in 1997 billion US dollars) (Piermartini and Teh, 2005)

Welfare losses could also happen at sectoral levels in each country. For example, both BDS and FMT showed that agricultural liberalisation would cause a reduction in welfare. One of the main reasons is due to the assumption of increasing returns to scale in manufacturing sectors, while constant returns to scale in agriculture (Piermartini and Teh, 2005). It could be explained that trade liberalisation would encourage resources such as labour and capital to be reallocated to the higher productive manufacturing sector from agriculture, causing a fall in agricultural output. Since agriculture has always been a politically sensitive and highly protected sector in many countries, such a welfare loss undoubtedly prevents further liberalisation. Net food-importing countries are particularly vulnerable to trade liberalisation in agriculture due to their inherent lack of natural resources for agricultural development.

While all aforementioned studies showed positive welfare gains from trade liberalisation in manufacturing globally, regardless of the assumptions of returns to scale, FMT is the outlier showing a welfare loss for developing countries. Worsening terms of trade and increased competition explained such a reduction.

Gains from service liberalisation tend to be much harder to quantify, and only two papers of BDS and FMT were attempted. Service trade data is a key barrier compared to that of merchandise trade in manufactured goods or agriculture. While BDS overcame the challenge by using the gross operating margins of services firms, FMT utilised the gravity model to estimate the equivalent tariff for service trade. While both papers relied on monopolistic competition and increasing returns to scale, the welfare gain estimated in BDS of around 440 billion USD is almost 20 times larger than that of FMT.

After having reviewed CGE papers for the Doha Round, particularly with the help from (Piermartini and Teh, 2005)'s surveys, it can be seen that despite all CGE papers coming up with positive welfare gains for the whole global economy, the values vary widely, and these positive pictures do not guarantee the Doha Round to be concluded after more than two decades. All papers over-estimated the success of the Doha Round, as some papers simulated a scenario where all barriers were removed. These papers, however, could still be seen as setting the maximum potential gains for the world only. Secondly, certain sectors and countries could still lose from trade liberalisation, hence certain assumptions of the market structure and production functions need to be carefully selected. Thirdly, CGE simulations on manufactured goods and agriculture are easier to carry out than those on services due to the availability of the database.

Additionally, it can be observed that Southeast Asia was never the main focus of the next round of trade research projects with applied Computable General Equilibrium modelling.

3.7.2.2 Alternative options for the global reversion of trade liberalisation – A regional approach

The ongoing stagnation of multilateral trade liberalisation negotiations under the auspices of the WTO, particularly evidenced by the long-running and inconclusive Doha Development Agenda, has prompted a significant strategic pivot. Consequently, the proliferation of Regional Trade Agreements (“RTAs”) reflects a concerted effort by nations to seek trade expansion amid

the inertia of global talks and the inherent complexity of purely bilateral arrangements (Petri and Plummer, 2014). As noted by Whalley (1996), RTAs offer more manageable and flexible frameworks for economic integration, allowing members to pursue targeted reforms and market access that multilateral talks failed to deliver. This response to global deadlock is evident in the proliferation of RTAs after the Uruguay Round, where countries leveraged these agreements to hedge against uncertainty and reinforce domestic policy changes (Crawford & Fiorentino, 2005).

However, the functionality of free trade agreements (“FTA”), a common form of RTA, is complicated by the necessity of rules of origin (“RoO”). Unlike customs unions (“CU”), which impose a common external tariff removing the need for RoO, FTAs depend on these rules to ensure preferential treatment is confined to member-origin goods, preventing trade deflection. Freund and Ornelas (2010) highlight how these RoO introduce significant compliance costs and administrative complexity, which often diminish the practical benefits of FTAs through increased bureaucracy and trade distortions. In comparison, customs unions, by adopting a single external tariff, offer simpler external trade regimes and reduce administrative burdens, though at the expense of ceding tariff-setting autonomy, a trade-off seen in examples like the European Union (a well-known example of a CU) versus agreements like North American Free Trade Agreement (“NAFTA”) (an FTA). Custom unions thus reduce trade diversion risks more effectively but require deeper policy harmonisation, entailing longer negotiation and implementation efforts (Crawford & Fiorentino, 2005; Freund and Ornelas, 2010).

Several mega-FTA initiatives were introduced, starting with the Trans-Pacific Partnership (“TPP”) with 12 Pacific Rim nations, beginning in 2010, the Regional Comprehensive Economic Partnership (“RCEP”) with 10 ASEAN countries plus China, the Republic of Korea, Japan, Australia, and New Zealand, starting from 2013. Another significant regional organisation, namely the Asia-Pacific Economic Cooperation (“APEC”) and its Free Trade Area of the Asia Pacific (FTAAP) initiative, dates back to 2004. A significant advancement in FTAAP was made in 2016 with the endorsement of the Lima Declaration³⁵. However, it still stops short of being finalised as of January 2025.

³⁵ APEC 2024: [https://www.apec.org/publications/2024/05/a-new-look-at-te-free-trade-area-of-the-asia-pacific-\(ftaap\)-review-of-apec-s-collective-progress#:~:text=The%20Free%20Trade%20Area%20of%20the%20Asia%2DPacific%20\(FTAAP\),as%20a%20long%2Dterm%20prospect](https://www.apec.org/publications/2024/05/a-new-look-at-te-free-trade-area-of-the-asia-pacific-(ftaap)-review-of-apec-s-collective-progress#:~:text=The%20Free%20Trade%20Area%20of%20the%20Asia%2DPacific%20(FTAAP),as%20a%20long%2Dterm%20prospect). Accessed on 16-Nov-2024.

3.7.2.2.1 Regional Comprehensive Economic Partnership (RCEP)

The Regional Comprehensive Economic Partnership was first introduced through the ASEAN Framework for Regional Comprehensive Partnership at the 11th ASEAN summit in Bali, Indonesia, in 2011. RCEP was built upon existing bilateral trade agreements between ASEAN and six other major economies in the Indo-Pacific region, namely with China (ACFTA, signed in 2002, came into force in 2010)³⁶, with Korea (AKFTA, 2005, 2010)³⁷, with Japan (AJFTA, Apr-2008, Dec-2008)³⁸, with India (AIFTA, 2003, 2010)³⁹, and with Australia and New Zealand (AANZFTA, 2009, 2010)⁴⁰.

A series of other events before 2011 were also credited with giving rise to the RCEP. The first event was the Asian Financial Crisis in 1997, which devastated many ASEAN economies. Such a crisis reduced growth, foreign direct investment into the region, and the capacity to expand export markets. With many countries in the region embracing export-led growth models, further integration into the global market was crucial for reviving domestic growth. Secondly, while the need for further integration was apparent as mentioned previously, the huge challenge of further negotiating trade liberalisation at a global scale became increasingly visible at the Uruguay Round and especially the latest unfinished Doha Round. Furthermore, China's economic might has been rising impressively after China's economic reform in 1978 to open its closed economy to the world, further enhancing interdependency across South and East Asia (Shimizu, 2021). While China's growth could undermine ASEAN economic performance, for example, by pushing up trade competition as well as drawing away foreign investment, all these opportunities and challenges underscore the need to strengthen intra-ASEAN economic cooperation.

Another major turning point for ASEAN and the wider region is the Global Financial Crisis in 2008 ("GFC") (Shimizu, 2021). Many Asian economies experienced a more rapid deceleration in growth than other regions. One of the reasons was due to the growth models adopted in many Asian countries, where exports of advanced manufacturing goods to developed economies, such as the US and EU, were the main driver of growth. However, advanced manufacturing

³⁶ ACFTA: <https://www.asean.org/wp-content/uploads/images/2015/October/outreach-document/Edited%20ACFTA.pdf>. Accessed on 16-Nov-2024.

³⁷ AKFTA: <https://asean.org/our-communities/economic-community/integration-with-global-economy/asean-korea-free-trade/>. Accessed on 16-Nov-2024.

³⁸ AJFTA: <https://www.asean.org/wp-content/uploads/images/2015/October/outreach-document/Edited%20AJCEP.pdf>. Accessed on 16-Nov-2024.

³⁹ AIFTA: <https://www.asean.org/wp-content/uploads/images/2015/October/outreach-document/Edited%20AIFTA.pdf>. Accessed on 16-Nov-2024.

⁴⁰ AANZFTA: <https://asean.org/our-communities/economic-community/integration-with-global-economy/asean-australia-new-zealand-economic-relations/>. Accessed on 16-Nov-2024.

export tends to fluctuate more with the business cycle than many other goods or services (Kato, 2009)⁴¹, while these developed regions were badly hit by the GFC (Kimura et al (ed), 2022). Furthermore, many countries, especially the epicentre of the global crisis, such as the US, implemented several “protectionist” policies to promote growth and protect domestic employment and firms, for example, a well-known “Buy National” provision, among many other measures in the US. However, according to Bown et al (2011) that contingent trade policies or better known as “temporary trade barriers” (“TTBs”), remain as the main tools for altering the “*relative cost and/or availability of imports*”. While the US deployed fewer TTBs between 2006 to 2010, compared to any five-year period since the 1960s, the length of the duration of new TTBs being put in place has become much longer on average, especially in anti-dumping and countervailing duties. Additionally, more than four-fifths of the flow of the US’s TTBs are against developing nations, even excluding China, by 2009, which historically were only a minority. China’s exports to the US suffered from a higher percentage being exposed to the US’s TTBs than that of all developing nations combined or that of all advanced economies put together. A similar pattern of an increasing focus on the antidumping subject of Chinese exports was also observed in the EU, with China-related cases accounting for around two-fifths of all cases between 2004 and 2009. Interestingly, the paper from Hylke Vandenbussche and Christian Viegelaahn (published in Bown et al, 2011), who focused on the EU case, did not find any major shifts in the EU’s trade policies during the GFC. Canada and South Korea also observed surges in anti-dumping measures during the GFC.

In contrast to such gloomy picture described above, the development in East Asia was credited with leading to the recovery of the global economy, thanks to many East Asian economies’ swift and large fiscal and monetary expansionary policies. Three East Asian countries, namely China, Indonesia, and Vietnam, did not experience any quarterly contractions (World Bank, 2010).

When RCEP was signed in November 2020 by 15 countries (ASEAN+5), this FTA was and has remained the largest trade deal, representing approximately 30% of global GDP and encompassing about one-third of the world's population (Ministry of Trade and Industry Singapore, 2024)⁴². India decided not to join RCEP in the 3rd RCEP Summit in Thailand in

⁴¹ Kato, T (2009). Why Has Asia Been Hit So Hard By The Global Economic and Financial Crisis? Presentation by Mr. Takatoshi Kato, Deputy Managing Director, IMF, at the Eighteenth General Meeting of the Pacific Economic Cooperation Council. Available at: <https://www.imf.org/en/News/Articles/2015/09/28/04/53/sp051209>. Accessed on 10-Mar-2024.

⁴² Ministry of Trade and Industry Singapore. Regional Comprehensive Economic Partnership (RCEP). Available at: <https://www.mti.gov.sg/trade-international-economic-relations/agreements/free-trade-agreements-fta/rcep/>. Accessed on 22-Mar-2025.

2019 (Ministry of Commerce & Industry of India, 2020)⁴³. The size of RCEP could have been much bigger in terms of the combined GDP (an additional 3.167 trillion current USD at purchaser's prices added) and combined population (additional 1.4 billion people added)⁴⁴ had India decided not to withdraw from RCEP negotiation in 2019. Sharma et al (2023) pointed out that the chief concern among Indian policymakers and stakeholders was the existing trade deficits India had with other RCEP members before signing the trade deal. As of 2019, India already had FTAs with ASEAN, Japan and South Korea but suffered from trade deficits with all three partners, totalling 38.78 billion USD. In addition, India also had trade deficits with the rest of the RCEP group, namely, China, Australia and New Zealand, pushing the total deficit to nearly 95 billion USD, with more than half of the total deficit with China (49 billion USD). It was expected that being part of the RCEP deal would worsen India's trade deficit with other RCEP members. To deal with the prospect of a worsening trade balance, India requested an “Automatic Trigger Safeguard Mechanism” (“ATSM”) as part of the deal that allows India to impose additional tariffs on additional import volume that is above a certain import threshold, but not successful (Council of States of India, 2019)⁴⁵. Sharma et al (2023) used the standard static GTAP model to estimate the GDP changes in two scenarios. The first simulation is India not joining RCEP, and in this case, India's GDP is projected to reduce by 10.35 billion USD, but the trade balance improves by 2.5 billion USD. The second scenario simulates India joining RCEP, and the GTAP model projects India's GDP to fall by 13 billion USD, and a 3.9 billion USD increase in trade deficit.

To evaluate the economic impact of RCEP, Sun et al (2023) observed that the majority of papers utilised Ex-ante forecasting, especially the Computable General Equilibrium (CGE) model, because RCEP was formally signed in 2020 and only came into effect on 1st January 2022, generating limited data for Ex-post analysis.

⁴³ Ministry of Commerce & Industry. India's on-Going Trade Negotiations. Available at: <https://www.pib.gov.in/pressreleasepage.aspx?prid=1606300>. Accessed on 01-Nov-2025

⁴⁴ World Bank – India: <https://data.worldbank.org/country/india>

⁴⁵ Council of States (Rajya Sabha). Parliamentary Debates. Available at: <https://cms.rajyasabha.nic.in/UploadedFiles/Debates/OfficialDebatesDatewise/Floor/250/F06.12.2019.pdf>. Accessed on 01-Nov-2025.

3.7.2.2.2 Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)

The Comprehensive and Progressive Agreement for Trans-Pacific Partnership (“CPTPP”) was a revised version of the Trans-Pacific Partnership (“TPP”). However, TPP is not the original form, but an expanded version of the Trans-Pacific Strategic Economic Partnership Agreement (“TPSEP”), which originally comprises four Asian Pacific nations, namely Brunei Darussalam, Singapore, New Zealand and Chile (“P4”) in 2006 (Ministry of Foreign Affairs and Trade of New Zealand, 2005) ⁴⁶. Just after the GFC, other countries joined the TPSEP, including Australia, Peru, Vietnam and the US in 2010, which laid the ground for the establishment of the Trans-Pacific Partnership (“TPP”). In November 2009, US President Barack Obama announced his intention for the US to join the Trans-Pacific Partnership. According to the Office of the United States Trade Representative, the Obama Administration sought to strengthen the U.S. economy by expanding exports to regions with high economic output, comprising almost 40% of global GDP ⁴⁷. Later on, from 2010 to 2013, Malaysia, Canada, Mexico and Japan completed the original TPP version of twelve countries.

On 4th February 2016, all twelve countries signed the agreement in New Zealand. However, President Trump withdrew the US from the trade pact in January 2017. The remaining eleven countries had made significant efforts to sign the new trade agreement called CPTPP in March 2018, and the agreement entered into force among members between late 2018 to 2023 (USTR, 2017; Government of Canada, 2018) ^{48 49}. Using the dynamic CGE model, an extension of the standard GTAP model's comparative static framework used in this doctoral thesis, Lee and Itakura (2017) estimate that the failure to implement the TPP results in an estimated opportunity cost to the US, which forgoes a potential 0.7% gain in economic welfare by 2034. Furthermore, delaying the country's participation in the TPP by five years is projected to diminish its welfare gain by 0.3 percentage points.

⁴⁶ Ministry of Foreign Affairs and Trade of New Zealand. The New Zealand - Singapore - Chile - Brunei Darussalam Trans-Pacific Strategic Economic Partnership. Available at: <https://www.mfat.govt.nz/assets/Trade-agreements/P4/trans-pacificbooklet.pdf>. Accessed on 22-Mar-2025.

⁴⁷ US Trade representative: <https://ustr.gov/tpp/overview-of-the-TPP#:~:text=President%20Obama%20announced%20in%20November,U.S.%20economic%20priorities%20and%20values.> 22-Mar-2025.

⁴⁸ Office of the United States Trade Representative. The United States Officially Withdraws from the Trans-Pacific Partnership: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2017/january/US-Withdraws-From-TPP>. 22-Mar-2025.

⁴⁹ Government of Canada. Timeline of the CPTPP: https://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/cptpp-ptpgp/timeline_negotiations-chronologie_negociations.aspx?lang=eng. Accessed on 22-Mar-2025.

The UK made a historical and strategic move by joining the CPTPP on 15th December 2024 (UK Government, 2024) ⁵⁰. Employing the standard CGE model, the UK's Department for Business and Trade (2023) estimated that the UK's bilateral trade with CPTPP partners would increase by £4.9 billion, the UK's GDP to increase by £2.0 billion while that of CPTPP as whole by £2.4 billion, in comparison to 2040 projections in 2021 price level. Petri and Plummer (2023), using the WTO's Global Trade Model ("GTM") – a dynamic CGE model, estimated that the UK would gain up to 42 billion USD in scenarios of expanding either or both CPTPP and RCEP.

Publications	Regions	CGE model	Data base	Key simulations
Raihan et al., 2022	Bangladesh Both RCEP and CPTPP	GTAP	GTAP v10	S1: LDC graduation S2: RCEP S3: CPTPP S4: LDC graduation & RCEP S4: LDC graduation & CPTPP
Park et al., 2021	Asia & the Pacific Both RCEP and CPTPP	Initially developed by Zhai (2008) based on an early version of the World Bank's LINKAGE system Petri, Plummer, and Zhai (2012) Petri and Plummer (2016)		

⁵⁰ The UK Government. UK to join CPTPP by 15 December: <https://www.gov.uk/government/news/uk-to-join-cptpp-by-15-december>. Accessed on 22-Mar-2025.

Petri and Plummer, 2020	East Asia	Petri, Plummer, and Zhai (2012) Petri and Plummer (2016) www.asiapacifictrade.org	GTAP v09	
Petri and Plummer, 2023	ASEAN, RCEP, CPTPP, Global	WTO's Global Trade Model (GTM) (Aguilar et al. 2019)	GTAP v11	S1: Reshoring S2: Near-shoring S3: Friend-shoring S4: RCEP (2022) S5: CPTPP2 (2024) S6: CPTPP3 (2027) S7: Global Reach (2030)
Ji et al., 2018	ASEAN	GTAP - Static	GTAP v09	S1: CPTPP S2: RCEP S3: Open CPTPP S4: Open RCEP S5: CPTPP + RCEP S6: Open CPTPP + Open RCEP S7: FTAAP ⁵¹ + S8: Open FTAAP+
Lee and Itakura, 2018	ASEAN, CPTPP, TPP, RCEP, FTAAP	GTAP - dynamic	GTAP v09	S1: Asian track – RCEP, RCEP + Taiwan, FTAAP S2: Trans-Pacific track 1 – TPP-11, TPP-16, FTAAP S3: Trans-Pacific track 2 – TPP-12, TPP-16, FTAAP S4: Two tracks – S1 & S2 combined

⁵¹ APEC's prospective Free Trade Area of the Asia-Pacific (FTAAP)

Li et al., 2017	RCEP	FDI-CGE model (FHFDI model) which builds on Zhai (2008), the first paper to introduce firm heterogeneity into a CGE model.	GTAP v08	S1: NTBs in China and PTN are reduced to the same target level of the average of NTBs in Japan and Korea. S2: NTBs in China and PTN are reduced to the target level, with the exception of s1 and s2 in China. Sectors s1 and s2 in China are reduced by the same percentage margin as the corresponding sectors in PTN.
Cheong and Tongzon, 2013)	TPP, RCEP	GDyn -recursive dynamic CGE model developed by GTAP	GTAP v08	S1: TPP – TPP9, TP, TP + China S2: RCEP – RCEP, RCEP – China, RCEP - Japan
Li & Whalley, 2014	TPP, China, Japan	Authors' own CGE model		S1: Impacts on China of Being in or Out of TPP S2: Impacts on TPP Countries When China Is In or Out S3: Impacts on Other Non-TPP Countries S4: Comparing the Effects of TPP Free Trade and Global Free Trade S5: Comparing Trade Cost Barrier to Tariff at Same Rate S6: Impacts of Japan In/Out TPP
Lee, Owen, & van der, Mensbrugghe, 2009	ASEAN+3, ASEAN+6, EU, North America	World Bank's LINKAGE model, described in detail by van	GTAP v06	S1: The FTA members remove bilateral tariffs and export taxes/subsidies (except rice)

		der Mensbrugghe (2005) (compared with GTAP and MIRAGE)		S2: A 2.5% reduction in frictional trade costs among the FTA members. S3: The sector-specific productivity factors related to the degree of openness are endogenously determined (fixed in S1 & S2) S4: A 10% reduction in the trade and transport margins for FTA members is incorporated in S3
Sharma et al, 2023	India, RCEP	GTAP – Static	v10	S1: India joins RCEP S2: India does not join RCEP
Lee and Itakura (2017)	RCEP, TPP- 11, TPP-16, FTAAP	GTAP - Dynamic	v09	S1: RCEP over the period 2019-2028, RCEP + Taiwan from 2024- 2033 and FTAAP from 2028-2035 S2: TPP-11 (TPP sans US) from 2019-2028, TPP-16 from 2024-2033, and FTAAP from 2028-2035 S3: S2 + the US joined TPP from the beginning
Department for Business and Trade (2023)	UK & CPTPP	DBT's CGE model	GTAP v11	S1: Ecuador, Costa Rica, Uruguay, Republic of Korea, Colombia, Philippines, and Thailand, and the UK join CPTPP S2: the US and the rest of ASEAN countries (Laos, Cambodia & Indonesia) join CPTPP

				S3: S1 + S2 countries join CPTPP
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Table 03.04: RCEP and (CP)TPP notable publication summary (Author’s own table)

What could be seen from the above summary is that, unlike the first two rounds of trade liberalisation at the global scale where Southeast Asia was not the main focus, Southeast Asia and ASEAN gradually gained more attention on applied CGE research, thanks to the establishment of mega-regional trade agreements such as CPTPP and RCEP. However, RCEP seems to play a more important role as all ASEAN countries belong to this agreement while only four Southeast Asian nations being part of CPTPP. Furthermore, the ASEAN region is frequently treated as one of several secondary geographical components within these studies, rather than serving as the primary subject of investigation in the extant literature.

3.7.2.3 President Trump’s first trade war, 2017 – 2020, and the decline of the regional approach

President Trump’s 2016–2020 trade policies marked a decisive shift from multilateralism to bilateralism, upending decades of the US’s commitment to regional trade frameworks. President Trump dismissed multilateral deals as “*mashed pots*”, favouring competitors, instead prioritising “*one-on-one*” negotiations to leverage U.S. economic power via his “*America First*” trade approach ⁵². Central to this approach was the 2017 withdrawal of the US from the TPP.

Concurrently, Trump launched a tariff-driven trade war with China, imposing Section 301 tariffs on around 370 billion USD of Chinese goods via four main lists, normally known as Lists 1, 2, 3, 4A and 4B ⁵³, which triggered retaliatory measures from China (to be discussed in more detail in Chapters 04 and 07) and disrupted global supply chains. The U.S.-China Phase One Trade Agreement, signed in January 2020, aimed to de-escalate tensions from the 2018–2020 trade war by addressing structural economic issues and expanding Chinese

⁵² President Trump’s speech at the congressional Republican retreat in Philadelphia in 2017. Available at: <https://www.c-span.org/program/white-house-event/president-trump-remarks-at-congressional-republican-retreat/468450>. Accessed on 17-Aug-25.

⁵³ Office of the United States Trade Representative. Section 301: <https://ustr.gov/issue-areas/enforcement/section-301-investigations/search>. Accessed on 17-Aug-25.

purchases of U.S. goods and services. The deal committed China to increase imports of U.S. products by “no less than” 200 billion USD above 2017 levels over 2020–2021, targeting specific sectors: 77.7 (32.9 + 44.8) billion USD in manufactured goods, 52.4 (18.5 + 33.9) billion USD in energy, 32 (12.5 + 19.5) billion USD in agriculture, and 37.9 (12.8 + 25.1) billion USD in services. The agreement also included enforceable commitments on intellectual property protections, prohibitions on forced technology transfers, improved market access for U.S. agricultural and financial services, macroeconomic policies and exchange rate⁵⁴. In exchange, the U.S. reduced List 4A tariffs from 15% to 7.5% but retained 25% tariffs on 250 billion USD of Chinese goods. However, China was estimated to have fulfilled only 58% of its purchase commitments by December 2021, with shortfalls exacerbated by the COVID-19 pandemic’s disruption to services (e.g., tourism, education) and declining Chinese demand for energy products amid falling global prices (PIIE, 2022a, PIIE, 2022b)^{55 56}.

For Southeast Asia, the Phase One deal and the period afterwards introduced mixed outcomes. According to Lim and Nguyen (2024)’s ex-post research, Vietnam has boosted its exports to both the US and China as a result of US tariffs imposed on China, whereas Thailand’s exports to the US have grown positively, but its shipments to China have decreased. Countries such as Brunei Darussalam, Indonesia, Malaysia, Myanmar, the Philippines, and Singapore have generally maintained steady export levels to the US. In contrast, Malaysia’s exports to China have fallen, while Myanmar’s have risen. Additionally, there is considerable variation among countries and sectors, with the machinery sector notably expanding in Vietnam, Thailand, and Indonesia. These results indicate that the varying degrees of trade integration with the US and China largely explain the uneven effects of the US-China trade conflict on different ASEAN economies.

By abandoning regional agreements like the TPP, starting new trade wars and undermining the WTO, President Trump’s policies fragmented global trade governance, incentivising countries to pursue alternative partnerships, such as the Comprehensive and Progressive Agreement for

⁵⁴ Office of the United States Trade Representative. Phase One Trade Agreement - Economic and Trade Agreement Between the Government of the United States of America and the Government of the People’s Republic of China: <https://ustr.gov/phase-one>. Accessed on 17-Aug-25.

⁵⁵ PIIE. (2022). US-China phase one tracker: China’s purchases of US goods. Available at: <https://www.piiie.com/research/piie-charts/us-china-phase-one-tracker-chinas-purchases-us-goods>. Accessed on 17-Aug-25.

⁵⁶ PIIE. China bought none of the extra \$200 billion of US exports in Trump's trade deal. Available at: <https://www.piiie.com/blogs/realtime-economics/2022/china-bought-none-extra-200-billion-us-exports-trumps-trade-deal>. Accessed on 17-Aug-25.

Trans-Pacific Partnership, without U.S. involvement. This unilateralist legacy reshaped trade dynamics, prioritising transactional gains over systemic stability.

A large body of literature, using CGE models, examines the bilateral US–China trade war as emblematic of this new approach. Zheng et al. (2023) use the GTAP model to simulate the trade dispute's effects, documenting large, discriminatory tariffs and retaliation between the two countries, while the rest of the trading system remained comparatively uninvolved. Their results show that if the US and China imposed tariffs on each other, the US's real income could fall by 33.5 billion USD, while China would lose more than 75 billion USD. However, if both the US and China were to remove all tariffs during President Trump's first administration, the real incomes would have increased by 31 billion USD and 73 billion USD, respectively. Sectoral effects are sharp; the US tariffs focused disproportionately on Chinese industrial exports, while Chinese retaliation concentrated on US agricultural products, illustrating a strategic, partner-specific targeting impossible under broader regional frameworks. Similarly, Giesecke et al. (2019), employing the GTAP-MVH dynamic model, decompose the effects of US tariffs in isolation, Chinese retaliatory tariffs in isolation, and their joint application. They found that, in the joint application scenario, the average annual US real consumption loss is estimated to be around 56 billion USD over 2020–2025, while China's average annual consumption loss is about 37 billion USD. Their scenario analyses underscore the bilateral nature of Trump-era trade battles, primarily targeting the US and China, and virtually no regional or global coordination in responses. Zheng et al. (2023) and Giesecke et al. (2019) also note the strong distortion and reduction in bilateral trade where the US's imports of Chinese goods and vice versa dropped sharply, while trade with other partners increased due to diversion but without forming new regional blocs or multilateral deals.

While the focus was most acute on China, other relationships were similarly reframed as bilateral contests or negotiations. Giesecke et al. (2019) also explored a policy scenario of “*a permanent policy-mandated 25% reduction in imports of Australian coal by China*”. The authors found that the average real consumption in Australia is reduced by around 24 AUD per person. Balistreri and Hillberry (2017) investigate the optimal and politically motivated US tariffs vis-à-vis Mexico and China, calibrating their simulations to different tariff proposals during Trump's campaign and presidency. Their results show that the US's optimal tariff level is around 12 percent, and its welfare gains from such an optimal tariff would be modest of around 6.3 billion USD. The proposed bilateral hikes (like a 35% tariff on Mexican goods) would actually make the US worse off by around 5 billion USD. Mexican welfare gains are

estimated to be 0.87 billion USD when the optimal tariff rate of 5 percent being on the US's exports.

Dixon (2017) and Rosyadi & Widodo (2018) extend the analysis to global and regional effects, respectively. Dixon's modelling of a hypothetical 45% US tariff on Chinese goods finds little macroeconomic or sectoral damage to Australia, unless there is worldwide contagion. This is due to the close-to-neutral impact of various terms of trade changes. Rosyadi & Widodo (2018) present full retaliation scenarios but emphasise that both China and the US lose, while other third countries such as Mexico, Canada and Vietnam can selectively benefit from diverted trade flows, again without any new region-wide response. Quite similar to Rosyadi & Widodo (2018)'s conclusion regarding third parties, Vanzetti et al. (2020) take a developing country perspective, quantifying 14 billion USD in annual welfare gains for developing economies such as Mexico and Vietnam from US–China trade diversion, with oilseeds, electronics, manufacturing and apparel being the winning sectors. The principal winners are countries able to step into the precise bilateral flows interrupted by the tariffs, further illustrating the partner-specific, not region-specific, nature of the new trade order.

Itakura (2019) offers additional insight into the consequences for global value chains, showing that the negative impacts on world GDP are more widespread when these chains are considered, but the mechanisms remain fundamentally bilateral and not multilateral. Losses are concentrated in US and Chinese output (–1.4% each in the most severe scenario with tariffs increased, investment deterred, and productivity reduced), while third country effects are mediated via direct trade diversion, not regional policy responses.

The table below summarises notable research papers that use the GTAP CGE models to analyse the impacts of President Trump's trade policies during his first presidency (2016 –2020).

Publications	Regions	CGE model	Data base	Key simulations
Vanzetti et al (2020)	US, China, EU, Vietnam and 14 other	GTAP TASTE software is used for	GTAP v10	S1: Unilateral tariff imposition by the US S2: Unilateral tariff imposition by China S3: Trade war between the US and China

	regions or countries	changes in the tariff level.		
Balistreri & Hillberry (2017)	US, China & Mexico	GTAP-in-GAMS (Lanz & Rutherford, 2016)	GTAP v09	S1: Unilateral tariff imposition by the US on Mexico S2: Unilateral tariff imposition by Mexico on the US S3: Trade war between the US and Mexico, based on the Nash-equilibrium tariffs S4: Trade war between the US and China, based on Nash-equilibrium tariffs
Itakura (2019)	US, China and 18 other regions or countries	dynamic GTAP model (GDyn)	GTAP v09 CARD Trade War Tariffs Database	S1: Trade war, primarily focusing on tariffs S2: Trade war, primarily focusing on tariffs, with a fall in FDI S3: Trade war, primarily focusing on tariffs, with a fall in FDI and a fall in productivity
Zheng et al (2023)	China, the USA, Korea, Oceania, ASEAN, the Middle East, EU, Brazil, Other	GTAP model	GTAP v10 HS codes	S1a: US tariffs & China's retaliation in 2018 S1b: US tariffs without China's retaliation S2a: US tariffs & China's retaliation in 2019 S2b: US tariffs without China's retaliation

	South America, and RoW			S3: Additional tariffs imposed by both China and the US S4: Eliminating the remaining above-MFN tariffs introduced in the Trump era trade dispute
Rosyadi & Widodo (2018)	China, the USA, EU-28 and 28 other regions or countries	GTAP model	GTAP v09A	S1: A full trade war between the US and China with a 45% import tariff imposed by each country S2: A manufacturing-only trade war between the US and China with a 45% import tariff imposed by each country
Dixon (2017)	China, the US and Australia	GTAP model	GTAP v09	S1: Unilateral tariff imposition by the US of 45% on Chinese manufacturing goods S2: A trade war between the US and China of 45% on Chinese manufacturing goods S3: S2 plus a global trade war where all other countries impose 20% tariffs The optimal tariffs are also discussed.
Giesecke et al (2019)	China, the US and 16 other regions or countries	GTAP-MVH model (an extension of the standard GTAP model that provides a	GTAP v09	S1: Unilateral tariff imposition by the US S2: Unilateral tariff imposition by China S3: Trade war between the US and China

		more detailed disaggregation of the motor vehicle and parts (MVH) sector)		
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Table 03.04: Basic model structure of CGE simulations of President Trump's trade policies during his first presidency (2016 –2020) (Author's own table)

As we can see from Table 03.04 above, while ASEAN remained relevant in CGE analysis, the main focus for this chaotic period was disproportionately but understandably between the US, China and their tariff wars. Any other countries being studied are really secondary to this Sino-US trade tension.

Date	Event
22/01/2018 ⁵⁷	The United States initiated the imposition of Section 201 tariffs
22/03/2018 ⁵⁸	The US announced tariffs under a Section 301 investigation
06/07/2018 ⁵⁹	The US imposed 25% tariffs on \$34 billion of Chinese imports
23/08/2018 ⁶⁰	The US imposed 25% tariffs on an additional \$16 billion of Chinese goods.
23/08/2018	China retaliated with 25% tariffs on \$16 billion of US goods.
24/09/2018 ⁶¹	The US imposed 10% tariffs on \$200 billion of Chinese imports (List 3).
24/09/2018	China imposed tariffs on \$60 billion of US goods.

⁵⁷ Office of the United States Trade Representative. President Trump Approves Relief for U.S. Washing Machine and Solar Cell Manufacturers. Available at: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/january/president-trump-approves-relief-us>. Accessed on 22-Mar-2025.

⁵⁸ Office of the United States Trade Representative. Section 301 Fact Sheet. Available at: <https://ustr.gov/about-us/policy-offices/press-office/fact-sheets/2018/march/section-301-fact-sheet>. Accessed on 22-Mar-2025.

⁵⁹ Office of the United States Trade Representative. USTR Issues Tariffs on Chinese Products in Response to Unfair Trade Practices. Available at: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/june/ustr-issues-tariffs-chinese-products>. Accessed on 22-Mar-2025.

⁶⁰ Office of the United States Trade Representative. USTR Finalizes Second Tranche of Tariffs on Chinese Products in Response to China's Unfair Trade Practices. Available at: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/august/ustr-finalizes-second-tranche>. Accessed on 22-Mar-2025.

⁶¹ Office of the United States Trade Representative. USTR Finalizes Tariffs on \$200 Billion of Chinese Imports in Response to China's Unfair Trade Practices. Available at: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/september/ustr-finalizes-tariffs-200>. Accessed on 22-Mar-2025.

10/05/2019 ⁶²	The US raised tariffs on List 3 from 10% to 25%.
13/08/2019 ⁶³	US announces 10% tariffs on \$300 billion of remaining Chinese imports (List 4), effective September 1.
23/08/2019 ⁶⁴	China announces tariffs on \$75 billion of US goods in retaliation, effective September 1.
01/09/2019 ⁶⁵	The US implements 15% tariffs on part of the \$300 billion of Chinese goods (List 4A).
15/01/2020 ⁶⁶	The US and China signed a Phase One trade deal.

Table 03.05: Key US-China trade dispute timeline (Author's own table)

3.7.3 ASEAN centrality

Thanks to ASEAN's role in fostering RCEP, more researchers have increasingly used the term “*ASEAN centrality*” to describe its role in determining regional architecture. However, according to Mueller (2019), most studies did not clearly define this term or provide a method for measuring it, while Petri and Plummer (2014) regard this concept as a relatively new term. The loose version of “*the centrality of ASEAN*” first appeared in the Joint Media Statement of the 38th ASEAN Economic Minister (AEM) Meeting in Kuala Lumpur, Malaysia, on 22nd August 2006. Given the nature of the Meeting, the term was strictly expressed in the external economic context rather than a political one⁶⁷. In the 2008 ASEAN Charter, also known as “*the legal and institutional framework for ASEAN*”, the term “*Centrality*” was used three times in articles 1.15, 2.2.m, and 41.3. In this crucial document, the term was extended beyond the

⁶² Office of the United States Trade Representative. Modification to Increase Duty from 10 Percent to 25 Percent. Available at: <https://ustr.gov/issue-areas/enforcement/section-301-investigations/section-301-china/200-billion-trade-action>. Accessed on 22-Mar-2025.

⁶³ Office of the United States Trade Representative. USTR Announces Next Steps on Proposed 10 Percent Tariff on Imports from China. Available at: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2019/august/ustr-announces-next-steps-proposed>. Accessed on 22-Mar-2025.

⁶⁴ CNN. China and the US ratchet up trade war in a day of retaliation. Available at: <https://edition.cnn.com/2019/08/23/business/china-tariffs-trade-war/index.html>. Accessed on 22-Mar-2025.

⁶⁵ Office of the United States Trade Representative. Notice of Modification of Section 301 Action: China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation. Available at: https://ustr.gov/sites/default/files/enforcement/301Investigations/Notice_of_Modification%E2%80%933August_2019.pdf. Accessed on 22-Mar-2025.

⁶⁶ Office of the United States Trade Representative. Phase One Trade Agreement. Available at: <https://ustr.gov/phase-one>. Accessed on 22-Mar-2025.

⁶⁷ AEM Joint Media Statement “They also reiterated the centrality of ASEAN in external economic relations”: <https://asean.org/joint-media-statement-of-the-thirty-eight-asean-economic-ministers-aem-meeting-kuala-lumpur-22-august-2006/>

economic domain into “*external political, economic, social and cultural relations*” and also in “*regional cooperation and community building*”⁶⁸.

ASEAN’s centrality was first put to the test in 2012 when the 10-country organisation, for the first time since its establishment in 1967, was unable to issue a Joint Communiqué and many researchers saw external partners’ influence on the host country, Cambodia, especially from China, for such failure (Yu, 2024). Given the increasingly hostile environment among superpowers, particularly between the US and China during US President Trump’s first and now second terms, in the Indo-Pacific region, the term ASEAN Centrality re-emerges. The terms “*ASEAN Centrality*” or “*ASEAN*” appear in several important and guiding documents, such as the EU’s strategy for cooperation in the Indo-Pacific (2021)⁶⁹, Japan’s vision on a Free and Open Indo-Pacific (FOIP) (2024)⁷⁰, the US’s Indo-Pacific Strategy (2022)⁷¹, and France’s Indo-Pacific Strategy (2022)⁷².

As ASEAN has become more and more important not just economically but also geopolitically, it would be highly valuable to examine the potential impact of the new reciprocal tariffs on the region, as well as how the region should strategically and optimally respond to the current trade world.

3.8 Conclusion

This chapter has examined the theoretical foundations, methodological evolution, and empirical applications of Computable General Equilibrium modelling, establishing its central role in analysing trade policy shocks and economy-wide interactions. Beginning with the Walrasian general equilibrium framework and its formalisation through the Arrow–Debreu model, the review traced how CGE modelling emerged as a practical tool for quantifying the simultaneous adjustments that occur across markets in response to policy changes. The chapter also highlighted the contributions of Leontief, Johansen, and the GTAP consortium in

⁶⁸ 2008 ASEAN Charter: <https://asean.org/wp-content/uploads/images/archive/publications/ASEAN-Charter.pdf>

⁶⁹ EU – AC: https://www.eeas.europa.eu/sites/default/files/jointcommunication_2021_24_1_en.pdf

⁷⁰ JP – AC: https://www.mofa.go.jp/policy/page25e_000278.html. Accessed on 22-Mar-2025.

⁷¹ US – AC: <https://www.whitehouse.gov/wp-content/uploads/2022/02/U.S.-Indo-Pacific-Strategy.pdf>. Accessed on 22-Mar-2025.

⁷² FR – AC: [https://www.diplomatie.gouv.fr/en/country-files/regional-strategies/indo-pacific/the-indo-pacific-a-priority-for-france/#:~:text=A%20crucial%20region%20given%20global%20challenges,-French%20strategy%20in&The%20Indian%20and%20Pacific%20Oceans,exclusive%20economic%20zone%20\(EEZ\)](https://www.diplomatie.gouv.fr/en/country-files/regional-strategies/indo-pacific/the-indo-pacific-a-priority-for-france/#:~:text=A%20crucial%20region%20given%20global%20challenges,-French%20strategy%20in&The%20Indian%20and%20Pacific%20Oceans,exclusive%20economic%20zone%20(EEZ).). Accessed on 22-Mar-2025.

transforming general equilibrium theory into an operational modelling framework capable of supporting large-scale policy simulations.

The review further distinguished CGE modelling from partial equilibrium approaches, emphasising its ability to capture intersectoral linkages, factor-market adjustments, and macroeconomic constraints that are essential for analysing trade policy. While static CGE models abstract from dynamic adjustment processes, they remain widely used for ex-ante policy evaluation due to their transparency, tractability, and capacity to simulate counterfactual scenarios. The chapter also acknowledged the limitations of CGE models, including their reliance on fixed elasticities, perfect mobility assumptions, and the potential vulnerability of econometrically estimated parameters to the Lucas Critique.

Empirically, the literature demonstrates extensive use of CGE models to simulate hypothetical or counterfactual trade shocks. However, early CGE research primarily focused on developed regions and hence ASEAN did not play any important role in those analyses. With the creations of mega-regional trade blocks, such as RCEP and CPTPP, ASEAN gained more attention in CGE research. However, with the first trade war during the first Trump Administration, all regional CGE studies were frequently relegated to a secondary status, appearing as subsidiary to the broader repercussions of the Sino-American economic rivalry.

Although these studies are forward-looking in design, they overwhelmingly focus on historical policy environments, particularly the tariff measures implemented during the 2018–2020 US–China trade war. Parallel strands of research analyse the economic implications of mega-regional agreements such as RCEP and CPTPP, while political-economy scholarship explores ASEAN centrality within the Indo-Pacific. However, these literatures remain largely disconnected: CGE studies rarely incorporate geopolitical concepts such as ASEAN centrality, and geopolitical analyses seldom employ formal general equilibrium modelling.

From this synthesis, *one critical gap emerges*. Although CGE studies are inherently forward-looking, the existing literature focuses almost exclusively on simulations of past tariff episodes, particularly the 2018–2020 US–China trade war. No published CGE study models the newly proposed reciprocal tariff regime associated with a second Trump administration, nor evaluates its potential spillovers for Southeast Asia. However, this is partly due to the novelty and recentness of the reciprocal tariff announcement. This gap has two important dimensions: first, the absence of any CGE-based quantification of Trump’s 2024–2025 tariff proposals; and second, the lack of analysis linking such external shocks to ASEAN’s economic

position and strategic centrality within the Indo-Pacific. Together, these omissions leave a significant gap in understanding how renewed US protectionism could reshape Southeast Asia's macroeconomic performance, sectoral structure, and regional role. Chapter 04 will outline how this thesis addresses this gap.

4 Chapter 04: Methodology

4.1 Introduction

This chapter outlines the methodological approach employed to achieve the study's aims and objectives. It examines relevant literature across diverse research paradigms to establish the philosophical foundations underpinning the investigation and the research strategy. The different sources of data required, as well as how they are collected and processed, will also be discussed later in this chapter in order to prepare for the four model simulations outlined in Chapter 01.

4.2 Research aim, objectives, and questions

As mentioned in Chapter 01, the aim of this research is to contribute to the understanding of the macroeconomic and sector-level impacts that might follow due to President Trump's recent reciprocal tariff announcement up to April 2025, as well as how SEA should respond strategically to such new trade policies.

This research sets out three objectives:

1. To conduct an analysis of the macroeconomic consequences of President Trump's tariff policies on Southeast Asia and its nine key trading partners, including the United States.
2. To conduct an analysis of the microeconomic or sector-level consequences of President Trump's tariff policies on Southeast Asia's twelve aggregated sectors
3. To investigate and formulate policy recommendations concerning the optimal response strategies for Southeast Asian nations in light of President Trump's tariff policies.

To achieve the aim and objectives set out above, the research will answer three questions:

1. What is the projected impact of President Trump's tariff policies on key macroeconomic aggregates, specifically the resulting changes in real economic growth, consumption, investment, export volumes, import volumes, and sectoral production output?
2. What is the differential sectoral impact of President Trump's tariff policies on the aggregated economy of Southeast Asia, specifically the absolute and relative gains and losses across key aggregate sectors and industries?

3. What is the most likely optimal economic response for Southeast Asian nations, specifically concerning retaliation versus restraint, to mitigate the adverse economic effects of President Trump's reciprocal tariff policies?

4.3 Philosophical Foundations of the Research

4.3.1 Research Philosophy and Paradigm

This study adopts a positivist research paradigm, which aligns with the objective of generating verifiable knowledge about the economic impacts of trade policies through formal modelling. Positivism maintains that social phenomena, including economic behaviour, can be studied using scientific methods similar to those in natural sciences, emphasising observable facts, causal relationships, and generalizable laws (Adams et al., 2007; Creswell, 2009; Saunders et al., 2023)⁷³. Unlike interpretivist approaches, which prioritise subjective meanings, positivism seeks to explain phenomena through hypothesis testing and empirical validation as well as to make generalisations about the studied population, making it suitable for analysing complex policy effects like those from trade wars (Bryman and Bell, 2007; Curral and Inkpen, 2002).

The choice of positivism stems from the need to test specific hypotheses as outlined in the later section. This paradigm rejects reliance on personal interpretations, instead favouring quantitative tools that minimise researcher bias and produce falsifiable results (Collis and Hussey, 2003). In the context of this DBA thesis, positivism supports deductive reasoning, starting from neoclassical economic theory to predict outcomes, then verifying them via simulations calibrated to real-world data.

4.3.2 Ontological Position

Ontology addresses the nature of reality, what exists independently of human perception (Saunders et al., 2023). The ontological position of this research is objectivism. An objectivist ontology posits that an objective economic reality exists externally, governed by measurable structures. In the context of trade war analysis, this means that economic outcomes, such as changes in GDP, trade flows or welfare, are real, external facts that exist regardless of the

⁷³ Creswell J.W (2009) *Research design: Qualitative, Quantitative and Mixed Methods Approaches* (3rd ed.) Thousand Oaks, CA: Sage

researcher's perspective. This position justifies the use of CGE modelling, as the model is designed to map this objective reality and identify the causal chains that drive macro and microeconomic outcomes.

4.3.3 Epistemological Position

Epistemology concerns how valid or acceptable knowledge is acquired (Saunders et al., 2023; Creswell, 2009). Following a positivist stance, this study asserts that valid knowledge emerges from impartial observation, precise measurement, and logical deduction. The researcher remains detached from the subject matter to maintain neutrality, especially when the researcher has a close personal connection with the studied region, SEA. In practice, this involves using several secondary databases, such as the GTAP database, to calibrate models and simulate economic shocks to derive predictions. This approach ensures that the research findings reflect underlying economic laws rather than personal narratives, allowing causal claims.

By adopting a positivist epistemology, this study deliberately moves away from interpretivist traditions that prioritise subjective lived experiences and stakeholder narratives (Saunders et al., 2023). In the context of trade war analysis, this stance ensures scientific neutrality; economic impacts are evaluated through quantifiable welfare metrics and price fluctuations rather than qualitative perceptions. Such an approach significantly enhances reliability, as the simulation results remain independent of the researcher and can be replicated by others utilising identical model parameters (Johnson and Onwuegbuzie, 2004).

4.3.4 Axiological Position

Axiology examines the role of values and ethics in research. This thesis pursues value-neutrality, where findings prioritise economic efficiency and welfare over moral judgments (Saunders et al., 2023). Analysis focuses on macro and micro economic performances, Pareto-improving outcomes or deadweight losses from trade distortions, without prescribing "fair" policies. While complete neutrality is aspirational, ethical transparency is maintained. These include publicly-available data sources and explicitly-stated assumptions. This axiology aligns with positivism, separating "is" from "ought," and ensures policy recommendations emerge

from evidence, not bias, crucial for DBA work influencing economic and business strategy amid geopolitical tensions.

4.3.5 Linking Philosophy to Quantitative CGE Methodology

The integrated framework, positivism underpinned by positivism, objectivism, and value-neutrality, requires quantitative, deductive methods. Positivism demands hypothesis-driven tests; objectivism insists on measurable variables; and axiology calls for unbiased simulation (Denzin and Lincoln, 2000).

CGE modelling, particularly the standard GTAP model v7, operationalises this. It deductively applies neoclassical theory to real data, simulating equilibrium responses to shocks like the newly announced reciprocal tariffs. Alternatives like partial equilibrium, as discussed in Chapter 02, lack multi-market consistency, while qualitative methods fail positivist criteria for generalisability.

Element	Position	Implication for CGE Methodology
Ontology	Objectivism	Models uncover hidden economic mechanisms
Epistemology	Positivism	Calibration to empirical data ensures validity
Axiology	Value-Neutrality	Welfare metrics over normative evaluation
Paradigm	Positivism	Hypothesis testing via policy simulations

Table 06.01: Summary of the philosophical-methodological alignment (Author’s own table)

4.3.6 Limitations of quantitative research

Quantitative methods have clear strengths in terms of objectivity and the ability to generalise findings, but they also come with some real limitations. One main issue is that these approaches often struggle to explain why relationships between variables exist. They can show that one thing is linked to another, like when X goes up, Y tends to follow, but they don't dig into the reasons behind it (Creswell, 1994). This makes them good for testing ideas but weaker when someone needs to build a new theory from scratch, since they focus more on patterns than deep causes (Kerlinger, 1979).

Another problem is that quantitative work relies on assumptions about how variables behave that don't always match real life. Things like attitudes or business decisions change over time and get influenced by all sorts of outside factors, but these methods treat them as fixed and stable (Sayer, 1992). Plus, they borrow heavily from natural science approaches, which works fine for physics but runs into trouble with people or small and medium firms, that don't always act predictably or homogeneously (O'Regan and Ghobadian, 2004). Groups like small firms can be very different from each other, so grouping them together misses important differences.

Since the literature review chapter already covers CGE models in detail (including some of their limitations), this section only revisits some of the key methodological constraints relevant to this study's implementation, building on those discussions.

CGE models, such as GTAP v7, make strong assumptions about how economies function, including perfect competition and rational agents who always maximise profits or utility. Such assumptions have been challenged by many economists, including Richard Thaler, who won the *Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel* in 2017 for his contributions to behavioural economics (Blink & Dorton, 2020). The model also stays within a static or comparative static framework here, so it misses dynamic effects like investment over time or learning by doing, which could change long-run outcomes (Piermartini and Teh, 2005).

Data is another sticking point. CGE relies on aggregated input-output tables and social accounting matrices, which smooth out differences within sectors or regions. For instance, treating all manufacturing as one block ignores firm-level variety, and calibration to a single benchmark year means shocks might not capture recent structural shifts. Finally, results depend heavily on parameter choices, notably elasticities, which introduce uncertainty, even with sensitivity tests (Burfisher, 2021). While tariff levels are calculated and updated by the researcher for this study, other key parameters, such as elasticities, are held constant at their

base-year values. These limits mean CGE gives directional insights rather than exact predictions.

4.4 Why CGE Modelling Is the Appropriate Method for This Study

The choice of a Computable General Equilibrium model follows directly from the nature of the research questions and the structure of the policy shock being examined. President Trump's proposed reciprocal tariffs are multi-country, multi-sector measures that affect production, consumption, trade flows, and welfare simultaneously. Because these effects spread across markets through price changes, factor reallocation, and inter-industry linkages, a method is required that can capture economy-wide adjustments rather than isolated, single-market outcomes.

Earlier chapters reviewed a range of analytical tools used in trade policy research, including partial equilibrium models, gravity models, and game-theoretic approaches. While each offers useful insights, they are limited for the purposes of this thesis. Partial equilibrium models cannot account for cross-sector spillovers or changes in factor markets. Gravity models estimate trade flows but do not capture changes in welfare or production. Game-theoretic models explain strategic behaviour but cannot quantify macroeconomic or sector-level impacts. These limitations, discussed in Chapter 02, point toward the need for a computable general-equilibrium framework.

Chapter 03 showed that CGE models are widely used to analyse tariff shocks because they combine neoclassical theory with detailed empirical data, allowing researchers to simulate counterfactual policy environments. They are particularly suited to large-country tariff changes, where terms-of-trade effects, retaliation, and global reallocation of production are central. The gap identified in Chapter 03, namely the absence of CGE analysis on Trump's 2025 reciprocal tariff proposals and their implications for Southeast Asia, further reinforces the suitability of this method.

For these reasons, a CGE model is the most appropriate tool for answering the research questions. It allows the study to quantify macroeconomic outcomes, sector-level adjustments, and welfare effects under multiple forward-looking scenarios, and to compare alternative strategic responses for Southeast Asia in a consistent, economy-wide framework.

4.5 Research design

This research design adopts a positivist paradigm, operationalising deductive hypothesis testing through CGE modelling via the standard GTAP version 7 framework to evaluate trade war impacts. Following the philosophical foundations outlined earlier, the design integrates multiple secondary data sources for model calibration and shock (tariff) implementation, including the GTAP database (version 9) for multi-regional input-output tables and bilateral trade flows, national macroeconomic statistics from sources such as the World Bank and Official national statistic agencies, and detailed sectoral tariff reduction schedules. This systematic approach ensures the CGE simulations replicate observed equilibria before applying policy shocks, enabling robust causal analysis of tariff escalations across scenarios while maintaining methodological transparency and replicability.

The diagram below summarises the logical flow of the thesis from the overall research aim to the final conclusions. It begins with the research aim and objectives, which are then framed within a clear research paradigm and associated research method. On this basis, the standard GTAP model version 7 is selected as the core analytical framework, reflecting the study's quantitative and positivist orientation. The model is then linked to two key design choices: defining the population (ten countries and regions, and twelve sectors) and specifying the data inputs required to operationalise the model.

Data preparation is shown as a multi-step process. The GTAP database forms the main data source and is aggregated using a software called GTAPAgg, while national macroeconomic indicators and tariff rate information are processed and prepared using Excel and R, respectively. These processed datasets are then fed into RunGTAP (GEMPACK) for model simulation. The resulting outputs are subjected to systematic data analysis and compared against the research hypotheses. Finally, the diagram indicates that these empirical findings inform the overall conclusions and recommendations of the thesis, closing the loop from conceptual design to policy-relevant insights.

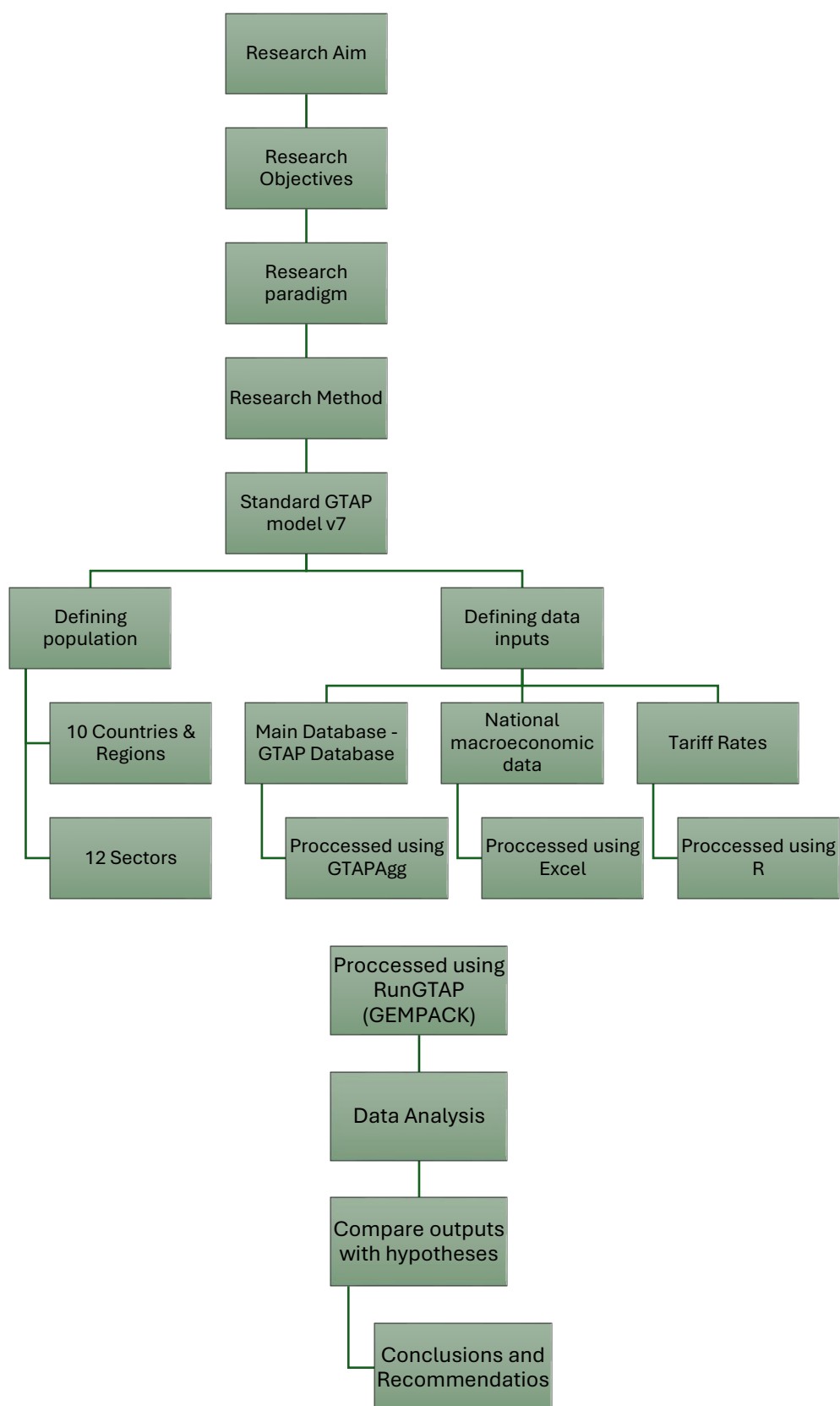


Figure 04.01: Author's Research Design

4.6 Model description

4.6.1 Introduction

This section outlines the main model and some of the system of formulas to simulate various trade war scenarios as mentioned in Chapter 01, using the standard GTAP model version 7 (“GTAPv7”, “version 7”, or “v7”). The GTAP model is one of the most widely used and versatile tools for analysing global trade policies, offering a comprehensive framework for understanding the economic impacts of the current international trade war, following the election of the 47th US President, Donald J. Trump. Version 7 of the GTAP model was released in 2017 and is currently freely provided by GTAP. The version has also undergone a few updates since its first launch.

The standard GTAP Model version 7⁷⁴ is well-suited for simulating current trade war scenarios due to its computable general equilibrium (CGE) framework, which captures the complex interdependencies of global trade. Version 7 incorporates improved sectoral and regional representations, allowing for a more detailed assessment of tariff and non-tariff barriers imposed during trade conflicts. One of the innovations of this version regarding sectors, at a fundamental level, is that commodities and production activities are distinguished from each other, which enables the existence of sectors that produce multiple products as well as the production of identical commodities by various sectors (Corong et al, 2017).

While the “*workhouse*” assumption of the stand GTAP model is perfect competition, which normally regards all goods are homogeneous and hence perfectly substitutable, the model’s adaptation of the Armington assumption, however, ensures that imported and domestic goods are imperfect substitutes, reflecting more realistic trade responses to tariffs. Additionally, the GTAP database provides detailed bilateral trade flows, input-output linkages, and factor mobility, making it possible to analyse the welfare, production, and trade effects of protectionist policies. Given that modern trade wars involve retaliatory tariffs and shifts in global trade patterns, GTAP’s comparative static approach helps estimate the impact of these policy changes across countries and sectors. Furthermore, the GTAP model allows for counterfactual analysis, enabling researchers to compare the effects of escalating trade tensions with alternative policy scenarios, such as tariff removal or trade liberalisation. These features make GTAP 7 a robust tool for understanding the economic implications of ongoing and future trade conflicts.

⁷⁴ Corong, E. L., Hertel, T. W., McDougall, R., Tsigas, M. E., & van der Mensbrugghe, D. (2017). The Standard GTAP Model, Version 7. *Journal of Global Economic Analysis*, 2(1), 1–119. <https://doi.org/10.21642/JGEA.020101AF>

In this chapter, for the sake of parsimony, the following selected elements will be discussed: the circular flow of income, the price system, and firm behaviour (production). For other important elements, such as final demand (consumption), trade and goods market equilibrium, factor market equilibrium, numeraire, and closure, the researcher will discuss these in the appendix.

This chapter relies mainly on the work of Corong et al (2017) to present the standard GTAP model version 7.

4.6.2 Model structure description

4.6.2.1 The Circular Flow of Income

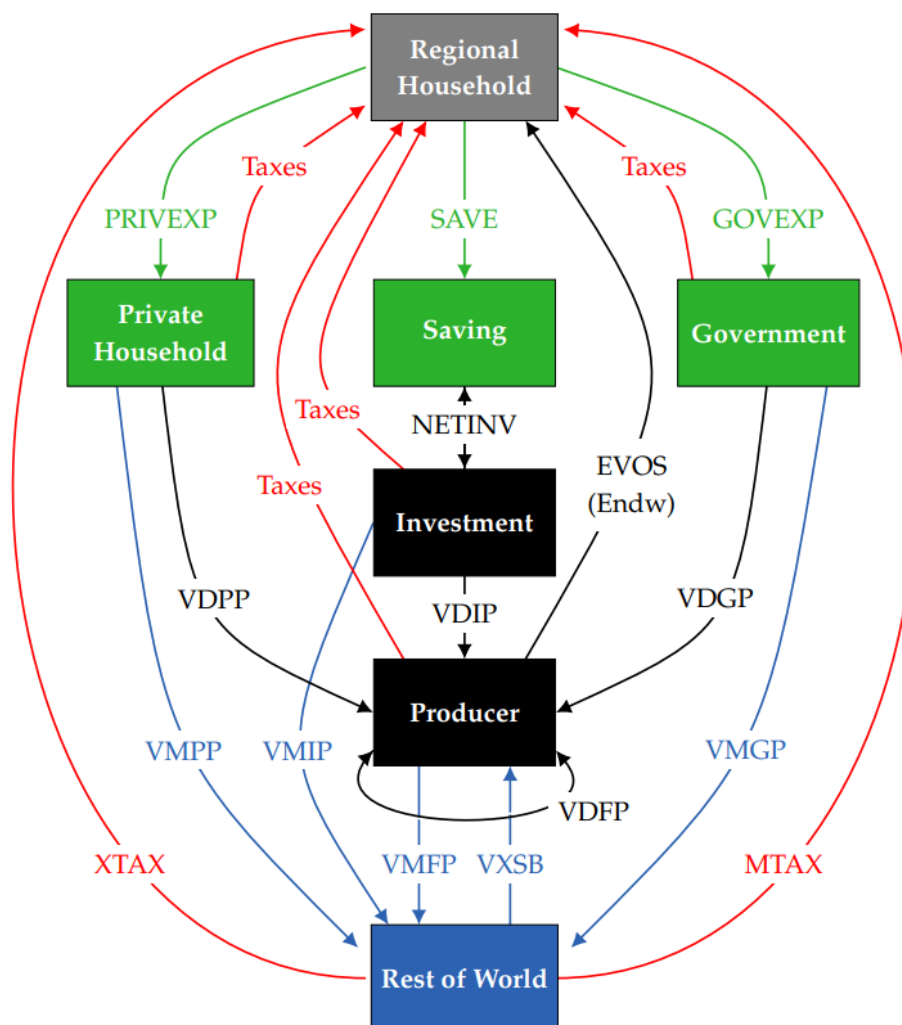


Figure 04.02: Circular flows in a regional economy (Corong et al, 2017)

In previous chapters, such as Chapter 03, a simplified circular flow of income model was briefly introduced. However, in this chapter, a more comprehensive circular flow for the stand GTAP model version 7 is presented, which lays the foundation for the logical development of the model codes.

Within this framework, production generates factor incomes that accrue to regional households or institutions (Private households and Government). These incomes are then allocated to three components of final demand: (1) Private consumption (**PRIVEXP**), (2) government expenditure (**GOVEXP**), and (3) saving (**SAVE**), with the latter fuelling investment (**NETINV**). Each component of the final demand by three institutions, namely Private households, Government and Investors for domestically produced commodities (**VDPP**, **VDGP**, and **VDIP**), of domestically produced intermediate goods purchases (**VDFP**), and of imported intermediate goods purchases (**VMFP**) by **Producers** or Firms, thereby generates domestic sales and exports for Firms. Private households, Government and Investors also spend part of their incomes on imports, which are recorded via **VMPP**, **VMGP** and **VMIP**, respectively. The representative regional household, mostly the Government, will receive additional income via import tax (**MTAX**) and export tax (**XTAX**).

Abbreviation	Description
PRIVEXP	Private expenditure
GOVEXP	Government expenditure
SAVE	Saving
NETINV	Net Investment
EVOS	Endowment / primary factor sales, at supply (post-income tax) prices
VDFP	Domestic purchases, by Firms, at producer prices
VDPP	Domestic purchases, by Private HHs, at producer prices
VDIP	Domestic purchases, by Investors, at producer prices
VDGP	Domestic purchases, by Government, at producer prices
VMPP	Import purchases, by Private HHs, at producer prices
VMIP	Import purchases, by Investors, at producer prices
VMGP	Import purchases, by Government, at producer prices
VMFP	Import purchases, by Firms, at producer prices
VXSB	Non-margin exports, at basic prices

XTAX	Tax - Export
MTAX	Tax - Import

Table 04.02: Summary of key variables

4.6.2.2 Price system

The diagram below demonstrates the international price linkages. There are 3 main sections in this model, namely the Domestic market, World market and Rest of the world (ROW) market.

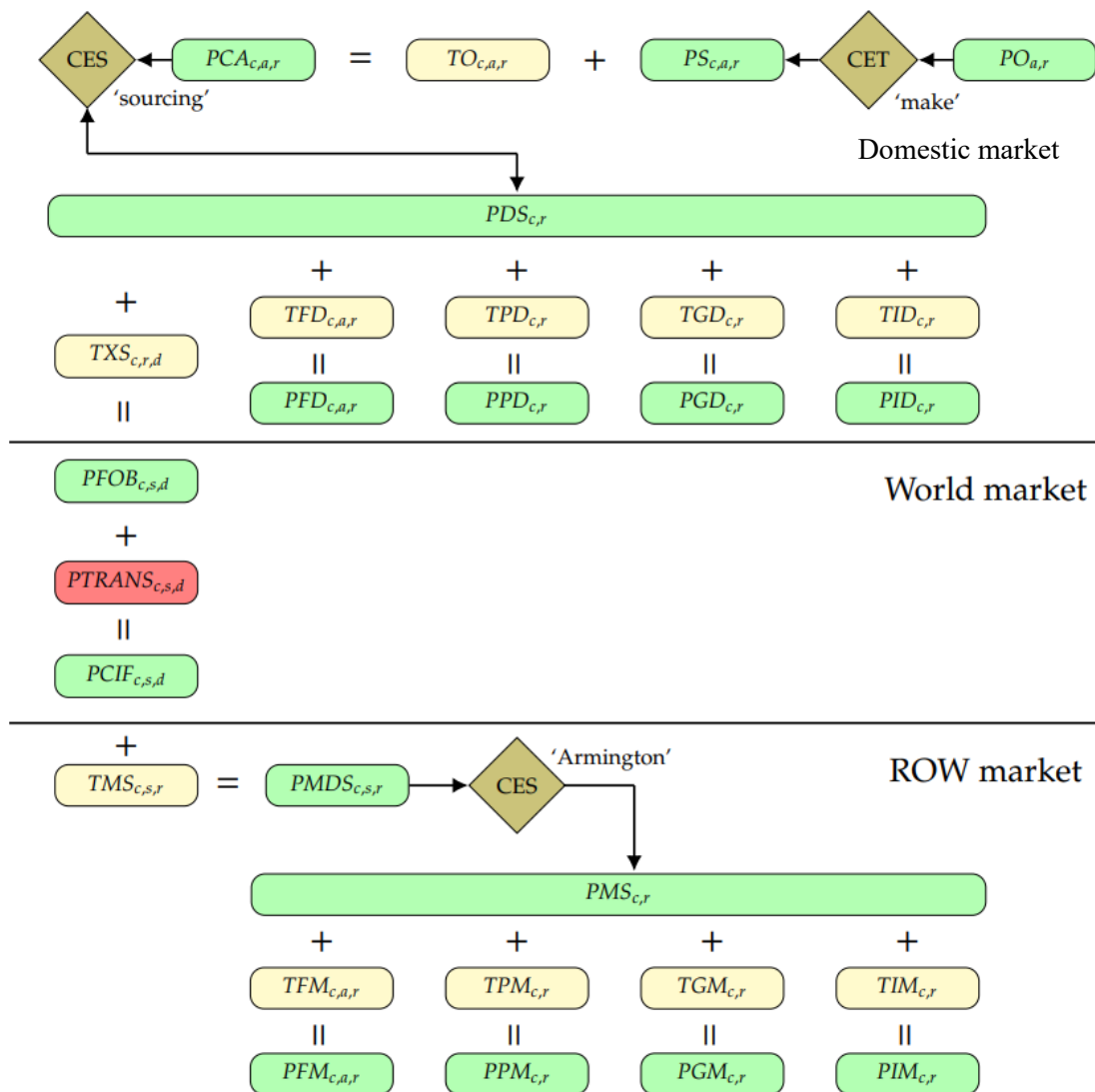


Figure 04.03: Price linkages in the model (Corong et al, 2017)

In the domestic market, under neoclassical economic assumptions, prices will be determined by equating the supply and demand of a commodity, called c . Graphically speaking, the basic commodity-and activity-specific price ($PCA_{c,a,r}$) needs to be equal to the market Price for Domestically Supplied commodity c in region r , ($PDS_{c,r}$). ($PCA_{c,a,r}$) is equal to the sum of Price set by the supplier (supplier's price) ($PS_{c,a,r}$) plus Commodity- and activity-specific Tax ($TO_{c,a,r}$). In v7, a 'make' matrix is incorporated to enable activities (industries or sectors) that produce multiple products. Consequently, supply prices need to be combined before calculating the unit revenue linked to each activity. Because of the zero-profit condition, the unit revenue must match the unit cost, which is denoted as $PO_{a,r}$.

There are four institutions in domestic (and ROW) markets, namely Firms (F), Private Households (P), Government (G) and Investors (I), and each pays their own specific consumption taxes, namely, $TFP_{c,a,r}$, $TPP_{c,a,r}$, $TGP_{c,a,r}$ and $TIP_{c,a,r}$ respectively. As a result, these institutions pay their corresponding prices for their domestic consumption of commodities, namely $PFD_{c,a,r}$, $PPD_{c,a,r}$, $PGD_{c,a,r}$ and $PID_{c,a,r}$ respectively.

Moving on to the World market, now some of the domestically produced commodities are exported, which face the export tax ($TXS_{c,r,d}$), making domestic commodities priced at $PFOB_{c,s,d}$ for foreign consumers before freight and insurance are added. If transportation costs ($PTRANS_{c,s,d}$) are subsequently added, then domestic commodities will cost $PCIF_{c,s,d}$ at the ROW market's customs border.

When entering the ROW market, imported goods and services face import tax ($TMS_{c,s,r}$), which helps establish the Price of iMports in the Domestic Market by Source ($PMDS_{c,s,r}$). Through the aggregation of bilateral imports from all origin countries, a 'national' importer effectively produces an aggregate import bundle valued at the Price of iMported Supplies ($PMS_{c,r}$). Again, four institutions in the ROW market, namely Firms (F), Private Households (P), Government (G) and Investors (I), face specific consumption tax rates $TFM_{c,a,r}$, $TPM_{c,a,r}$, $TGM_{c,a,r}$ and $TIM_{c,a,r}$ respectively before they can access the imported commodities at the following corresponding prices $PFM_{c,a,r}$, $PPM_{c,r}$, $PGM_{c,r}$, $PIM_{c,r}$. The four economic agents also decide between imports, which are priced at $PMS_{c,r}$, or domestically produced equivalents, valued at $PDS_{c,r}$.

Abbreviation	Description
$PDS_{c,r}$	Price for Domestically Supplied comm c in r
$PCA_{c,a,r}$	Price for Basic commodity & activity-specific
$TO_{c,a,r}$	Commodity- and activity-specific Tax/subsidy
$PS_{c,a,r}$	Price set by supplier (supplier's price)
$PO_{a,r}$	Unit revenue of activity a in region r
$PDS_{c,r}$	Price for domestically supplied goods
$TFD_{c,a,r}$	Tax on domestic goods paid by Firms
$TPD_{c,r}$	Tax on domestic goods paid by Private HH
$TGD_{c,r}$	Tax on domestic goods paid by Government
$TID_{c,r}$	Tax on domestic goods paid by Investors
$TXS_{c,r,d}$	Tax on Export ($TXS_{c,s,d} = 1 + XTAX$)
$PFD_{c,a,r}$	Price of domestic goods paid by firms
$PPD_{c,r}$	Price of domestic goods paid by private HH
$PGD_{c,r}$	Price of domestic goods paid by Government
$PID_{c,r}$	Price of domestic goods paid by Investors
$PFOB_{c,s,d}$	Price before freight and insurance are added
$PTRANS_{c,s,d}$	Price for transportation margin
$PCIF_{c,s,d}$	Price CIF
$TMS_{c,s,r}$	Tax on imported Supplies
$PMDS_{c,s,r}$	Price of Imports in the Domestic Market by Source
$PMS_{c,r}$	Price of imported Supplies
$TFM_{c,a,r}$	Tax on imported goods paid by Firms
$TPM_{c,r}$	Tax on imported goods paid by Private HH
$TGM_{c,r}$	Tax on imported goods paid by Government
$TIM_{c,r}$	Tax on imported goods paid by Investors
$PFM_{c,a,r}$	Price of imported goods paid by firms
$PPM_{c,r}$	Price of imported goods paid by private HH
$PGM_{c,r}$	Price of imported goods paid by Government
$PIM_{c,r}$	Price of imported goods paid by investors
$PFA_{c,a,r}$	Price of aggregated goods (M + D) paid by Firms
$PPA_{c,r}$	Price of aggregated goods (M + D) paid by Private HH

$PGA_{c,r}$	Price of aggregated goods (M + D) paid by Government
$PIA_{c,r}$	Price of aggregated goods (M + D) paid by Investors
$PB_{a,r}$	Unit revenue at basic Prices
$(PDS_{c,r}) \times$ $(TXS_{c,s,d})$	Export Price (where $TXS_{c,s,d} = 1 + \text{export tax rate}$)

Table 04.03: Summary of key variables

4.6.2.3 Supply and Firm behaviour

The diagram presented below provides a comprehensive overview of the simplified production process within the model framework, beginning at the foundational level with the specification of inputs and culminating in the generation of the final output, represented by the variable $QO_{a,r}$. In computable general equilibrium models such as this version of the GTAP model, uppercase notation is conventionally used to denote the levels or quantities of variables, for example, the total units of final output produced by activity “a” in region “r”, denoted as $QO_{a,r}$. Conversely, lowercase letters represent proportional or percentage changes in these variables, such as $qo_{a,r}$, which captures the relative variation in output. Employing percentage or proportional changes offers distinct advantages within the CGE modelling context, particularly because the model’s core equations are typically linearised. Linearisation ensures mathematical tractability and allows the model to approximate equilibrium conditions through percentage deviations from a baseline, facilitating comparative static analysis and scenario evaluation. This dual notation system, distinguishing levels from changes, is essential for clarity in model formulation and interpretation of simulation results. In Chapter 08, almost all simulation results are presented in a percentage change format.

Additionally, all variables representing technical change are denoted by substituting the first letter of the associated quantity variable with the letter "a". This notation signifies that these technical change variables operate directly on the original quantities they modify.

While the main paper (Corong et al, 2017) describes only two nests, this chapter will adapt and divide the original diagram into three nests. The first nest refers to the top production nest, the second nest concerns the intermediate and value-added inputs, and the last nest refers to the sources of commodities by firms.

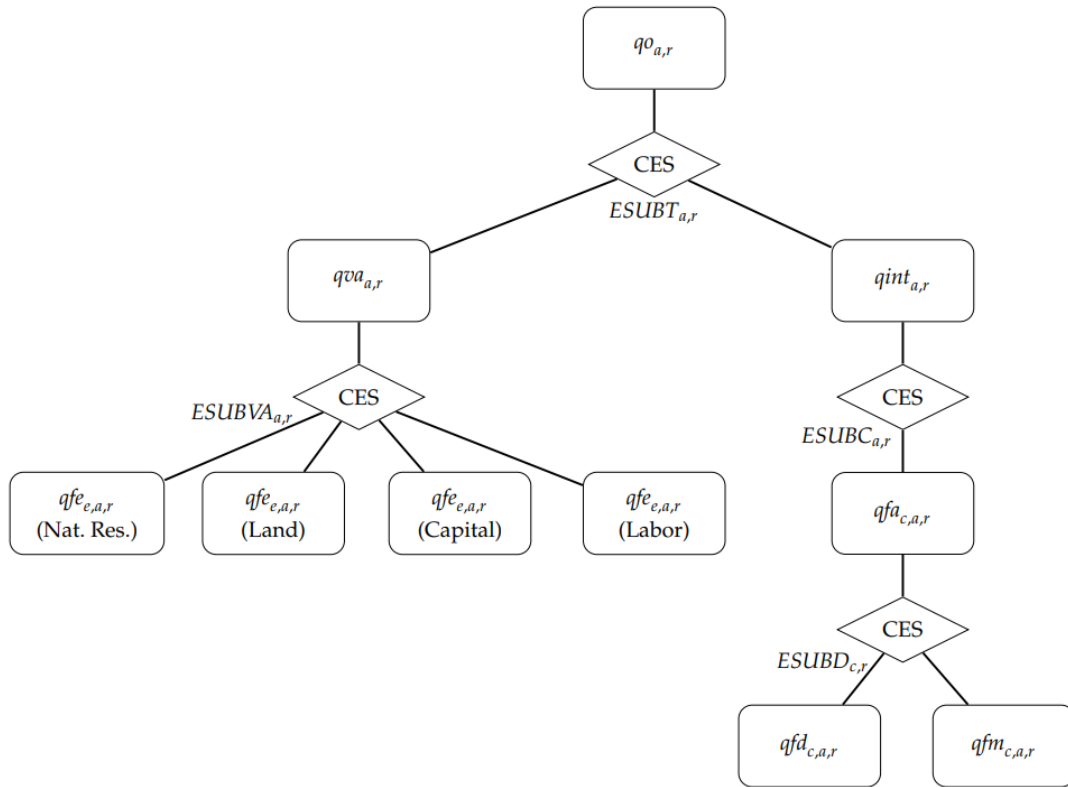


Figure 04.04: Production Structure (Corong et al, 2017)

4.6.2.3.1 Top production nest

The top nest covers the top two layers, with the first layer being presented by $q^o_{a,r}$, and the second layer covering $q^{va}_{a,r}$ (the value-added bundle) and $q^{int}_{a,r}$ (the intermediate demand bundle). The combination of the value-added bundle and the intermediate demand bundle is needed to produce the final output, and firms need to decide the optimal combination that maximises profit. Such combination decisions are determined by the production function, which is assumed to be the Constant Elasticity of Substitution (“CES”) in this model. To simplify the model even further, the elasticity of substitution ($ESUBT_{a,r}$) derived from the CES function can be set to zero. In other words, the Leontief production function is employed, demonstrating a fixed relationship between the value-added bundle and the intermediate bundle or perfect non-substitutability between inputs. In the model written in GEMPACK, there are four specific formulas to calculate $q^{int}_{a,r}$, $q^{va}_{a,r}$ and $po_{a,r}$:

Abbreviation	Description
qo	Quantity of final output - percentage changes (pc)
qva	Quantity of the value-added bundle - pc
qint	Quantity of the composite intermediate input bundle - pc
qfe	Quantity of factor endowments – pc
qfa	Quantity of individual intermediate input bundle – pc
qfd	Quantity of individual intermediate goods, domestically produced - pc
qfm	Quantity of individual intermediate goods, imported – pc
ao	Output-augmenting technical change for final output (Hicks-neutral)
aint	Technical efficiency change Intermediate input-augmenting
ava	Technical efficiency change specific to the value-added bundle
afe	Technical efficiency change specific to factor Endowments
afa	Technical efficiency change for individual intermediate input
po	Price of final output – pc
pint	Price of the composite intermediate input bundle – pc
pva	Price of the value-added bundle - pc
pfa	Price of individual intermediate component - pc
pfe	Price of factor endowments - pc
PO	Price of final output
QO	Quantity of final output
PINT	Price of the composite intermediate input bundle
QINT	Quantity of the composite intermediate input bundle
QVA	Quantity of the value-added bundle
PVA	Price of the value-added bundle
QFA	Quantity of individual intermediate input bundle
PFA	Price of individual intermediate input by bundle
STC	Cost share of the composite bundle
INTSHR _c	Cost share of individual intermediate input c

SVA	Cost share of the value-added bundle
FMSHR	Cost share of the imported intermediate input
CES	Constant Elasticity of Substitution

Table 04.04: Summary of key variables

$$(01) \text{qint}_{a,r} = \text{qo}_{a,r} - \text{ao}_{a,r} - \text{aint}_{a,r} - \text{ESUBT}_{a,r} (\text{pint}_{a,r} - \text{aint}_{a,r} - \text{po}_{a,r} - \text{ao}_{a,r})$$

$$(02) \text{qva}_{a,r} = \text{qo}_{a,r} - \text{ao}_{a,r} - \text{ava}_{a,r} - \text{ESUBT}_{a,r} (\text{pva}_{a,r} - \text{ava}_{a,r} - \text{po}_{a,r} - \text{ao}_{a,r})$$

$$(03) \text{PO}_{a,r} \cdot \text{QO}_{a,r} = \text{PINT}_{a,r} \cdot \text{QINT}_{a,r} + \text{PVA}_{a,r} \cdot \text{QVA}_{a,r}$$

$$(03') \text{po}_{a,r} = \sum_c \text{STC}_{c,a,r} (\text{pfa}_{c,a,r} - \text{afc}_{a,r} - \text{aint}_{a,r}) + \sum_e \text{STC}_{e,a,r} (\text{pfe}_{e,a,r} - \text{afe}_{e,a,r} - \text{ava}_{e,r}) - \text{ao}_{a,r}$$

Regarding (1), the first three terms ($\text{qo}_{a,r} - \text{ao}_{a,r} - \text{aint}_{a,r}$) capture how changes in output, general technology, and input-specific technology affect the demand for intermediate inputs. If output increases ($\text{qo}_{a,r} > 0$), or if there are negative shifts in technology parameters ($\text{ao}_{a,r}$ & $\text{aint}_{a,r} < 0$), demand for intermediate inputs rises. The second part of the formula ($\text{ESUBT}_{a,r} (\text{pint}_{a,r} - \text{aint}_{a,r} - \text{po}_{a,r} - \text{ao}_{a,r})$) captures how relative price changes affect intermediate input demand. Firms are likely to reduce their consumption of intermediate inputs if the relative cost, specifically, the price ($\text{pint}_{a,r}$) and productivity ($\text{aint}_{a,r}$) of those inputs, increases in comparison to the output prices ($\text{po}_{a,r}$) and productivity ($\text{ao}_{a,r}$) of the final product. The magnitude of this adjustment depends on the elasticity of substitution ($\text{ESUBT}_{a,r}$). A higher elasticity value means firms are more responsive to price changes and use fewer intermediate inputs. Intuitively, if we set $\text{ESUBT}_{a,r} = 0$ (Leontief condition), this means that the relative changes in the price of intermediate inputs would have no impact on the demand for intermediate inputs. Equation (2) follows the same logic as above for equation (1).

Equation (3) technically represents a zero-profit condition, typically seen in a perfectly competitive market, where the total revenue of selling all final output equals the total combined costs of value-added and intermediate inputs. If (3) is fully differentiated, (3') is then derived.

The first part of (3') refers to the cost contribution from intermediate inputs $\text{STC}_{c,a,r}$. The $\sum_c \text{STC}_{c,a,r} (\text{pfa}_{c,a,r} - \text{afc}_{a,r} - \text{aint}_{a,r})$ captures how changes in intermediate input prices and technical efficiency affect production costs. The second part refers to cost contribution from

primary factors. $\sum_c \text{STC}_{e,a,r} (\text{pfe}_{e,a,r} - \text{afe}_{e,a,r} - \text{ava}_{e,r})$ accounts for how changes in factor prices and technological efficiency influence production costs. For example, higher prices of primary factors increase production costs. It is worth noting that both $\text{afc}_{c,a,r}$ and $\text{afe}_{e,a,r}$ capture the technological change of individual elements in each bundle while $\text{aint}_{a,r}$ and $\text{ava}_{e,r}$ capture the augmenting technological change of the whole bundle. Finally, a higher $\text{ao}_{a,r}$ means a higher productivity for the whole production process and hence a higher output per given inputs and a lower price. Therefore, $\text{ao}_{a,r}$ has an inverse relationship with the unit price (cost per unit of production) $\text{po}_{a,r}$.

4.6.2.3.2 Second-level nests

The second level nests concern the disaggregation of $\text{qva}_{a,r}$ (the percentage change in the value-added quantity) and $\text{qint}_{a,r}$ (the percentage change in the intermediate quantity). For both $\text{qva}_{a,r}$ and $\text{qint}_{a,r}$, the production functions are assumed to be CES, with the elasticities of substitution being denoted as $\text{ESUBVA}_{a,r}$ and $\text{ESUBC}_{a,r}$ respectively.

$\text{qint}_{a,r}$ is an aggregation of commodities called $\text{qfa}_{a,r}$, which comprise the intermediate demand for both domestically produced intermediate goods $\text{qfd}_{c,a,r}$ and intermediate imported goods $\text{qfm}_{c,a,r}$ (to be discussed in the third production nest). Unlike factor endowments, which are well specified and exhaustive, such as natural resources, land, capital, labour, what constitutes $\text{qfa}_{c,a,r}$ is industry-specific and hence only one representative $\text{qfa}_{c,a,r}$ is presented. In other words, QINT should contain several QFAs , depending on the nature of the industry concerned. The price of the intermediate demand above is $\text{PFA}_{c,a,r}$ or $\text{pfa}_{c,a,r}$ in the percentage change format. The price for the intermediate bundle is denoted as $\text{pint}_{a,r}$ and is calculated under the perfectly competitive market's condition of zero profit.

$$(04) \text{qfa}_{c,a,r} = \text{qint}_{a,r} - \text{afa}_{c,a,r} - \text{ESUBC}_{a,r}(\text{pfa}_{c,a,r} - \text{afa}_{c,a,r} - \text{pint}_{a,r})$$

$$(05) \text{PINT}_{a,r} \cdot \text{QINT}_{a,r} = \sum_c \text{PFA}_{c,a,r} \cdot \text{QFA}_{c,a,r}$$

$$(05') \text{pint}_{a,r} = \sum_c \text{INTSHR}_{c,a,r} (\text{pfa}_{c,a,r} - \text{afa}_{c,a,r})$$

Formula (4) shows that $\text{qfa}_{c,a,r}$ is positively influenced by a higher demand for the composite intermediate input bundle $\text{qint}_{a,r}$, but will reduce if the technical efficiency change parameter

for intermediate input, $afa_{c,a,r}$, improves. $qfa_{c,a,r}$ is also driven negatively by the substitution effect $ESUBC_{a,r}$ and by the relative price changes between $pfa_{c,a,r}$ and $pint_{c,a,r}$. Formula (5) simply states that the total value (price times quantity) of the composite intermediate inputs used by activity “a” in region “r” must be equal to the sum of all individual components, either domestically produced or imported. Formula (5’) aggregates individual input prices into a composite price index, weighted by their respective cost shares $INTSHR_{c,a,r}$.

Similar explanations for $qfa_{c,a,r}$ can be applied to $qfe_{c,a,r}$, which cover the quantity demanded for factor endowments. Hence, we have the following three formulas:

$$(06) \quad qfe_{c,a,r} = qva_{a,r} - afe_{c,a,r} - ESUBVA_{a,r}(pfe_{c,a,r} - afe_{c,a,r} - pva_{a,r})$$

$$(07) \quad PVA_{a,r} \cdot QVA_{a,r} = \sum_c PFE_{c,a,r} \cdot QFE_{c,a,r}$$

$$(07') \quad pva_{a,r} = \sum_c SVA_{c,a,r}(pfe_{c,a,r} - afe_{c,a,r})$$

4.6.2.3.3 Third-level nest

As mentioned above, the aggregation of $qfa_{c,a,r}$ depends on both domestic and foreign commodities, namely $qfd_{c,a,r}$ and $qfm_{c,a,r}$ respectively. The choice between these two types of commodities is determined by the elasticity of substitution $ESUBD_{c,r}$. Unlike $ESUBT_{a,r}$ and $ESUBC_{a,r}$, which tend to be set to zero or Leontief, $ESUBD_{c,r}$ is assumed to be Armington.

$$(08) \quad qfd_{c,a,r} = qfa_{c,a,r} - ESUBD_{c,r}(pfd_{c,a,r} - pfa_{c,a,r})$$

$$(09) \quad qfm_{c,a,r} = qfa_{c,a,r} - ESUBD_{c,r}(pfm_{c,a,r} - pfa_{c,a,r})$$

$$(10) \quad PFA_{c,a,r} \cdot QFA_{c,a,r} = PFD_{c,a,r} \cdot QFD_{c,a,r} + PFM_{c,a,r} \cdot QFM_{c,a,r}$$

$$(10') \quad pfa_{c,a,r} = (1 - FMSHR_{c,a,r}) pfd_{c,a,r} + FMSHR_{c,a,r} \cdot pfm_{c,a,r}$$

Equation (8) states that the quantity demanded for domestically produced commodities is positively influenced by a higher demand for intermediate commodities but negatively impacted by the relative price between domestic and individual intermediate commodities ($pfd_{c,a,r} - pfa_{c,a,r}$). The same logic goes to equation (9). Formula (10) states that the total value

for each intermediate commodity is equal to the sum of all domestically produced and imported inputs. Equation (10') calculates the price for an individual intermediate commodity, which depends on the weighted (FMSHR) sum of the prices of domestic and imported commodities.

Other relevant equations will be included in the appendix.

4.6.3 Model Closure and Key Assumptions

This study uses the standard GTAP Model Version 7 without making any structural changes to the model. All behavioural equations, elasticities, and functional forms remain exactly as specified in the original framework. The only modifications introduced by the researcher are the tariff shocks applied in the simulation scenarios. This approach ensures that the results reflect the internal logic of the established GTAP system rather than researcher-driven alterations.

The standard GTAP model operates under a comparative-static closure, not a dynamic one. In practical terms, this means the model compares two equilibrium states, before and after the tariff shock, without modelling the adjustment path between them. Capital stocks are fixed within each region, and labour is mobile across sectors but not across borders (Corong et al, 2017). These assumptions are widely used in CGE studies of trade policy and are appropriate here because the research questions focus on the immediate, economy-wide effects of tariff changes rather than long-run investment or dynamic growth processes.

The model assumes perfect competition, constant returns to scale, and profit-maximising firms. Consumers maximise utility subject to income constraints, and all markets clear through price adjustments. International trade follows the Armington structure, where domestic and imported goods are treated as imperfect substitutes (Corong et al, 2017). This is important for tariff analysis because it allows the model to capture realistic switching behaviour when relative prices change.

4.6.4 Interpretation of Results

Because the model uses a comparative-static closure and standard GTAP assumptions, the results should be interpreted as short-run, economy-wide adjustments to the tariff shocks. They

capture how production, trade flows, and welfare shift once the new tariffs are in place, but they do not incorporate long-run dynamics such as capital accumulation, technological change, or learning effects. For the purposes of evaluating the direct macroeconomic and sector-level impacts of Trump’s proposed tariffs and comparing alternative strategic responses for Southeast Asia, this framework is appropriate and consistent with established practice in the CGE literature.

4.7 Rationale for Updating Tariffs Only

In this study, tariff rates are the only parameters that are updated. This reflects both the nature of the policy shock and the need to maintain consistency across scenarios. Trump’s reciprocal tariff proposal is implemented entirely through changes in ad valorem import duties, so tariffs are the sole policy instrument relevant to the research questions. Updating these tariffs already requires substantial detail: each region faces up to nine trading partners across nine non-service sectors, resulting in a maximum of 108 bilateral tariff entries per region. With ten regions and two simulation periods, the model incorporates more than 2,000 individual tariff updates. Altering additional parameters, such as elasticities or behavioural coefficients, would introduce unnecessary variation and make it harder to isolate the effect of the tariff shock. Keeping all other parameters fixed ensures comparability across scenarios, preserves the internal logic of the GTAP model, and supports replicability for future researchers.

4.8 8 Methods for data collection - GTAP Database

4.8.1 GTAP Database Version 11

The Global Trade Analysis Project (GTAP) was established in 1992 to facilitate quantitative analyses of international economic issues. The GTAP database is its centrepiece, providing a comprehensive framework for understanding global economic activities. Version 11 (“v11”) of the database offers enhanced features and expanded coverage, making it a valuable tool for researchers and policymakers. In total, the GTAP database v11 offers a time series of 5 reference years (2004, 2007, 2011, 2014, and 2017). As of March 2025, v11 is the latest database offered by GTAP and requires purchasing from GTAP’s official website. (Aguiar et al, 2023)

Below are the key and new Features of the GTAP database v11:

- **Geographic Coverage:** GTAP 11 includes 141 individual countries and 19 aggregate regions, covering 99.1% of global GDP and 96.4% of the world population. This represents an increase of 20 countries, primarily from Central Africa and the Middle East, in version 10⁷⁵.
- **Sectoral Coverage:** The database distinguishes 65 sectors, such as Paddy rice (pdr), Animal products nec (oap), Meat products nec (omt), Wood products (lum), Computer, electronic and optical products (ele), Trade (trd), Business services nec (obs), Dwellings (dwe). GTAP v11 also has 8 more sectors compared to database version 9 (to be discussed in the next section).
- **Data Sources and Updates:** GTAP 11 incorporates new data sources, such as for agriculture production from Chepeliev (2020b), services trade from Wettstein et al. (2021), and energy data from Chepeliev (2022a). It also includes updates on carbon dioxide emissions and energy subsidies.
- **Satellite Data:** Additional data extensions are available, including energy volumes, CO2 emissions, and food balance sheets.

GTAP 11 is available in three formats: the new standard format, GAMS Data Exchange (GDX) containers, and the classic version for backward compatibility. The database is accessible on the GTAP website, with recent versions available free of charge to contributors and consortium members.

The GTAP v11 database faces several criticisms and limitations related to its construction and data reconciliation. Firstly, the database's reliance on reconciling diverse data sources can lead to inconsistencies and discrepancies, particularly in trade data, where world exports often do not match world imports due to reporting discrepancies between countries (Gehlhar et al, 2014). Additionally, the process of adjusting data to fit macroeconomic conditions may introduce biases or inaccuracies, especially if underlying assumptions are flawed. Furthermore, the geographic coverage, while extensive, still lacks detailed representation for some regions, as certain countries remain aggregated into composite regions. These limitations can affect the accuracy and reliability of analyses conducted using the GTAP Database.

⁷⁵ GTAP Version 10 is currently neither available for free download on the Global Trade Analysis Project website (unlike prior versions, such as Version 9) nor accessible for purchase at this time.

Another significant limitation of the GTAP v11 database is its methodological focus and technical constraints. The database is primarily suited for medium-run analyses (Aguiar et al, 2023, p.8), which can limit its ability to capture short-term economic fluctuations or long-term structural changes. Additionally, the technical requirements for accessing and manipulating the data, particularly the need to familiarise with and to purchase licenses for GEMPACK and GAMS software, as discussed in Chapter 03, might create barriers for some researchers. This technical complexity, combined with the medium-run focus, restricts the database's utility for certain types of economic and environmental analyses that require more dynamic or detailed modelling capabilities.

4.8.2 GTAP Database Version 09

The GTAP 9 database (“v09” or “v9”) is a comprehensive global database developed by the Global Trade Analysis Project, providing a detailed representation of the world economy. It includes complete bilateral trade information, transport, and protection linkages, making it a key input for computable general equilibrium (CGE) analyses of global economic issues. The database features three reference years: 2004, 2007, and 2011 (Aguiar et al, 2016).

Below are the key and new Features of the GTAP database v09:

- This is an older version compared to v11 and was released in 2011
- Geographic Coverage: GTAP 9 includes 140 regions, with detailed data for 120 countries and 20 composite regions.
- Sectoral Coverage: The database distinguishes 57 sectors, such as paddy rice, wheat, coal, oil, gas, and various manufacturing and service sectors are represented.
- Data Sources and Construction: The foundation of the GTAP Database is built on statistics derived from input-output tables.

The GTAP 9 Database is well-documented, with detailed guides available for new users. It includes software tools like GTAPAgg2 for data aggregation, which allows users to customise the data to their desired level of detail⁷⁶. The database is accessible electronically, and users can benefit from GTAP short courses and online resources for learning how to utilise it

⁷⁶ "Chapter 5: GTAPAgg2 Data Aggregation Program" by Horridge, Mark. Available at: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5930. Accessed on 28-Aug-2025.

effectively. However, the main limitation of v09 is that this version is six years older than the latest version (v11), and many parameters, such as elasticities or shares, might have changed since then.

4.8.3 Comparisons between GTAP v09 and v11

Although GTAP Database version 11 offers distinct advantages over version 9, such as expanded country coverage, updated input-output tables, improvements in data reconciliation techniques, and refined sectoral detail, the use of version 9 in this study is primarily driven by budgetary constraints. The author acknowledges that the financial requirements for accessing version 11 are prohibitive within the context of this research, necessitating reliance on the earlier version despite its methodological and coverage-related limitations.

Feature	GTAP v09	GTAP v11
Regional coverage	140 regions, including 120 countries and 20 composite regions	141 individual countries and 19 aggregate regions
Sectoral coverage	57 sectors	65 sectors
GDP coverage	Not explicitly stated, but likely less than GTAP v10 (98% of the world's GDP)	99.1% of the world's GDP
Population coverage	Not explicitly stated, but likely less than GTAP v10 (92% of the world's population)	96.4% of the world's population
Reference years	2004, 2007, 2011	2004, 2007, 2011, 2014, 2017
Energy & Environmental data	Less comprehensive compared to v11	Improved energy data, CO2 emissions accounting, and energy subsidies
Data Sources and Updates	Uses various international data sources, but is less updated compared to v11	Incorporates new data sources for agriculture, services trade, and energy
Technical features	Classic format available	_New standard format

		_GDX containers (For GAMS users) _Classic version for backward compatibility
Cost	FREE	\$1,220 (Standard price for a single user) ⁷⁷

Table 04.05: GTAP Database v09 and v11 comparisons (Author's own table)

Additionally, GTAP has announced that GTAP Database version 12 is scheduled for public release in 2026, which will render version 11 superseded and intensify the costs, both financial and procedural, associated with upgrading from version 11. At present, the standard academic fee for upgrading the GTAP Database is set at 790 USD, representing approximately 65% of the initial purchase price for version 11 (1,220 USD). This pricing structure highlights the considerable financial commitment required for researchers aiming to maintain access to the most current database resources, particularly in the context of rapidly evolving global trade data and analytical requirements.

This pragmatic decision for choosing v09 underscores the ongoing challenge within quantitative international economic research of balancing the desirability of cutting-edge data resources against the economic realities of database acquisition and access.

The software, called GTAPAgg, as recommended by the database provider GTAP, will be used to generate the required database containing 10 chosen regions and 12 studied sectors.

The thesis's simulation results rely fundamentally on a consistent multi-regional GTAP database that links national economies through trade flows and factor movements. The next chapter (Chapter 5) will provide comprehensive detail on this database construction, tracing its development from primary sources including the System of National Accounts (SNA), supply-use tables (SUT), input-output tables (IOT), and the final aggregation into a Social Accounting Matrix (SAM). This process ensures theoretical consistency between national accounts and the model's general equilibrium structure.

⁷⁷ GTAP Data Base Pricing: <https://www.gtap.agecon.purdue.edu/databases/pricing.asp>. Accessed on 14-Jul-2024.

4.9 Methods for data collection – Macroeconomic data

For this research, 10 countries and regions have been selected. The Southeast Asian region (SEA) is created by aggregating eleven countries, namely: Brunei (BRN), Cambodia (KHM), Indonesia (IDN), Lao PDR (LAO), Malaysia (MYS), Philippines (PHL), Singapore (SGN), Thailand (THA), Viet Nam (VNM), Myanmar and Timor-Leste (XSE)⁷⁸. The other nine regions were chosen based on ASEAN Top Ten Destinations of Exports of Goods, 2021-2022 (ASEAN Statistical Yearbook, 2023)⁷⁹, namely the United States (USA), the EU-27 (EU_27), Japan (JPN), the Republic of Korea (KOR), India (IND), Taiwan (TWN), Australia (AUS), China (CHN) and Hong Kong (HKG). China and Hong Kong are grouped as one region in this study under the code (CHN_HK). The principal justification for aggregating China and Hong Kong in this analysis stems from the revocation of Hong Kong's preferential trade status by President Trump on July 14, 2020, effectively aligning Hong Kong's economic treatment with that of mainland China. Consequently, Hong Kong is no longer distinguished from mainland China in trade and economic considerations (The White House, 2020)⁸⁰. All other 95 countries and regions not listed above are grouped as Rest of the World (RoW).

In addition, 57 sectors in the GTAP v09 database were aggregated into 12 sectors, namely Grains and Crops, Livestock and Meat Products, Mining and Extraction, Processed Food, Textiles and Clothing, Light Manufacturing excluding MVH, Motor vehicles and parts, Heavy Manufacturing excluding Iron & Steel, Iron and Steel, Utilities and Construction, Transport and Communication, and Other Services. Iron & Steel is separated from Heavy Manufacturing, while Motor vehicles and parts are separated from the Light Manufacturing, as Steel and Motor Vehicles have been specifically targeted during the US's trade wars with the rest of the world since 2018. Having these two sectors standalone rather than aggregated would allow a better understanding of the impacts of trade wars on these two sectors. It is important to note that the first ten aggregated sectors are automatically generated by GTAPAgg as soon as the dataset is loaded. Additionally, due to the financial constraint, the researcher relies on the free version of the RunGTAP, which unfortunately restricts the number of disaggregated sectors and regions.

⁷⁸ Myanmar and Timor-Leste are grouped into one region called XSE in GTAP v09

⁷⁹ ASEAN Statistical Yearbook 2023: <https://www.aseanstats.org/wp-content/uploads/2023/12/ASYB-2023-v1.pdf>. Accessed on 22-Dec-2024.

⁸⁰ The White House (2020). The President's Executive Order on Hong Kong Normalization. Available at: <https://trumpwhitehouse.archives.gov/presidential-actions/presidents-executive-order-hong-kong-normalization/>. Accessed on 23-Jul-2025.

As tested, the free RunGTAP version appears to only allow up to 15 regions and 15 sectors (15x15) matrix dataset to be loaded as input.

Since the base year for the GTAP v09 is 2011, the base data needs to be projected to 2024, ahead of President Trump’s reciprocal tariff announcement in April 2025. The procedure for projection follows Burfisher (2020), using the following criteria: real GDP, population, labour force, physical capital and arable land. The last three criteria refer to typical aggregated input factor endowments. Data for real GDP⁸¹, population⁸² and labour force⁸³ were taken from the World Bank’s website. Data for physical capital were taken from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) as described in Fontagné et al (2022), with the Shared Socioeconomic Pathways (“SSP”) Scenario 2 being chosen. Finally, data for arable land were published by the Food and Agriculture Organisation of the United Nations (“FAO”)⁸⁴. For Taiwan (the Republic of China), data were sourced directly or adapted from its official National Statistics website, as the region is excluded from key international databases like the World Bank and Fontagné et al. (2013)⁸⁵.

The three tables below summarise the studied aggregated regions and sectors.

Description	Code
Grains and Crops	GrainsCrops
Livestock and Meat Products	MeatLstk
Mining and Extraction	Extraction
Processed Food	ProcFood
Textiles and Clothing	TextWapp
Light Manufacturing excluding MVH	LightMnfc_ex_MVH
Motor vehicles and parts	MotorVehicl_Parts
Heavy Manufacturing excluding Iron & Steel	HeavyMnfc_ex_IS
Iron and Steel	Iron_Steel
Utilities and Construction	Util_Cons
Transport and Communication	TransComm
Other Services	OthServices

Table 04.09: Summary of 12 studied sectors

⁸¹ World Bank. GDP (constant 2015 US\$). Available at:

<https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?end=2023&start=2011>. Accessed on 01-May-2025.

⁸² World Bank. Population. Available at: <https://data.worldbank.org/indicator/SP.POP.TOTL?end=2023&start=2011>. Accessed on 01-May-2025.

⁸³ World Bank. Labour force. Available at: <https://data.worldbank.org/indicator/SL.TLF.TOTL.IN>. Accessed on 01-May-2025.

⁸⁴ FAO. Arable land. Available at: <https://www.fao.org/faostat/en/#data/RL>. Accessed on 01-May-2025.

⁸⁵ National Statistics of the Republic of China (Taiwan): <https://eng.stat.gov.tw/Default.aspx>. Accessed on 01-May-2025.

Region	Name	Code
SEA	Brunei	BRN
SEA	Cambodia	KHM
SEA	Indonesia	IDN
SEA	Lao PDR	LAO
SEA	Malaysia	MYS
SEA	Philippines	PHL
SEA	Singapore	SGP
SEA	Thailand	THA
SEA	Viet Nam	VNM
SEA	Other	XSE

Region	Name	Code
SEA	Southeast Asia	SEA
Other	United States	USA
Other	China & HK	CHN_HK
Other	Japan	JPN
Other	Republic of Korea	KOR
Other	India	IND
Other	Taiwan	TWN
Other	Australia	AUS
Other	EU_27	EU27
Other	Rest of the world	RoW

Table 04.10: Summary of all studied regions and countries (Author’s own table)

4.10 Methods for data collection – Tariff rates

The projected period from 2011 to 2024 is broken down into two parts: the first part covers the period from 2011 to 2017, and the second part covers the period from 2017 to 2024. The first period could be seen to be much more stable than the second period, where the main US trade wars took place. The first period also observes efforts to establish some successful (mega) regional trade blocks, notably in the Asia-Pacific region. To project the 2011 baseline to 2017, apart from using the five criteria mentioned above, the tariff reduction schedules from major FTAs were also calculated for 2017, by using the MacMap database and by following Part 6 from Ngavozafy et al. (2020) on how to download the database.

The MacMap database contains “*forward-looking preferential tariffs*” covering from 2014 to 2050, which were calculated based on “*all trade agreement of more than 200 countries*”, according to Ngavozafy et al. (2020). To process the large MacMap database, especially with raw files containing HS6 codes rather than processed ones for GTAP, I have used R programming software (R) and developed my own codes for this task. The main reason for choosing the raw database with HS6 codes is that some ready-made GTAP-sector aggregated datasets at the individual country level appear to be corrupt, showing only zero values for scheduled tariffs, while the raw Harmonized System with 6-digit (HS6) code files show non-zero values and were also used to construct all GTAP-sector aggregated datasets. However, when calculating the scheduled tariffs by the aggregated RoW region on other partners, the

ready-made GTAP-sector aggregated dataset was selected as the size of this data file is only 0.54 Gigabyte (“GB”), while the raw HS6 file is almost 70 GB, making it unloadable into R.

When the MacMap database was processed using R, the level of data completeness varied across countries and regions examined for this study. Australia has the most complete dataset showing scheduled tariffs in 2017 and 2024, with all other nine regions, while Taiwan has the lowest number of partners that can be mapped against the MacMap dataset. However, this might not come as a surprise, as according to the US’s International Trade Administration⁸⁶, Taiwan only has three FTAs as of 2023 with three partners in Central America (Guatemala, El Salvador, and Honduras), all being grouped in RoW. The other two regions showing scheduled tariffs are CHN_HK and SEA. As a result, existing tariffs from GTAP v09 are used for Taiwan’s other partners in this study, apart from RoW, CHN_HK and SEA. The Tariff reduction schedules tables for the main studied regions in this study (the US, China and SEA) for the year 2017, and 2024 are included in Chapter 07, the rest will be included in the Appendix.

For the second part of the baseline projection that covers the period from 2017 to 2024, apart from using the MacMap database to work out the Tariff reduction schedules for 2024, additional efforts were made to calculate the actual tariffs that the US and China have imposed on each other during the President Donald John Trump’s first administration (2017 – 2021) and during President Joseph Robinette Biden’s administration (2021 – 2025). The two most notable tariff actions taken by President Trump are Section 232 targeting steel and aluminium, and Section 301 targeting around £370 bn of Chinese exports to the US during the first term. The Harmonized System (HS) Codes used for Section 232 can be found in Proclamation 9704 and Proclamation 9705. For Section 301, the HS codes were taken from four Notices of Actions from the Office of the United States Trade Representative (USTR) covering List 1 (34 billion USD), List 2 (16 billion USD), List 3 (200 billion USD), and List 4 (300 billion USD)⁸⁷. Thanks to the Phase One Trade Agreement reached between the US and China in January 2020, only one part of List 4, also known as List 4A, which covers around 120 billion USD of China’s exports to the US, was subjected to reduced tariffs. The rest of List 4, known as List 4B, was suspended. Both Section 232 and Section 301 were continued during President Biden’s administration against China. However, it was not until the very last months of President Biden’s presidency that he announced his own tariffs against China. President Biden targeted

⁸⁶ The International Trade Administration. Taiwan’s FTAs: <https://www.trade.gov/country-commercial-guides/taiwan-trade-agreements>. Accessed on 01-May-2025.

⁸⁷ Office of the United States Trade Representative. Section 301: <https://ustr.gov/issue-areas/enforcement/section-301-investigations/search>. Accessed on 01-May-2025.

approximately 18 billion USD of China's exports to the US in 2023, covering 14 key product items such as Electric vehicles and Semiconductors. The full list of HS codes can be found in Notice of Modification to Section 301 2024-21217 (89 FR 76581)⁸⁸.

President Trump's and Biden's tariffs have been calculated and then added together, before being stacked on top of the tariff reduction schedules calculated for 2024. The main methodology to calculate President Trump's and Biden's tariffs was adopted from Giesecke et al (2019). I also used R programming software and developed my own codes for this section. To simplify the complexity caused by trade wars between the US and China, other minor modifications to Section 232 and 301 were not considered. Some of the challenges include the difficulties in finding the exact import amounts being targeted by the US as well as other highly technical custom-related information. While the full breakdown of trade data can be downloaded from the UN's COMTRADE platform, these data are only available at HS6 (6 digit) level while vast majority of the codes targeted by the US are in 8-digit forms, with some are in HS10 formats. In addition, due to the small import amount being targeted by Section 201 regarding solar panels and washing machines, the level of aggregation in the studied sectors in this study, as well as the high level of technicality adopted in Section 201, this research will not take Section 201's tariffs into account.

A critical, yet unstated, assumption inherent in the methodology of Giesecke et al. (2019) has significant implications for the accuracy of the computed effective rates across sectors. Specifically, the authors derive a uniform discount factor by dividing the aggregate value of actual imports by a predetermined target value (e.g., 34 billion USD or 16 billion USD). This discount factor is then indiscriminately applied across all sectors' actual import sums to reconcile the total with the targeted aggregate. This procedure implicitly assumes that each HS6-level product code contributes equally to the total export value — effectively treating all codes as if they have identical export magnitudes. As a result, the approach neglects the heterogeneity in export values across HS6 codes and fails to employ a weighted average when applying the discount factor. Such an oversimplification risks distorting the sectoral effective rates, as it does not account for the actual distribution of trade flows within and across sectors. This methodological shortcut may therefore compromise the precision and representativeness of the sector-specific effective rates generated by the model.

⁸⁸ Biden's Modification to Section 301: <https://www.federalregister.gov/documents/2024/09/18/2024-21217/notice-of-modification-chinas-acts-policies-and-practices-related-to-technology-transfer>. 01-May-2025.

On the other hand, China also retaliated against every single list announced by the US. China's response to the US first 2 lists by imposing the same level of tariffs 25% on 50 billion USD (34 billion USD plus 16 billion USD) ⁸⁹ of the US's exports to China. However, the actual amount appeared to be much smaller than what the Chinese government announced. For example, Giesecke et al (2019) suggest that their methodology would overstate the actual import amount being targeted by using HS6 codes rather than HS8 codes, as not all HS8 codes are targeted. For example, these two HS8 codes are included in China's lists against the first 34 billion USD of the US's export: 87149610 and 87149610. However, when both are reduced to the HS6 form of 871496, this means that all HS8 codes from 87149601 to 87149699 (99 codes in total and not just 2 codes actually listed) are included in the calculation. In other words, the summation of the first 2 lists announced by China should exceed 50 billion USD in theory, using the 2018 data. However, the actual sum calculated by R programming software only returned 36,6 billion USD, which is much lower than the 50 billion USD announced. This suggests that the actual amount should be much lower than 36,6 billion USD. To some extent, this might be understandable from China's point of view because while China's export to the USA is worth around 560 billion USD, the USA only exported around 146 billion USD in return in 2018 value, leaving the US with more room to impose tariffs on China. As a result, trying to match the same amount of 50 billion USD might hurt China a lot more than for the US. To estimate the targeted level of the US's export that China wanted to impose tariffs to retaliate against List 1 and List 2, this research makes an assumption that China targeted the same proportion as the US did with List 1 and List 2 against China's export ($50 \text{ billion USD} / 560 \text{ billion USD} = 0.09$ or 9% approximately). This translates to around 13,8 billion USD of the US's exports being targeted by China in retaliation against List 1 and List 2. This assumption might underestimate the true magnitude of China's retaliation. However, given the discount factor of almost 1.83 applied to the US's first two lists by following Giesecke et al (2019)'s methodology as well as the small difference of just 1.49 percent point between the normal averages of the effective rates across 12 highly aggregated sectors between this assumption (14.105%) and if 1.83 discount factor above were adopted (15.593%), this research considers that this assumption is acceptable given all the constraints this research faces.

⁸⁹ The Central People's Government of the People's Republic of China (referred to as "China Government Network"): 国务院关税税则委员会关于对原产于美国500亿美元进口商品加征关税的公告 (Google translate: Announcement of the State Council Tariff Commission on imposing additional tariffs on US\$50 billion worth of imported goods originating from the United States), accessed on 01-July-2025. https://www.gov.cn/xinwen/2018-06/16/content_5299069.htm

China's retaliation against List 3 of 60 billion USD of the US's exports ⁹⁰ can be logically followed by using Giesecke et al (2019)'s methodology. However, China's retaliation against the US's List 4A and List 4B appear to be the most complex as most of China's 75 bn USD ⁹¹ of targeted US export contains many HS8 codes listed in the previous two retaliatory rounds (1180 out of 1717 HS8 codes used to retaliate List 4A). Additionally, it is not clear how much exactly China wanted to retaliate List 4A and how much to retaliate list 4B given that List 4B has been suspended. To overcome this challenge of unknown US export amounts being targeted, this research follows the undeclared assumption made by Giesecke et al (2019) as explained above and makes a simple assumption that each HS8 codes of the total 1717 + 3361 = 5078 codes carry the same weight in the 75 bn USD of US export being targeted. Of the 1717 HS8 codes being used to retaliate List 4A, 537 HS8 codes are new, while 1180 HS8 codes have already been used in previous rounds. These translate into around 8 bn USD of new US export and around 17,4 bn USD of US export that were already targeted by China.

4.11 Key CGE software

There are many programming languages which can be used to build applications to process the main GTAP database. This section will discuss GAMS, GEMPACK and R.

4.11.1 GAMS

World Bank's shift in its agenda in the late 1960s and early 1980s to alleviating poverty, and the difficulties that followed, accidentally created a fruitful environment for a transformation in applied CGE modelling ⁹². During this period, frustrations arose within the World Bank while building large economic models. The reason was that existing tools in the 1970s were relatively high cost, manual, time-consuming, less reliable in applying optimisation (a key part of neoclassical economics), and also required highly technical skills to operate. Modellers

⁹⁰ The Central People's Government of the People's Republic of China (referred to as "China Government Network"): 国务院关税税则委员会关于对原产于美国的部分进口商品 (第二批) 加征关税的公告 (Google translate: Announcement of the State Council Tariff Commission on imposing additional tariffs on some imported goods originating from the United States (second batch)), accessed on 01-July-2025. https://www.gov.cn/xinwen/2018-08/03/content_5311619.htm

⁹¹ The Central People's Government of the People's Republic of China (referred to as "China Government Network"): 国务院关税税则委员会关于对原产于美国的部分进口商品 (第三批) 加征关税的公告 (Google translate: Announcement of the Tariff Commission of the State Council on imposing additional tariffs on some imported goods originating from the United States (third batch)), accessed on 01-July-2025. https://www.gov.cn/xinwen/2019-08/24/content_5424152.htm

⁹² World bank. Bretton Woods Conference. Available at: <https://www.worldbank.org/en/archive/history#>. Accessed on 05-Jun-2025.

sometimes had to rely on irrational aspects of existing versions or were unable to reproduce or re-apply their models in different environments, as the time and money required to make adjustments were unavailable. To overcome these problems, the World Bank funded the initial research and development (“R&D”) stage of the General Algebraic Modeling System (“GAMS”) while the GAMS Development Corporation was in charge of further R&D funding since 1987. Mathematical economists have been playing crucial roles in the development of GAMS⁹³. While the programme was developed around mid-1970s by Alex Meeraus and Jan Bisschop at the World Bank, it took more than a decade until the first non-linear CGE model for Cameroon using GAMS was published by Condon, Dahl, and Devarajan (1987).

4.11.2 GEMPACK

Around the same period, another software, GEMPACK, as mentioned previously, was being developed to specifically show Johansen-style models by Ken Pearson in the early 1980s. The software was quickly adopted by researchers, especially in Australia.

The origins of GEMPACK⁹⁴ can be traced back to a 1982 seminar at La Trobe University (Melbourne), where Peter Dixon presented the ORANI model, which was developed by himself and colleagues at the Impact Project since 1975. At that time, ORANI was solved using a collection of “*custom-written computer programs*”, with model size constrained by the computing power then available. It was Ken Pearson, a senior mathematics lecturer at La Trobe, who proposed applying sparse matrix methods to improve the efficiency of solving ORANI’s linear equation system and achieved a significant reduction in simulation time. This collaboration marked the inception of GEMPACK, though in its earliest form it differed greatly from its modern incarnation such as it lacked the TABLO language, the multi-step exact solution method, and Windows-based tools such as ViewHAR or TABmate. Equation files with the coefficients of the linearised system still had to be produced via bespoke programs.

The first GEMPACK training session was delivered at Melbourne University in 1984, with the software then restricted to VAX machines. Pearson soon began work on a portable version, which was initially tested in 1985 on a PRIME computer at the University of Tasmania. In

⁹³ GAMS. Introduction to GAMS. Available at: https://www.gams.com/latest/docs/UG_Introduction.html. Accessed on 15-Aug-2025.

⁹⁴ COPS. The historical development of GEMPACK in this section is entirely taken from: <https://www.copsmodels.com/gpmanual.htm>. Accessed on 15-Aug-2025.

1986, the Impact Project, based at Melbourne University, assigned Pearson to develop the TABLO language and a TABLO program capable of producing Fortran code from TAB files, assisted by George Codsì.

GEMPACK Release 4.2, issued in 1990, became the first widely distributed version, followed in 1991 by Release 4.2.02, which offered improved efficiency and introduced multi-step solution procedures. Releases 5.0 (1993), which debuted GEMSIM, and 5.1 (1994) followed. Afterwards, another 13 versions of GEMPACK have been released, with the latest version being introduced in 2024.

4.11.3 R programming language

Specialised computational software, such as GAMS and GEMPACK, has significantly advanced the practical application of computable general equilibrium modelling by enabling researchers to formulate models and scenarios in an accessible, human-readable form and execute them with high computational efficiency. Despite its effectiveness for CGE analysis, GAMS and GEMPACK are proprietary software that adhere to their own set of conventions and standards, which diverge considerably from those commonly adopted in mainstream data analysis environments. Additionally, users are required to purchase licenses to work with more advanced and complex models. For example, an educational single user from an advanced country has to pay 2,960 USD, as of August 2025⁹⁵, to purchase a permanent license for an unlimited RunDynam and Source-Code GEMPACK. This also does not include the cost of the GTAP dataset. Such a divergence can create substantial challenges when attempting to integrate GAMS and GEMPACK outputs or workflows with widely used analytical ecosystems, such as R (and RStudio⁹⁶), which is one of the most popular and freely available programming languages (Maros Ivanic, 2020).

Maros Ivanic (2020) investigates whether open-source, community-driven alternatives could feasibly replicate the key functionalities of GEMPACK. To explore this, a representative GTAP model simulation, with ten regions and ten sectors, was implemented in R, employing several recently developed R packages, and the outputs were compared with those from the established framework. The findings indicate that, although current R-based solvers exhibit slower

⁹⁵ GEMPACK licence prices: <https://www.copsmodels.com/gpprice.htm>. Accessed on 15-Aug-2025.

⁹⁶ According to Posit.co, which offers free download of RStudio: “RStudio is an integrated development environment (IDE) for R and Python.” Available at: <https://posit.co/products/open-source/rstudio/?sid=1>. Accessed on 11-Aug-2025.

performance and take much longer times, particularly when handling large-scale models, the pace deficit is likely surmountable as the research community continues to refine these tools. Moreover, the advantages of operating within R's extensive analytical ecosystem are anticipated to outweigh the additional computation time required.

Given the technical superiority and open-source nature of R, this research employs the R programming language to manage and calculate the extensive, time-series tariff data across various regions. This choice was further necessitated by the scale of the dataset, which exceeds the capacity (i.e., the 1,048,576-row limit) of common commercial spreadsheet applications like Microsoft Excel.

For this research, GEMPACK and, more specifically, the publicly available and free RunGTAP application, a software developed by GTAP to simulate the GTAP database built on GEMPACK, are chosen to run the four scenarios outlined in previous chapters. As pointed out earlier, there is one main limitation of this free version which limits the number of disaggregated regions and sectors.

4.12 Scenario Design Using Game-Theoretic Framework

While this DBA thesis primarily employs quantitative computable general equilibrium (CGE) modelling through GTAP v7 to simulate trade war impacts, the scenario design incorporates qualitative insights from non-cooperative game theory, as discussed in Chapter 02, to systematically capture strategic interactions among trading blocs. Game theory provides a structured lens for modelling tariff decisions as sequential or simultaneous moves in a payoff matrix, where players (US, China, SEA) weigh costs of retaliation against cooperation amid asymmetric power dynamics. This approach justifies the four scenarios (S1, S2, S3 and S4) as progressive equilibria paths, starting from unilateral (one-shot) US action, escalating through tit-for-tat retaliations, and culminating in partial concessions.

Scenario 1 (S1) represents a dominant strategy equilibrium where the US, under President Trump, imposes full reciprocal tariffs unilaterally, assuming rational partners prioritise short-term gains over costly retaliation. Drawing from Nash's non-cooperative equilibrium, trading partners remain passive, absorbing tariffs to avoid mutual destruction. This baseline tests the isolated shock of US protectionism, isolating direct effects on global supply chains before strategic responses complicate outcomes.

In Scenario 2 (S2), China introduces retaliation with a calibrated 34% tariff, transforming S1 into a grim trigger strategy from repeated game theory, where defection provokes symmetric punishment. This mirrors historical events leading to the US-China Phase One deal, where China's response signals credibility without full escalation, allowing GTAP simulations to quantify bilateral damage while assuming SEA's free-riding.

Scenario 3 (S3) extends retaliation to Southeast Asia (SEA) at 34.44%, modelling a coordinated punishment equilibrium, where multiple players defect simultaneously, resembling a multi-player prisoner's dilemma. Here, SEA abandons free-riding, potentially amplifying aggregate welfare losses through fragmented trade blocs. This scenario tests regional coalition formation risks, with tariffs calibrated to mirror Vietnam's announced responses.

Finally, Scenario 4 (S4) introduces bargaining under reciprocity, where SEA offers unilateral tariff cuts to 0% for all non-services in exchange for US concessions reducing SEA's effective rate from 34.44% to 14.97% (2.3x moderation). Framed as a Rubinstein bargaining game with alternating offers, this reflects side-payments in asymmetric negotiations, where weaker players buy access via liberalisation (Rubinstein, 1982). Excluding SEA from initial US tariffs adds realism to hub-spoke dynamics and enables GTAP to evaluate potential trade creation or diversion effects when SEA has an advantage over any other major region when it comes to dealing with the US reciprocal tariffs.

This game-theoretic scaffolding ensures scenarios are theoretically grounded yet empirically tractable, bridging qualitative strategic reasoning with quantitative equilibrium analysis for robust policy insights.

4.13 Hypotheses development

This thesis develops four hypotheses to be measured against in Chapter 08, based on the research aim, objectives, questions and scenarios.

Hypothesis 01 (H1) - Macroeconomic impact in SEA

President Trump's reciprocal tariff policies are expected to generate net macroeconomic losses for Southeast Asia in terms of real GDP, investment, terms of trade and welfare across the first

three simulated scenarios (S1 to S3), with the largest losses occurring when Southeast Asia retaliates (S3). However, unilateral tariff liberalisation vis-à-vis the US (S4) might reverse these effects and yield positive outcomes relative to the baseline.

Hypothesis 02 (H2) – Microeconomic (Sectoral) impact in SEA

President Trump's tariffs will produce heterogeneous sectoral effects in Southeast Asia, with most of the nine non-service GTAP-aggregated sectors registering output and export contractions under S1–S3, whereas S4 will concentrate expansion in key export-competing manufacturing sectors (Textiles & Wearing Apparel, Light Manufacturing, Heavy Manufacturing).

Hypothesis 03 (H3) – US's exports to SEA

Exports from the US to SEA are expected to increase significantly after SEA removes all tariffs for the US's exports.

Hypothesis 04 (H4) - Optimal SEA Response

Unilateral tariff liberalisation toward the US (S4), which secures a relatively lower reciprocal tariff rate in comparison to other regions, is expected to confer Southeast Asia a comparative advantage in macroeconomic and sectoral performance over alternative responses (S1–S3), though this SEA-preferred equilibrium will exacerbate welfare losses for the rest of the world relative to the one-shot non-retaliatory baseline (S1), potentially generating an overall net welfare loss at the global scale.

4.14 Conclusion

This chapter has explained how the study is carried out, why the CGE approach is used, and how the data and scenarios are prepared for the model. By following a positivist and quantitative framework, the chapter showed how the GTAP model helps examine the wider economic effects of President Trump's proposed tariffs and the possible responses from Southeast Asia. The scenarios were designed to reflect realistic policy choices, and the shocks were implemented in a consistent way so that the results can be compared clearly across cases. Because the model structure and assumptions follow the standard GTAP version, the findings

can be interpreted with confidence and reproduced by other researchers. Together, these steps provide a solid foundation for the analysis that follows in the next chapter.

5 Chapter 05: Data in CGE modelling: The methodological development of the GTAP Databases

5.1 Introduction

Following the detailed methodological discussion in the previous chapter, this current chapter focuses on the input data required for the operationalisation of the Computable General Equilibrium model. Specifically, this section examines and presents the largest primary source of empirical data that will be utilised in the subsequent policy simulations.

This chapter provides a detailed examination of the procedures through which data are collected, processed, and systemically structured for use within CGE modelling. Although the overarching orientation of this dissertation is situated within economics, the methodological focus of the present chapter necessitates an extensive engagement with accounting frameworks. Nevertheless, economic theory, most notably the conceptual logic of the circular flow of income, as detailed in Chapter 04, remains essential in explaining how accounting conventions can be mobilised to facilitate the preparation of consistent and analytically robust datasets for economic modelling.

The discussion begins with an exposition of the System of National Accounts (SNA), the internationally standardised framework that governs the compilation and presentation of national accounts across countries. Building upon this foundation, attention turns to the Supply and Use Tables (SUT), which provide a systematic mapping of production and consumption flows and serve as the basis for deriving the Input–Output Tables (IOT). While both the SUT and IOT constitute indispensable tools for applied economic analysis, they remain limited in their capacity to capture the comprehensive theoretical representation of the circular flow of income. To address this conceptual shortcoming, the chapter considers the construction of the Social Accounting Matrix (SAM), which extends and integrates information from the SUT and IOT to provide a fuller representation of intersectoral and institutional linkages within the economy.

5.2 The System of National Accounts (SNA)

The Social Accounting Matrix (“SAM”) plays a crucial role in the development of CGE modelling. According to the United Nations’ Department of Economic and Social Affairs Statistics, it is “*a means of presenting the SNA accounts in a matrix which elaborates the linkages between a supply and use table and institutional sector accounts*”⁹⁷. In this context, the SNA refers to the System of National Accounts and is an internationally recognised framework that provides standardised guidelines for measuring economic activity. It establishes a “*coherent, consistent and integrated set of macroeconomic accounts*”, following globally agreed-upon concepts, definitions, classifications, and accounting principles to ensure consistency in economic reporting and analysis⁹⁸. This critical requirement was initially underscored by the United Nations Statistical Commission in 1947, which justified the need due to “*a large array of policy needs*”⁹⁹. Since the United Nations (1947) Report, the System of National Accounts (SNA) has undergone several revisions and improvements, with the most recent update occurring in 2008.

The United Nations (1953) Report on the System of National Accounts is “*a sequel*” of the 1947 report and expands substantially the previous version, and is re-structured into six standard accounts, namely:

1. The domestic product account
2. The national income account
3. The domestic capital formation account
4. The current and capital reconciliation accounts of households and private non-profit institutions
5. The current and capital reconciliation accounts of general government
6. The current and capital reconciliation accounts for external transactions,

together with 12 standard tables:

1. Expenditure on gross national product
2. Industrial origin of gross domestic product at factor cost
3. National income by type of organisation

⁹⁷ UN. Glossary of the 1993 SNA - Definition of Term - Social accounting matrix (SAM). Available at: [https://unstats.un.org/unsd/nationalaccount/glossresults.asp?gID=507#:~:text=A%20social%20accounting%20matrix%20\(SAM,extra%20breakdowns%20of%20the%20household](https://unstats.un.org/unsd/nationalaccount/glossresults.asp?gID=507#:~:text=A%20social%20accounting%20matrix%20(SAM,extra%20breakdowns%20of%20the%20household). Accessed on 22-Mar-2025.

⁹⁸ UN. The System of National Accounts (SNA). Available at: <https://unstats.un.org/unsd/nationalaccount/sna.asp>. Accessed on 22-Mar-2025

⁹⁹ See 97

4. Distribution of the national income
5. The finance of gross capital formation
6. Composition of gross domestic capital formation
7. Receipts and expenditures of households and private non-profit institutions
8. Composition of private consumption expenditure
9. General government revenue and expenditure
10. Composition of general government consumption expenditure
11. External transactions
12. Receipts and disbursements of the rural sector

The United Nations (1968) Report presents a new version of the SNA, which was developed in 1953. Both versions technically follow the Keynesian approach to national income accounting (Ruggles, 1995). Some of the innovations of the 1968 Report include the addition of input-output accounts, which were introduced by Leontief in 1941, as mentioned in Chapter 03. This addition aims to capture inter-industry relationships within the economy more accurately, as well as to incorporate balance sheets. Previous versions only paid attention to the flows of income, production, and expenditure (transactions) via the circular flow of income model, but completely ignored assets and liabilities (generally referred to as stocks)¹⁰⁰. Without having a snapshot of the national wealth or stock, the assessment of economic sustainability and the intertemporal impacts of past economic activities on future wealth accumulation is challenging. A better estimation of constant prices was also introduced, as previous versions were only concerned with current monetary terms¹⁰¹. Finally, efforts were made to bring the SNA and the Material Product System (MPS) more into alignment with each other. The Material Product System (MPS)¹⁰² were used in some socialist countries, and such an above move would improve consistency and comparability internationally.

The United Nations (1993) Report represents a pivotal advancement in the theoretical coherence and practical utility of national accounting frameworks and other major statistical systems, “*to eliminate conceptual differences between them*” (p.11). This revision markedly enhanced the integration of the SNA with a broad spectrum of complementary international statistical standards and specialised statistical domains, including, but not limited to, financial

¹⁰⁰ UN (1968). A System of National Accounts Report. “1.35. *So far, only transactions (flows) have been accounted for; assets and liabilities (stocks) have been ignored ...*” (p.6)

¹⁰¹ UN (1968). A System of National Accounts Report. “... *The main purpose of the work was to provide a uniform basis for reporting national income statistics ...*” (p.1)

¹⁰² Also referred to as “*the System of Material Product Balances (MPS)*” in the 1968 Report.

statistics, balance of payments statistics, labour force statistics, government finance statistics, and monetary and banking statistics. Such comprehensive harmonisation addressed a critical methodological imperative at the time, which is the evolving nature of these parallel frameworks, which underwent substantial revisions contemporaneously with the SNA itself and were governed by distinct international organisations with their own mandates and technical protocols. Through this rigorous alignment process, the 1993 SNA improved the conceptual consistency and comparability across macroeconomic datasets. This synthesis enabled national accounts to better reflect the increasingly complex and interdependent realities of modern economies, thereby expanding their relevance for both national statistical agencies and international institutions engaged in economic monitoring and coordination.

The United Nations (2008) Report was an update to the 1993 SNA, reflecting significant changes in the “*economic environment*”, particularly the rise of financial innovations, globalisation, and the digital economy. One of the key updates was the expanded treatment of financial instruments, including a more detailed classification of financial derivatives and the recognition of employee stock options as part of compensation. Another major area of improvement in the 2008 Report is “*advances in methodological research*”, particularly through its expansion of the asset boundary to better capture the sources of economic growth in modern economies. The most salient changes in this regard pertain to the treatment of Research and Development (R&D) and military weapons systems. The 1993 Report, by convention, treated expenditures on R&D and durable military goods as intermediate consumption, effectively categorising them as expenses used up in the production process. The 2008 Report, however, identifies both as long-term investments that generate future economic benefits. Consequently, R&D expenditures and military weapons platforms are now classified as produced assets and recorded as gross “*fixed capital formation*” (p.122). This reclassification provides a more accurate measure of a nation's capital stock and, by increasing the value of goods and services produced, might lead to a higher reported Gross Domestic Product.

5.2.1 Price system in SNA and SAM

The 2008 SNA report identifies three key prices: the basic price, the producers' price, and the purchaser's price.

The basic price is the net revenue received by the producer from the buyer or purchaser for a unit of output, after accounting for taxes and subsidies related to its production or sale, but excluding any separate transport charges.

The producer's price is the net revenue received by the producer from the buyer or purchaser for a unit of output, excluding any value-added tax (VAT), similar deductible taxes incurred by the purchaser, and any separate transport charges issued by the producer.

The purchaser's price is the amount the purchaser pays to get a good or service delivered to the purchaser. This amount includes transport charges and VAT or any other tax deductibles.

The three different types of prices mentioned above, and their mathematical relationship, are presented below:

$$\begin{array}{r}
 \textbf{Basic Price} \\
 + \\
 \text{Taxes on products excluding invoiced VAT} \\
 - \\
 \text{Subsidies on product} \\
 = \\
 \textbf{Producers' prices} \\
 + \\
 \text{VAT not deductible by the purchaser} \\
 + \\
 \text{Separately invoiced transport charges} \\
 + \\
 \text{Wholesalers' and retailers' margins} \\
 = \\
 \textbf{Purchasers' prices}
 \end{array}$$

Figure 05.01: Basic, producers' and purchasers' prices (SNA, 2008, par 6.69)

CGE models are primarily concerned with the basic price and the purchaser's price. The 2008 SNA Report confirms that the preferred approach for valuing output is at basic prices; however,

if this is not achievable, producers' prices may be applied instead. On the other hand, all transactions concerning the utilisation of goods and services, including “*final consumption, intermediate consumption, and capital formation*”, are consistently valued at their respective purchasers' prices. (p.22).

5.2.2 Product balances and the Goods & Services account

There are three approaches to the measurement of the Gross Domestic Product (GDP), namely the income approach, the output approach, and the expenditure approach, based on the standard Circular Flow of Income model. In theory, the results of the three approaches are identical. The 2008 SNA report spent Chapters 6 to 13 focusing on the Income approach, particularly with generation, distribution, and redistribution, while Chapter 14 focused on the output approach with the Supply table and the expenditure approach with the Use table¹⁰³ (p. 271).

In either a closed or open economy with trades, the total supply of a product must be equal to the total demand for that product (Product balance). Knowing the product balance allows researchers to identify data inconsistency (e.g., between supply and demand) and to improve data quality, and support policy analysis. The SNA 2008 report takes an example of tobacco (p.271) to illustrate the role of Product balance. While the production, import, and export of tobacco can be easily measured, the consumption is not quite so. Therefore, the product balance would allow researchers to better estimate the actual level of domestic consumption of tobacco. Since the purchaser's price is used for goods and services that are consumed by an economy, while the basic price is used for products supplied to an economy, it is important to add a trade margin¹⁰⁴, transport margin, taxes, and minus subsidies to ensure both sides of the following product balance equation are valued at the purchasers' prices:

$$(\text{Output} + \text{Imports}) + (\text{Trade \& transport margins} + \text{taxes} - \text{subsidies}) =$$

¹⁰³ “The sequence of accounts described in chapters 6 to 13 portrays the working of the economy with particular emphasis on how income is generated, distributed, redistributed and used for consumption or the acquisition of assets and when assets are disposed of, or a liability is incurred, to acquire other assets or undertake more consumption than current income permits. An alternative view of the economy focuses less on income and more on the processes of production and consumption. Where do products come from and how are they used? The present chapter is concerned with this aspect of the accounts. It consists of a description of a product balance and the generalization of this to the goods and services account, as well as the practical and conceptual benefits of these accounts. It also shows how supply and use tables can be compiled for the economy and provides a link to input-output tables, which are described in chapter 28.” (p.271)

¹⁰⁴ “A trade margin is defined as the difference between the actual or imputed price realized on a good purchased for resale and the price that would have to be paid by the distributor to replace the good at the time it is sold or otherwise disposed of” (p.113)

$$\text{Intermediate Consumption} + \text{Final Consumption} + \text{Capital Formation} + \text{Exports}$$

Trade and transport margins are also regarded as products used to produce either intermediate, final consumption, capital formation, or exports. Hence, if the value of margins is internalised in the calculation of any of the above four elements, trade and transport margins could be removed. If the above formula is re-arranged to become the “*goods and services account*”, we would have a more familiar right-hand side sum of aggregate demand (expenditure approach):

$$\text{Output} - \text{Intermediate Consumption} + \text{Taxes} - \text{Subsidies} =$$

$$\text{Final Consumption} + \text{Capital Formation} + \text{Exports} - \text{Imports}$$

Without the inclusion of the goods and services account, the supply and use table would be incomplete, failing to encompass all products available within the economy.

5.3 Supply and Use Table

Supply and Use Tables (“SUT”) constitute “*an integral part of the System of National Accounts 2008*”, underpinning the broader national accounting framework by offering a detailed and integrative depiction of the production, supply, and consumption of goods and services within an economy. As elaborated in the United Nations (2018)’ “*Handbook on Supply & Use Tables and Input Output-Tables with Extensions & Applications*”, the SUT framework meticulously documents the sources of goods and services, encompassing domestically produced output alongside imported commodities, and traces their subsequent deployment across diverse economic sectors (United Nations, 2018). These sectors encompass inter-industry intermediate consumption, final consumption by households, government entities, and other ultimate demand categories, gross capital formation through investment activities, as well as exports directed to foreign markets.

The significance of SUTs lies in their capability to reconcile the supply and demand sides of the economy, thereby facilitating a comprehensive understanding of the flow of goods and services. The supply table specifically captures the production or output dimension of the

economy, reflecting the quantity and value of goods and services generated. Conversely, the use table represents the expenditure perspective, detailing how these goods and services are utilised across various final and intermediate uses.

Fundamentally, the SUT is an integrated accounting schema composed of the supply and use tables, which are intrinsically linked to ensure consistency and balance within the national accounts. The subsequent sections will elaborate on the distinct roles, structures, and interactions of these two tables, highlighting their importance in supporting accurate economic measurement, policy analysis, and systemic economic assessments.

5.3.1 Supply Table

The supply table within the SNA provides a detailed breakdown of how goods and services enter an economy. It categorises these sources by both the specific type of product and the industry responsible for its production. Furthermore, it distinguishes between goods and services produced domestically within the country and those imported from other nations.

The core part of the Supply table is the “*make matrix*”, which shows which products are supplied or made by which industries. It is common for one industry to produce several products, meaning that the supply table looks more rectangular rather than square (with more rows than columns).

Products \ Industries	Industries				Imports	Total
	Agriculture, forestry, etc.	Mining and quarrying	...	Services		
Agriculture, forestry, etc.	Output by product by industry				Imports by product	Total supply by product
Ores and minerals, etc.						
...						
Services						
Total	Total output by industry				Total imports	Total supply

Table 05.01: Simplified structure of the supply table (United Nations, 2018, p.24)

Attentions are normally paid in the last column, which shows the “*Total supply by product*” for each row (product), both produced domestically and imported, and also in the last row, which shows the “*Total output by industry*” and “*Total imports*”.

5.3.2 Use Table

The use table within the SNA details how goods and services are utilised within the economy. It categorises these uses by both the specific type of product and the purpose for which they are used. These uses include their consumption as inputs by other industries in the production process (intermediate consumption), their consumption by households and governments (final consumption), their investment in the form of capital goods (gross capital formation), and their sale to other countries (exports).

While the last column shows the total uses by different products, the last row sums up the total outputs by different domestic activities (final consumption and capital formation) and total exports.

Products \ Industries	Industries				Final uses			Total
	Agriculture, forestry, etc.	Mining and quarrying	...	Services	Final consumption	Gross capital formation	Exports	
Agriculture, forestry, etc. Ores and minerals, etc. ... Services	Intermediate consumption by product and by industry				Final uses by product and by category			Total use by product
Value added	Value added by component and by industry							Value added
Total	Total output by industry				Total final uses by category			

 Empty cells by definition

Table 05.02: Simplified structure of the use table (United Nations, 2018, p.24)

5.3.3 The integration of supply and use tables

The establishment of the SUT also relies on three basic identities for the balancing process. If the below identities are not in balance, the supply and use tables cannot be integrated.

Identity (1): $\text{Output} = \text{Intermediate consumption} + \text{Gross Value Added ("GVA")}$ ¹⁰⁵

¹⁰⁵ "GVA is the sum of compensation of employees, other taxes (less subsidies) on production and consumption of fixed capital" (p.60). GVA = compensation of employees (labour costs) + imputed charge for consumption of fixed capital (depreciation) + other taxes on production and imports - other subsidies on production (p.61)

Identity (2): Output + Imports = Intermediate consumption + Final consumption + Capital formation + Exports

Identity (3): production-approach GVA = income-approach GVA (For each industry)

		Products				Industries				Final uses			Total
		Agriculture, forestry, etc.	Ores and minerals, etc.	...	Services	Agriculture, forestry, etc.	Mining and quarrying	...	Services	Final consumption	Gross capital formation	Exports	
Products	Agriculture, forestry, etc.					Intermediate consumption by product and by industry				Final uses by product and by category			Total use by product
	Ores and minerals, etc.												
	...												
	Services												
Industries	Agriculture, forestry, etc.	Output by product by industry											Total output by industry
	Mining and quarrying												
	...												
	Services												
Value added						Value added by component and by industry							Value added
Imports		Total imports by product											Total imports
Total		Total supply by product				Total output by industry				Total final uses by category			
		Empty cells by definition											

Empty cells by definition

Table 05.03: Simplified structure of the supply and use table (United Nations, 2018, p.25)

Simply speaking, the “*Total supply by product*” (bottom-left next to “*Total*” in the last row) must be equal to the “*Total use by product*” (top-right below “*Total*” in the last column) while the sum of the “*Industries*” columns must also equal the sum of the “*Industries*” rows. When the SUT is in balance, a single estimate of GDP is presented for all three approaches, in both current prices as well as in volume terms (United Nations, 2018, p.26).

It can also be seen that while the use table tracks how different products are used by industries and final consumers, it doesn't differentiate between domestically made and imported products. Although it is not essential to create balanced SUTs at current prices, this separation of domestic and imported products is crucial for bridging the gap between SUTs and input-output tables (IOTs).

5.4 Input-Output table (IOT)

Developing the Input-Output (I-O) table is fundamentally dependent upon the prior construction of the Supply and Use Table (SUT); circumventing this step requires the adoption of “*very restrictive assumptions*” (United Nations et al., 2009, p.507). It is important to note

that the central function of the macroeconomic data, collected for the GTAP database, is to facilitate the intertemporal reconciliation of regional Input-Output tables by updating them to a common base year (Aguilar et al., 2016).

Products	Products				Final uses			Total
	Agriculture, forestry, etc.	Ores and minerals; etc.	...	Services	Final consumption	Gross capital formation	Exports	
Agriculture, forestry, etc. Ores and minerals; etc. ... Services	Intermediate consumption by product				Final uses by product and by category			Total use by product
Imports	Intermediate consumption of imported products				Final use of imported products			
Value added	Value added by component							Value added
Total	Total supply				Total final uses by category			

Empty cells by definition

Table 05.04: Simplified IOT (product by product) (United Nations, 2018, p.36)

Compared to the simplified Use table above, the IOT (a simplified version shown above) technically originates from the Use table. The reason is due to the existence of secondary products (UN et al, 2009, p.514).

Secondary products are distinguished from principal products. Principal product means the main good or service that an industry is classified under and is typically most known for producing. This is the largest component of the industry's output. A secondary product, on the other hand, means a good or service produced by an industry in addition to its principal product. These are typically smaller components of the industry's output. The 2008 SNA, paragraph 28.46, lists three different types of secondary products:

- “Subsidiary products: those that are technologically unrelated to the primary product. Just a few examples include a large retailer with a fleet of trucks used primarily for its own purposes that may occasionally offer transport services to another unit, a farmer who use part of his land as a caravan site, or a mining company that builds access roads and accommodation for its workers.”*
- “By-products: products that are produced simultaneously with another product but which can be regarded as secondary to that product, for example gas produced by blast furnaces.”*

- c. *“Joint products: products that are produced simultaneously with another product that cannot be said to be secondary (for example beef and hides).”*

If each industry specialised in producing only one distinct product, and the number of industries perfectly matched the number of products, then a separate supply table for domestic production would be redundant; hence, only the Use table is needed. In this simplified scenario, the total output of each industry would be identical to the total supply of its corresponding product. In other words, the inter-industry matrix would naturally be square, as initially constructed, without needing further manipulation or adjustment. The only entries appearing in the supply table will be on the diagonal.

However, in the real world, the number of distinct products in an economy typically exceeds the number of recognised industries. Furthermore, it's common for a single product to be manufactured by multiple industries. Because of these, several issues emerge, for example, it becomes ambiguous which product is being used as an input by which industry in the inter-industry part of the table. The SUT shows the total output of an industry and the total use of a product, but it doesn't clearly link specific product flows between industries. Hence, the interdependence among different industries remains unclear. Knowing such interdependence would allow a better understanding of the ripple effects throughout the entire economy, which allows the operations of the general equilibrium analysis rather than the partial equilibrium analysis of one industry with the *ceteris paribus* assumption. The ripple effects can then be quantified by using multiplier analysis (United Nations, 2018, pp. 629-635)

To create a standard input-output matrix from the more detailed supply and use tables, one can either construct the input-output table based solely on products or on industries.

As we can see from the above simplified Use table and IOT, while the Use table presents data for both “Products” and “Industries”, the IOT only presents either “Products” or “Industries” at a time. The “Industries” column in the Supply table is replaced with the “Products” column in the IOT. This is also true if the “Products” row is replaced by the “Industries” row in the Use table. After such changes, the matrix for intermediate consumption (product-by-product or industry-by-industry) becomes square or symmetric (there are the same number of rows and columns with the same headings). In addition, an extra row for “Imports” is added to differentiate between domestically made and imported products, which are ignored in the Use table. The product-by-product IOT above shows the relationship between products (outputs)

and their primary inputs. The primary inputs include imports and GVA and are technically not produced by domestic industries.

To remove secondary products, hence their issues, and to keep all entries along the diagonal, information from the Use table is applied and transformed into the supply table. Such a transformative process generates the IOT. If the product-by-product IOT is developed, only the intermediate consumption and value-added parts are transformed from industry to product. To do this, the “**technology approach**” is employed, involving relocating values within a table, specifically along a horizontal line (row), while keeping the overall sum of that row unchanged. This approach assumes that the product, not the industry, determines the production process, hence fixed technology under the Leontief production function assumption. There are two ways to develop the product-by-product IOT, namely, the “**product technology assumption**” and the “**industry technology assumption**”. The product technology assumption means that regardless of the industry from which the product is made, each product has its own technological production method (e.g., the same input structure). The industry technology assumption, on the other hand, suggests that regardless of the product mix, each industry has its own technological production method (United Nations et al., 2009, pp. 514-515).

If, however, the industry-by-industry IOT is developed, the value-added part remains unchanged while the “*composition of intermediate consumption*” is altered. Opposite to the technology approach, the reallocation of items vertically between rows is needed, not horizontally between columns. Such an exercise is called the “**sales structure approach**”. This approach assumes that each industry's total “*level of output*” remains the same, and only the mix of products it sells changes. The “*level of output*” refers to the total value of goods and services produced by an industry, but it is measured based on how the industry sells its output (monetary terms) rather than how it produces its output (physical or real terms). There are two ways the industry-by-industry IOT is derived; either the “**fixed industry sales structure**” or the “**fixed product sales structure**” assumption is employed. The former means that regardless of the product mix, the sales structures are unique for different industries. The latter means that regardless of the industry from which the product is made, the sales structures are unique for different products (United Nations et al., 2009, pp. 514-515).

The product-by-product and industry-by-industry tables serve distinct analytical purposes. For instance, a product-by-product matrix is preferable when ensuring strict consistency in price indices. Conversely, an industry-by-industry table is more relevant for analysing labour market

dynamics since this allows the value-added part (labour included) to vary. While product-by-product tables have traditionally been the primary focus (United Nations, 1994, par 15.150)¹⁰⁶, largely due to their connection to the underlying production process (technology), there is, however, growing interest in industry-by-industry tables as economic interactions between different industries become increasingly complex and important (United Nations et al., 2009, p.518). In short, the most effective approach for transforming a SUT into an IOT depends on the specific characteristics of the goods or sectors being analysed. In other words, the “*knowledge*” of the products or industries studied should guide the choice of conversion method. It is also worth remembering that since the IOT can only be derived from the SUT, not directly from empirical observations, the IOT is an “*analytical construct*”.

However, despite their usefulness, SUTs and IOTs do not represent the full circular flow of income. While the SUT focuses primarily on the production and consumption of goods and services, it does not explicitly include income distribution or institutional transactions (households, government, or the rest of the world). On the other hand, the IOT focuses on inter-industry relationships and the flow of intermediate inputs, hence, mostly on the production approach. As a result, there is a need for a different table that can capture the whole circular flow of income, and the Social Accounting Matrix fills this gap.

5.5 Social Accounting Matrix

SUTs and IOTs offer a granular representation of an economy’s structure by detailing the flows of products across industries and uses; however, they do not explicitly map the connections between gross value added, final demand categories, and the distribution of incomes on their own. By integrating SUTs with institutional sector accounts, these relationships can be fully articulated within a Social Accounting Matrix (“SAM”), which captures the entire circular flow of income, including the linkages between production, distribution, and spending across all sectors of the economy.

5.5.1 The circular flow of income

The circular flow of income model detailed in Chapter 04 reminds readers of a simplified visualisation of the circular flow of income within a macroeconomic framework, highlighting

¹⁰⁶ SNA 1993 (<https://unstats.un.org/unsd/nationalaccount/docs/1993sna.pdf>) “Since the product-by-product table will often prove most useful, only this table is actually described in detail in this manual”

the interconnected roles of production, households, government, and investment sectors. At its core, the model articulates how income generated through production, primarily via the compensation of factors such as labour and capital, is distributed to households as factor payments. Households, in turn, allocate their income towards consumption, savings, and taxes. Tax revenues collected by the government are then re-injected into the economy through public expenditures and transfers, shaping aggregate demand and influencing productive activity. Savings routed to the investment sector facilitate the financing of capital formation, which further propels productive capacity and future economic growth. The diagram's feedback loops emphasise the dynamic nature of these transactions, where each sector's activity both drives and is driven by the flows of resources and payments, thereby maintaining the systemic equilibrium fundamental to national income accounting and macroeconomic analysis. However, the above diagram only demonstrates a closed economy without interaction with the outside world.

In the intertemporal closed model, the final goods and services can either be consumed in the current period or saved / accumulated for the future period. In other words, in such an economy, production, consumption, and accumulation cover all economic activities. When a closed economy opens up to the world, the above diagram incorporates interactions with the 'Rest of the World' in the product markets, the factor markets, and institutions, including imports and exports of goods and services, capital flows, and the exchange of factor services.

This circular flow highlights the continuous movement of resources and money throughout the economy, emphasising the interdependence of various sectors and their influence on overall economic activity. Unlike the SUT and IOT, which only represent the goods and services account and disregard income distribution and factor payments, SAM covers “*the whole of the sequence of accounts*” (United Nations et al., 2009, par 28.4). The SUT and IOT do present the final uses (demands), which are consumed by institutions, but neither table specifies institutions, let alone transfers among them, such as welfare benefits paid by governments to households.

Although the 1968 revised SNA integrated macroeconomic and inter-industry data, the SAM was not incorporated as a core component until the 1993 SNA revision (United Nations, 1993). As a reminder, the sequence of accounts in the SNA consists of three main groups, namely current accounts, accumulation accounts and balance sheet or 14 accounts, including the production, capital, financial, accounts, eight income-linked accounts and balance sheet,

covering production, income generation, distribution, and expenditure (United Nations et al., 2009, pp. 3-4, 561-579). Each account presents “*the resources available to institutional units*” and their utilisation. A SAM expands this sequence by organising the same transactions into a matrix format, making it easier to analyse economic linkages. Hence, the SAM is also a matrix table that presents the sequence of accounts (United Nations et al., 2009, para. 28.4).

It is important that all accounts need to be balanced, and this is done by using “*a balancing item*”. A balancing item is defined as the difference between total resources and total uses. This balancing item is then carried forward as the initial entry in the subsequent account, creating an integrated system. (United Nations et al., 2009, Par 1.14)

SAM offers the most comprehensive aggregate view of the real economy, compared to SUT and IOT. However, it often prioritises production information, limiting detail on factor payment distribution and inter-institutional transactions. This limitation of SAM appears to stem from data collection and reconciliation challenges rather than intentional design. However, this is not an intrinsic limitation of the SNA.

5.5.2 Accounts in SAM

A SAM is characterised by its square matrix format, in which each agent or account is symmetrically represented by both a row and a column. The row reading represents incomes, while the column reading shows expenditures. SAM uses a single-entry bookkeeping approach, wherein each entry constitutes a transaction, characterised by both price and quantity components. To maintain consistency, prices within each row must be identical. Consequently, the total expenditures of each account are precisely balanced by its total receipts, leading to the equality of row and column totals within the SAM.

There are five main groups of accounts used in SAM, namely, (1) Factors of production account, (2) Institutions account, (3) Production account, (4) Capital Account and (5) Rest of the world accounts (Round, 2003).

Account		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Factors of production		(1)					Gross value added payments to factors		Net factor income from RoW
Institutions (Current accounts)	Households	(2)	Labour and mixed income	Inter-household transfers	Distributed profits to households	Current transfers to households			Net current transfers from RoW
	Corporate enterprises	(3)	Operating surplus			Current transfers to companies			Net current transfers from RoW
	Government (& NPISHs)	(4)		Direct taxes	Direct taxes		Net taxes on products		Net current transfers from RoW
Production	Goods and services	(5)		Household consumption		Government consumption	Intermediate consumption	Fixed capital formation and change in stocks	Exports
	Activities	(6)					Domestic sales		
Combined capital accounts		(7)		Household savings	Corporate savings	Government savings		Capital transfers	Net capital transfers from RoW
Rest of World (combined account)		(8)					Imports	Current external balance	
Totals			Factor Income payments	Current household outlays	Corporate outlays	Current government outlays	Supply of products	Costs of production activities	Capital outlays
									Aggregate receipts from RoW

Table 05.05: A basic Social Accounting Matrix (SAM) (Round, 2003)

5.5.2.1 Factor of Production Account

Factor accounts are concerned with the factors of production, such as labour, land, and capital. These factors represent institutionally owned assets and record payments for their use, including returns to natural resources (land), wages for human capital (labour), and returns to capital. The row entries in factor accounts represent incomes paid for productive utilisations of factors of production, while column entries record expenditures by these accounts. The level of disaggregation in the household is crucial if one wants to examine the effects of changes in factor incomes on different household classes. A single aggregated representative household in SAM would not allow for such a study to take place.

5.5.2.2 Institutions Accounts (Current accounts)

According to the 2008 SNA, there are four main types of institutions recorded in these accounts. They are (1) households, (2) corporations, (3) government, and (4) non-profit institutions. As a standard practice, the rows record incomes to the above institutions while the columns record expenditures and payments.

5.5.2.2.1 Households Account

Households primarily earn income from their labour services in domestic and international markets in the form of wages. Apart from that, households can also earn their incomes from the corporations they own in terms of profits. Households can also receive income from the government in terms of transfers, such as welfare benefits. Incomes from abroad to households mostly come from selling labour services. Transfers can only take place among households themselves. On the other hand, households primarily spend their incomes on final goods and services, which are valued at purchaser prices.

5.5.2.2.2 Corporations Account

Within a SAM, the Corporation account, as defined by the 2008 SNA, is divided into two primary sub-accounts: Financial Corporations and Non-financial Corporations. Financial Corporations engage primarily in financial activities, such as providing financial intermediation, insurance, and pension fund services. This sub-account tracks their income and expenditures related to these activities, including interest, dividends, and fees.

Non-financial corporations, on the other hand, encompass entities that produce goods and services for the market, excluding financial activities. This sub-account captures their income and expenditures related to production, including revenue from sales, costs of inputs, and compensation of employees. By distinguishing between these two types of corporations, the SAM provides a clearer picture of the distinct roles they play in the economy and their respective contributions to the circular flow of income.

5.5.2.2.3 Government Account

The principal source of government income is tax revenue. Consequently, the degree of aggregation within this account has a substantial influence on the precision of analyses concerning specific tax areas, given the large number of different types of tax. Also, the degree of importance of a specific tax depends on the nature of the country being studied; hence, SAM might look different across countries based on the Government account. While taxes are mostly declared as positive values, in certain SAMs, values can be negative to present subsidies. In addition, the recording of government savings as an expenditure means that a negative entry directly corresponds to government borrowing.

5.5.2.2.4 Non-profit Institutions Account

Non-profit institutions (“NPIs”) are defined as distinct legal or social organisations designed to produce goods and services within a framework that precludes the derivation of income, profit, or other financial benefits for those who establish, govern, or fund them. (United Nations et al., 2009).

These institutions are distinct from both market-oriented corporations and government entities. They often have social or public service objectives, and their funding can come from various sources, including donations, grants, and membership fees. The NPI account tracks their income and expenditure, including how they acquire resources and how they use those resources to fulfil their missions. This account encompasses a wide variety of organisations, such as arts and culture organisations, advocacy groups, political parties, and social clubs (United Nations et al, 2009, para 4.167).

5.5.2.3 Production Account

There are two main groups in this account, namely the Goods and Services account and the Activities account.

5.5.2.3.1 Goods and Services Account

The Goods and Services Account tracks the origins and uses of commodities within the economic system during a specified accounting period. The row sums of the product accounts, representing total incomes, are valued at purchasers’ prices, and the column shows the disaggregated purchases of final goods and services by the economic institutions and also intermediate goods and services, if used in other production processes, by Activities or Industries in a closed economy.

5.5.2.3.2 Activity Account

Activity accounts detail the input and output structures of the production process. Column entries represent purchases or total costs paid for intermediate inputs and value-added. The row entries show the total revenue received from selling the products and services. Inputs consumed

during production are classified as intermediate goods, while changes in inventories or stocks are recorded as part of final demand (Pyatt, 1991).

However, this account only records transactions for productive activities that could sit within the production boundary of the SNA and the measured economic activities. Many activities carried out within households, such as childcare and cleaning, are not included in this account.

5.5.2.4 (Combined) Capital accounts

In SAM, based on the 2008 SNA, the capital account for institutions is a crucial component that records the allocation of resources for capital formation. The rows in the capital account typically represent the sources of funds, such as net saving, consumption of fixed capital, and net capital transfers received from non-residents. These sources finance the acquisition of non-financial assets. The columns, on the other hand, show the use of these funds, including gross fixed capital formation (“GFCF”), changes in inventories, and acquisitions less disposals of non-produced non-financial assets. The balancing item in this account is net lending (if positive) or net borrowing (if negative), reflecting whether an institution is a net lender or borrower.

5.5.2.5 Rest of The World Accounts

According to the 2008 SNA, the Rest of the World (“RoW”) account captures transactions between the domestic economy and non-resident units. The rows in the RoW account typically represent the resources received from the rest of the world, such as exports of goods and services, and capital inflows like foreign direct investment and other capital transfers received. The columns show the uses of these resources, including imports of goods and services, and capital outflows like foreign aid or investment abroad. This account ensures that international transactions are properly recorded, maintaining consistency in the flow of funds between the domestic economy and the rest of the world. The balancing item in this account represents the country's net lending or borrowing position to the rest of the world.

However, as mentioned earlier, it is IOT, not SAM, that is the foundation for the creation of the GTAP Database, partly because SAM is simply an extension of IOT, and methodologies have been developed to transform the GTAP IOT-based data structure into a SAM (McDonald and

Thierfelder, 2004). Another important reason is that IOTs are more likely to be produced and maintained at the national level through the National Statistical Offices than the SAM¹⁰⁷.

5.6 Conclusions

This chapter has outlined the main data sources used to build the database inputs for all CGE models in general, not just for the standard GTAP version 7. It explained how the System of National Accounts, Supply and Use Tables, Input–Output Tables, and Social Accounting Matrices provide the structure needed to organise economic information in a consistent way. By showing how these national and international accounting systems fit together, the chapter clarified both their practical role in constructing CGE databases and their importance in linking economic theory to real-world data. These elements form the foundation for the modelling work that follows. The next chapter will describe another macroeconomic dataset and how the GTAP v09 database is updated and calibrated to create the 2017 and 2024 base years, based on that dataset, to prepare the operationalisation of the policy simulations in Chapter 08.

¹⁰⁷ This information was obtained directly by email from Dr Angel Aguiar, Principal Research Economist at the Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, on 24-Mar-2025. The Center for Global Trade Analysis produces and manages the GTAP databases. A copy of the email is available upon request.

6 Chapter 06: Data – Projections for baseline scenarios: Southeast Asian economies and their partners from 2011 to 2024

6.1 Introduction

In the preceding chapter, the theoretical and empirical foundation of how the primary database being constructed was thoroughly discussed. However, a significant temporal limitation exists: the latest reference year for the GTAP Database v09 is 2011. To effectively conduct policy simulations concerning President Trump's reciprocal tariffs, the baseline scenario requires rigorous extension and updating to accurately reflect economic conditions through at least the end of 2024.

Given the dramatic shift in the global trade policy landscape commencing with President Trump's first term, the analytical period spanning 2011 to 2024 will be disaggregated into two distinct sub-periods: (1) 2011 to 2017 and (2) 2017 to 2024. The methodological rationale for this specific break point is the implementation of Section 201, 232, and 301 tariffs beginning in early 2018, as detailed in the key timeline summary of the US-China trade dispute provided in Chapter 03. Consequently, the 2011 baseline database must first be projected to 2017 to establish the appropriate pre-shock equilibrium before simulating the impact of the substantial tariff escalations from 2018 onward.

Ten different aggregate regions, including Southeast Asia (SEA), have been chosen for this research. Within this chapter, a comprehensive examination of key macroeconomic indicators, specifically real GDP, population, labour force, physical capital, and arable land, will be undertaken to provide readers with an integrated overview of the economic trajectories of the specified entities over a span approaching fifteen years. These particular indicators have been deliberately selected due to their critical role in calibrating and constructing the foundational database essential for the simulation and evaluation of the four scenarios introduced in Chapter 01. To optimise the utility of the data collected for this chapter, all data will be processed and computed as percentage change figures. This transformation will facilitate robust comparative analysis across the various Southeast Asian nations and between the Southeast Asian bloc and its nine major trading partners. The methodological approach to data collection for this Chapter has been specified in Chapter 04.

This chapter is organised into two primary sections to facilitate a comprehensive and multidimensional understanding of Southeast Asia's economic landscape. The first section concentrates exclusively on the eleven individual economies of Southeast Asia, offering nuanced analyses of each country's structural characteristics, developmental trajectories, and internal economic dynamics. Through this focused inquiry, readers will gain a detailed appreciation for the heterogeneity and transformative trends shaping the region from within, highlighting both commonalities and divergences among member states.

In the second section, the analysis broadens its scope to a comparative perspective, positioning Southeast Asia as an integrated economic bloc alongside its eight largest external export markets, as well as the aggregate "Rest of the world". This comparative framework is crafted to illuminate Southeast Asia's evolving economic role within the broader context of global trade and production networks. By juxtaposing intra-regional developments with external relationships, the chapter enables readers to discern how Southeast Asia's economic fortunes are shaped both by endogenous factors and by its interactions with major partners on the world stage.

The aggregated results, encompassing the entire period from 2011 to 2024, will serve as the foundational dataset for model calibration in Chapter 08.

As a reminder, these two tables below summarise eleven Southeast Asian nations as well as their nine aggregated main trade partners.

Region	Name	Code
SEA	Brunei	BRN
SEA	Cambodia	KHM
SEA	Indonesia	IDN
SEA	Lao PDR	LAO
SEA	Malaysia	MYS
SEA	Philippines	PHL
SEA	Singapore	SGP
SEA	Thailand	THA
SEA	Viet Nam	VNM
SEA	Other	XSE

Region	Name	Code
SEA	Southeast Asia	SEA
Other	United States	USA
Other	China & HK	CHN_HK
Other	Japan	JPN
Other	Republic of Korea	KOR
Other	India	IND
Other	Taiwan	TWN
Other	Australia	AUS
Other	EU_27	EU27
Other	Rest of the world	RoW

Table 04.10: Summary of all studied regions and countries

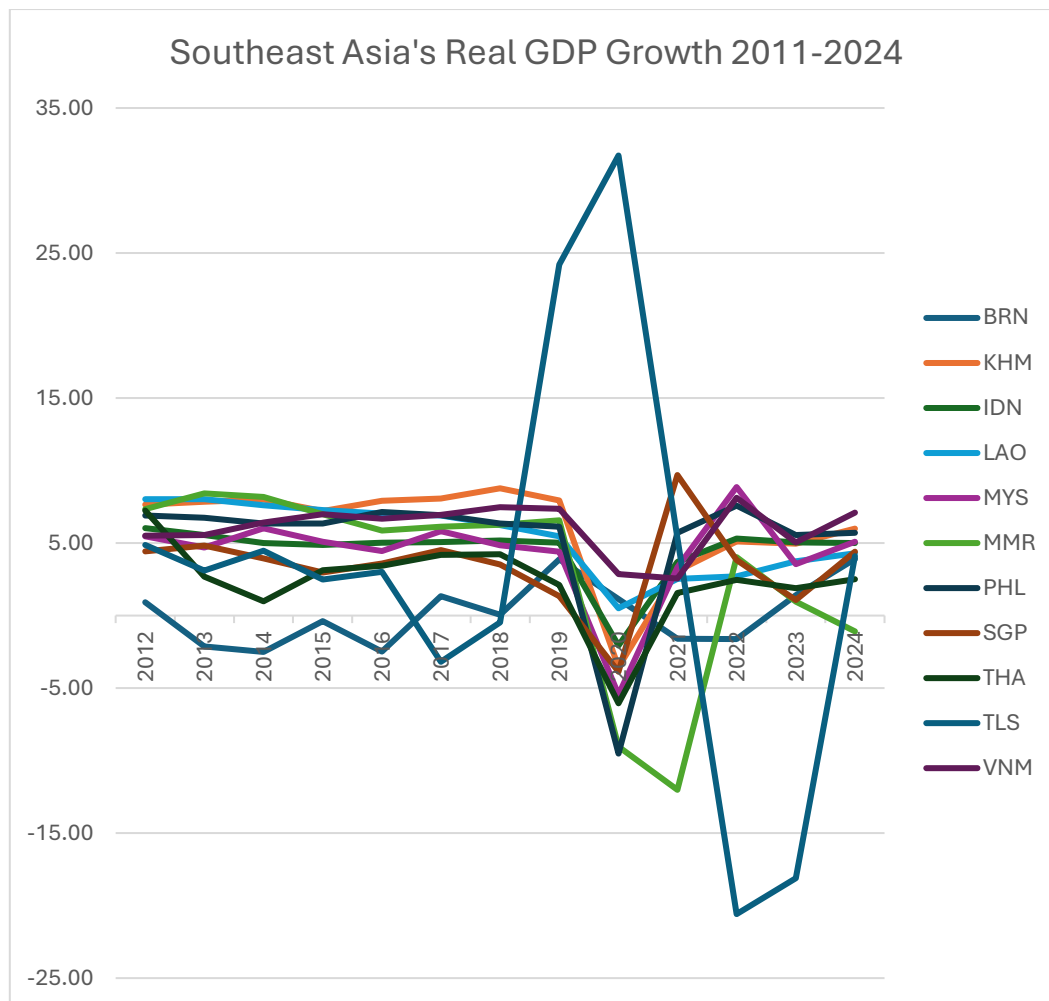
6.2 Southeast Asian economies

6.2.1 Real GDP

The figure below offers a panoramic view of Southeast Asia's economic performance from 2011 through 2024, capturing the real annual GDP growth rates of 11 member countries as well as the aggregated regional growth. Organised chronologically, the data affords both a longitudinal perspective on trends and an inter-country comparison each year, where individual country growth is explicitly compared with the regional average. The visual aid of green highlighting further enhances the interpretive clarity by flagging instances where a country's annual performance exceeds the regional mean, offering immediate insights into economic dynamism, convergence, and divergence within the bloc (See Table 05.01 in Appendix).

Diving beneath the regional aggregate, the heterogeneity of economic experiences within Southeast Asia becomes readily apparent. Countries such as **Vietnam and Cambodia** emerge as archetypes of sustained, transformative growth. Both nations essentially more than double their economies over the period in question, with cumulative real GDP growth of 114.19% for Vietnam and 114.01% for Cambodia. These numbers testify to underlying processes such as industrial diversification, export-led development, effective integration into global value chains, and, in the case of Vietnam, particularly successful policy reforms oriented toward economic liberalisation, labour market vitality, and technological adoption. Cambodia, similarly, demonstrates the fruits of a concerted pivot toward labour-intensive manufacturing and services, supported by foreign direct investment and demographic momentum.

Lao PDR and the Philippines, while not matching the cumulative percentages of Vietnam and Cambodia, nonetheless showcase performance that is both sustained and, more often than not, superior to the regional average. Lao PDR's cumulative growth of 97.74% reveals a decade marked by infrastructure-driven investment, strong hydroelectric exports, and, until recently, significant inflows of FDI. The Philippines' 91.57% cumulative growth is all the more notable for the country's size and population; its resilience is founded on a potent mix of domestic consumption and overseas remittances, which together buffered the shocks of the pandemic more effectively than in many neighbouring countries.



In stark contrast, the cases of **Brunei, Timor-Leste, and Myanmar** exemplify the hazards and headwinds that can thwart long-term economic advancement. Brunei, singular in its extreme resource dependence, especially on oil and gas, displays pronounced volatility, with several years of negative growth and a paltry total expansion of just 1.61% over the entire period. Brunei's experience thus serves as a cautionary tale about the risks associated with limited diversification. Myanmar's story is perhaps the most instructive in terms of how non-economic shocks can derail growth. After beginning the period with above-average growth, the country descends rapidly following the 2021 military coup¹⁰⁸ and the compounded impact of the

¹⁰⁸ United Nations (2021). Statement attributable to the Spokesperson for the Secretary-General - on Myanmar. Available at: https://www.un.org/sg/en/content/sg/statements/2021-01-31/statement-attributable-the-spokesperson-for-the-secretary-general-myanmar?_gl=1%2At2f0eq%2A_ga%2ANDU1MzgZNDIyLjE3Njg5MzAyNjg.%2A_ga_S5EKZKSB78%2AczE3Njg5MzAyNjgkbzEkZzEkdDE3Njg5MzAyMzckajU4JGwwJGww%2A_ga_TK9BQL5X7Z%2AczE3Njg5MzAyNjgkbzEkZzEkdDE3Njg5MzAzMTikajE2JGwwJGww. Accessed on 23-Jul-2025.

COVID-19 pandemic. Its experience underscores the paramount importance of political stability and institutional legitimacy for sustained economic development, factors as vital as market mechanisms or demographic dividends.

More mature Southeast Asian economies, specifically **Singapore, Thailand, and Malaysia**, illustrate patterns of moderate yet consistent long-term growth, albeit with significant intra-country variation. Singapore, the region's most advanced economy, posts a cumulative growth rate of 53.75%, lower than most neighbours, but reflective of its highly developed status, wage maturity, and the limited headroom for explosive growth characteristic of less developed economies. Thailand's experience is instructive for another reason. Posting a cumulative growth of 41.80%, the country is repeatedly outpaced by its regional peers. Thailand's fate is shaped by a complex interplay of domestic political turbulence, structural ageing, and, most recently, the severe impact of the pandemic on tourism, a key economic pillar. Malaysia's trajectory, with 72.25% growth over the period, strikes a middle ground; it benefits from an advantageous mix of natural resources, manufacturing, and services, but, like Singapore and Thailand, faces middle-income growth constraints. **Indonesia**, by far the region's largest economy and population, also showcases steady growth, cumulative 77.24% over the period.

6.2.2 Population

The figure under analysis provides a comprehensive, longitudinal view of population growth trends for the 11 member states of Southeast Asia from 2011 to 2024, with yearly data displayed across columns and countries listed in rows. The final row of Table 05.02 (see Appendix) represents the aggregated or composite annual population growth rate for Southeast Asia as a whole—a crucial benchmark for assessing individual country performance. The final column shows the total population growth of each country (and of the region collectively) over this 14-year period. What makes this presentation particularly insightful for comparative analysis is its use of green highlighting to denote each year in which an individual country's population growth exceeds the group's aggregate rate, providing immediate visual cues to relative outperformance or underperformance in demographic expansion.

Beneath this aggregate, considerable heterogeneity emerges among the member states. **Timor-Leste, Lao PDR, and the Philippines** consistently exhibit the highest annual population growth rates, with Timor-Leste standing out for the magnitude and persistence of its

demographic expansion. **Timor-Leste**'s population increased by 27.23% over this period, nearly double the Southeast Asian average. Its annual growth rates remain substantially above the regional mean each year, as indicated by near-continuous green highlighting. Similarly, **Lao PDR**'s population expanded by 20.77%; its growth rate, while gently declining, stays well above the regional mean, reflecting high fertility. **The Philippines** provides another compelling case of demographic exceptionalism. It accumulated an 18.76% increase in population between 2011 and 2024, among the highest in the region. Year after year, the country's population growth tends to outperform the regional mean, as evident from frequent green highlights. This enduring demographic momentum underpins the Philippines' considerable projected economic potential: a large labour force may act as both a driver of consumption-led growth and a source of global labour mobility (notably through remittances). **Cambodia**, too, demonstrates strong, steady population growth (19.52%), supported by sustained higher fertility relative to most regional peers, particularly in recent years.

In contrast, most of the more developed or urbanised Southeast Asian nations exhibit either modest or declining rates of population growth. **Thailand** is the most pronounced case: its rate declines steadily from 0.62% in 2011 to as low as -0.07% in 2023, indicating the onset of absolute population decline. Thailand's cumulative increase is just 7.48% for the entire period, the lowest among large ASEAN economies. This scenario arises from a combination of long-term success in family planning, rapid ageing, and stalled fertility.

Singapore represents a distinctive anomaly. While its annual population growth rates fluctuate widely, ranging from highs (such as 2.48% in 2011) to dramatic lows (and even negative rates in 2020 and 2021), its cumulative growth remains high at 15.15%. Singapore's volatility can be attributed to fluctuations in net migration rather than natural increase, as the city-state's birth rate is among the lowest globally. Notably, population growth soared after the pandemic but plunged during 2020–2021, likely as a result of severe pandemic restrictions, labour market flux, and sharp reductions or increases in migrant flows.

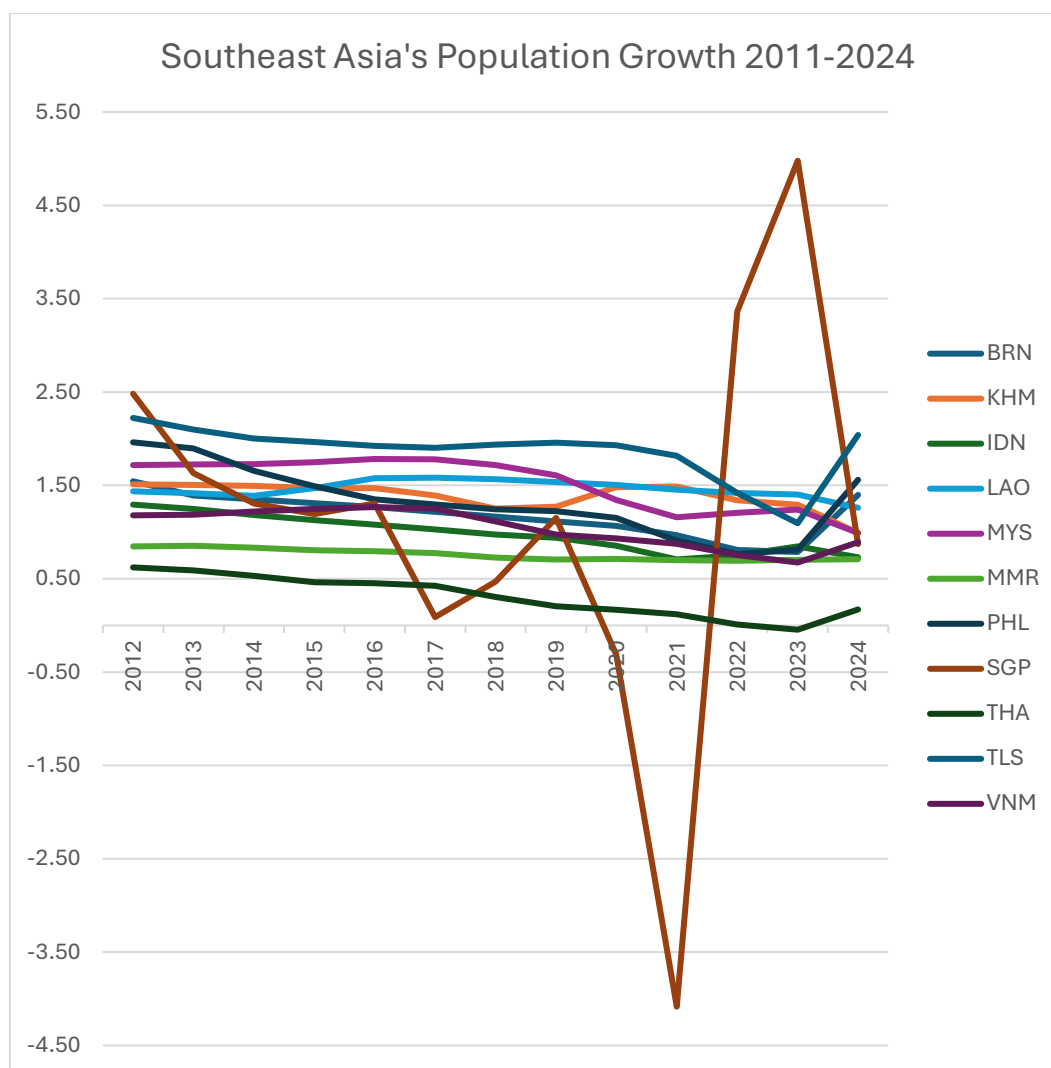


Figure 05.02: Southeast Asia's Population Growth 2011-2024 (Author's own calculations)

Brunei and Malaysia both experience patterns of modest, gradually receding growth, attaining total expansions of 16.52% and 21.84%, respectively, over this period. Their annual growth rates persistently exceed or hover around the regional average, as indicated by the frequency of green highlights. **Malaysia**, in particular, maintains above-group rates for much of the period, reflecting a relatively high fertility by middle-income country standards.

Vietnam, despite its much larger absolute population than most SEA countries, continues to see population increases of 14.44% cumulatively, though with growth rates steadily falling year over year. Vietnamese growth remains close to the regional average, but not as dynamic as the fast-growing states of the region. **Indonesia**, as Southeast Asia's giant, similarly records steady,

if unspectacular, cumulative growth at 13.54%. **Myanmar** occupies the moderate growth bracket, with the cumulative increase standing at 10.32%, reflecting historical turbulence and the recent political crisis.

6.2.3 Labour Force

The below figure provides a granular, cross-sectional and longitudinal perspective on annual labour force growth for eleven Southeast Asian countries from 2011 to 2024. (Also see Table 05.03 in the Appendix)

A careful examination reveals pronounced heterogeneity in labour force trajectories. At the upper end of the spectrum, **Laos, Malaysia, and Timor-Leste** stand out with strikingly elevated cumulative labour force growth, 42.79%, 39.31%, and 39.90% respectively. The annual rates for these countries are persistently above regional and global norms, as evidenced by the prevalence of green-highlighted cells.

The next tier comprises the **Philippines and Singapore**. Both countries post double-digit cumulative growth, 28.75% and 21.90%, respectively, and are frequently highlighted, indicating sustained periods of above-average labour force expansion relative to regional benchmarks. **The Philippines'** performance is underpinned by dynamic population growth and a high labour force participation rate, even as the magnitude and consistency of outperformance vary over time. **Singapore's** notable showing, surpassing many of its high-income regional comparators, might be driven by high-skilled immigration, participation incentives, and ongoing economic diversification.

A middle grouping is formed by **Brunei, Cambodia, and Indonesia**, each showing cumulative gains in the 17–19% range. These countries exhibit substantial but uneven growth, oscillating between years of above- and below-average performance.

At the opposite end, **Myanmar and Thailand** exhibit minimal or even negative labour force growth, with cumulative figures of -2.34% and 0.10%, respectively. Their trajectories are characterised by years of stagnation and frequent contraction. **Myanmar's** negative growth is most pronounced in the latter part of the period, coinciding with economic and political disruptions that have undermined job creation and constrained labour market participation. **Thailand**, emblematic of many upper-middle-income economies facing late-stage demographic transition, displays a stagnating or shrinking workforce.

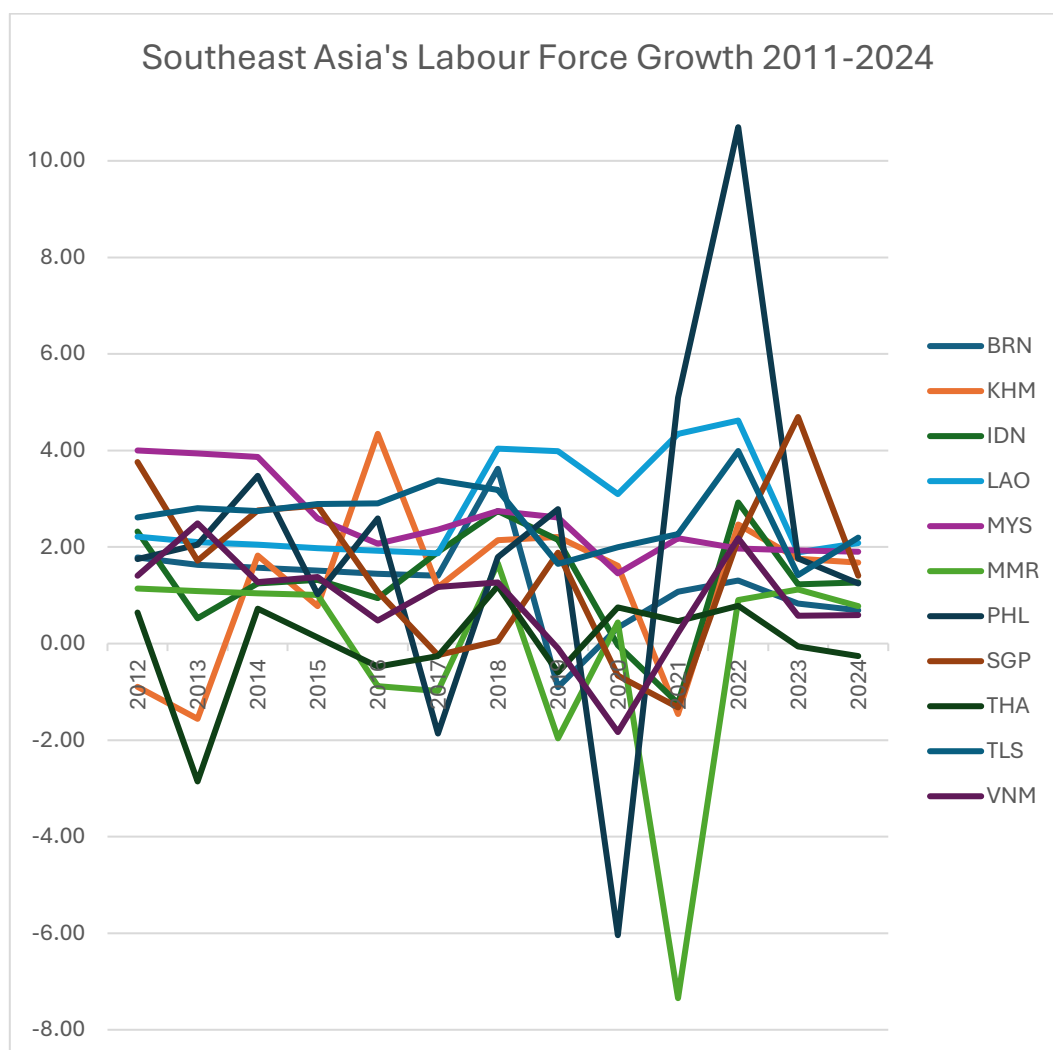


Figure 05.03: Southeast Asia's Labour Force Growth 2011-2024 (Author's own calculations)

Vietnam's position is uniquely interesting. Despite its large (and still growing) population, cumulative labour force growth (11.59%) lags behind the regional average and is outpaced by its own population increase. Vietnam's annual values consistently fall below the regional norm, potentially suggesting that demographic momentum has not fully translated into workforce expansion. This pattern may reflect rising educational attainment leading to later entry into the workforce, shifts to informality, or other factors that depress labour force participation relative to population growth.

6.2.4 Physical Capital

The attached figure provides a granular view of annual physical capital growth across eleven Southeast Asian countries from 2011 to 2024, with a strong comparative framework that highlights, in each year, which national economies outperformed the regional average (Also see Table 05.04 in the Appendix).

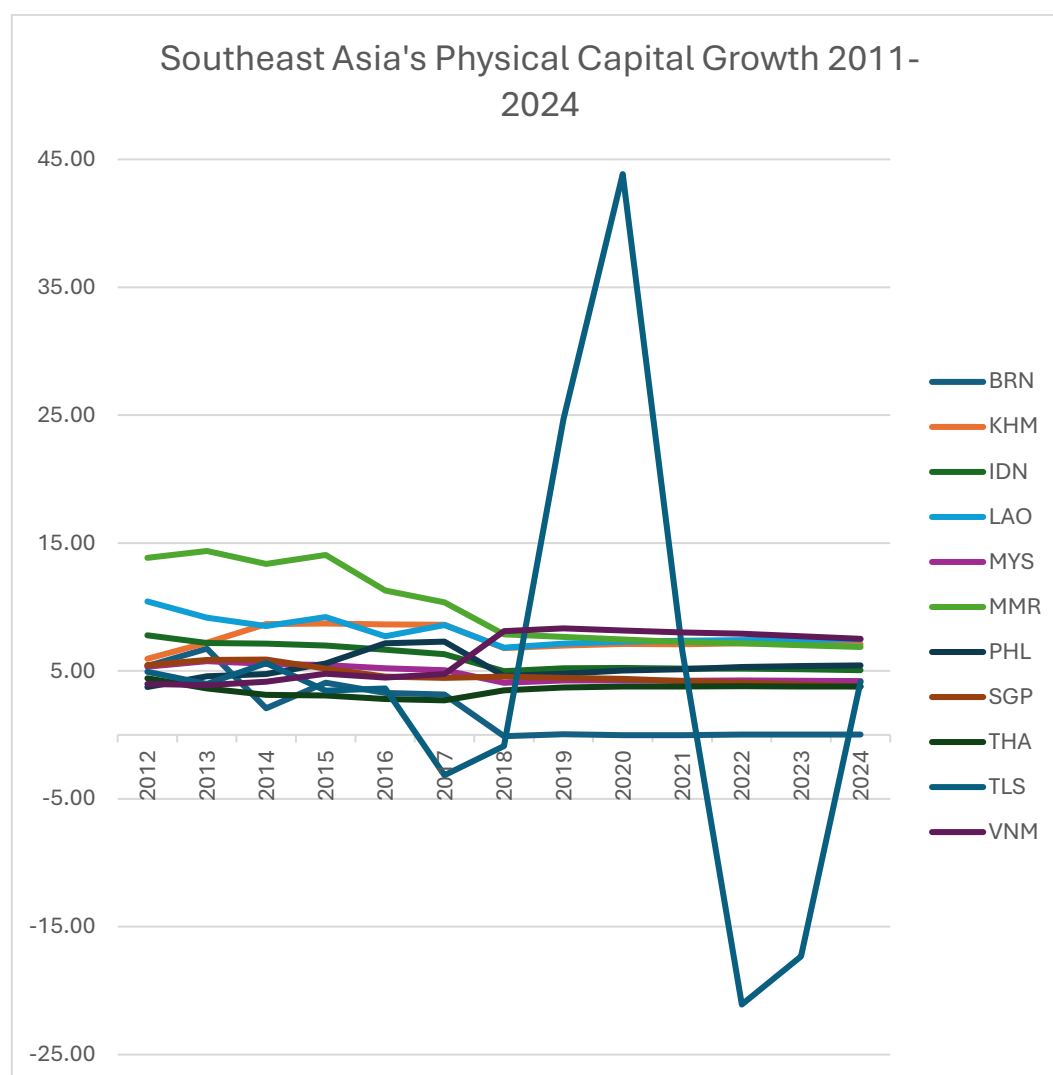


Figure 05.04: Southeast Asia's Physical Capital Growth 2011-2024 (Author's own calculations)

Early years in the dataset, particularly 2011–2015, reveal high rates of capital accumulation across the region, perhaps mirroring a post-global financial crisis surge in investment, infrastructure spending, and booming foreign direct investment inflows.

Diving deeper, the table reveals pronounced heterogeneity in performance among the member states. Countries such as **Cambodia, Lao PDR, and Myanmar** routinely display higher-than-average physical capital growth, a testament to their stage of economic development. These economies are characterised by rapid industrialisation from a low initial capital base, resulting in double-digit annual growth for several years. The data suggest that domestic political instability in **Myanmar** appears to exert a detrimental impact on its rate of physical capital accumulation after 2021.

Indonesia and Vietnam, two of the region's largest economies by population and output, also posted impressive and consistent gains. **Indonesia**'s robust domestic market, natural resource endowments, and strong policy focus on infrastructure propelled it to outperform much of the region, particularly in the years preceding and immediately following the COVID-19 pandemic. **Vietnam** stands out for the speed of capital accumulation, especially since 2018. Such an impressive performance since 2018 might indicate that Vietnam has benefited from the trade war between the US and China, as shown in Chapter 03.

A resource-constrained **Singapore** is a persistent underperformer. Yet, Singapore's capital productivity, perhaps in high-value sectors like R&D and advanced manufacturing, remains regionally unparalleled, pointing to the difference between absolute growth rates and capital quality. In contrast, **Brunei**, an oil-rich nation, often shows negative or tepid growth in physical capital

Thailand, Malaysia and the Philippines, all considered as upper-middle-income economies, generally post growth rates below or close to the regional average but seldom dominate in year-on-year rankings. Notably, **the Philippines'** performance in the post-pandemic period was unexpectedly above the group's performance.

6.2.5 Arable Land

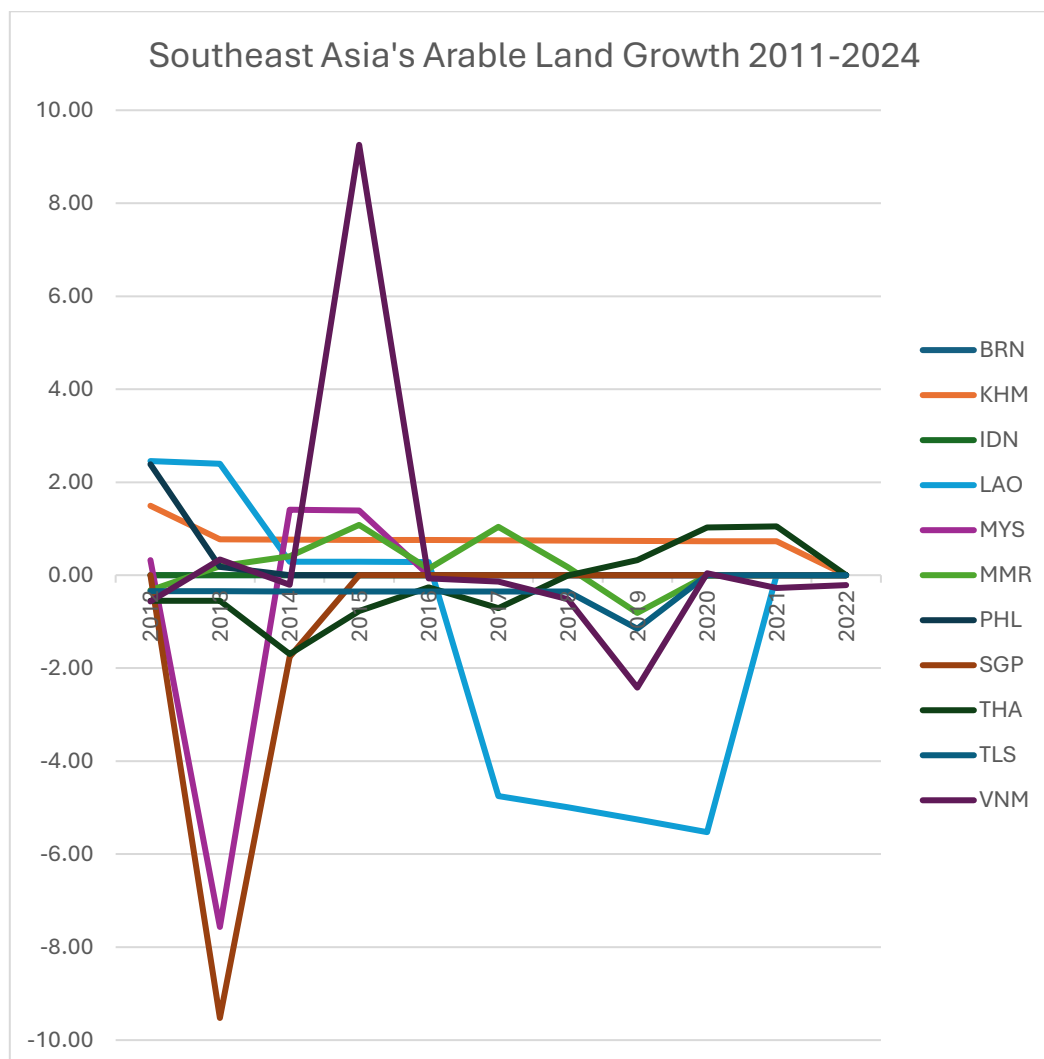


Figure 05.05: Southeast Asia's Arable Land Growth 2011-2024 (Author's own calculations)

The scope of this section is necessarily restricted to the period spanning 2011 to 2022, as comprehensive data for the complete required dataset is currently available on the Food and Agriculture Organisation (FAO)'s website only up to the year 2022 (Also see Table 05.05 in the Appendix).

Cambodia, Myanmar, the Philippines, and Vietnam form a group with positive cumulative growth; all other regional countries, excluding Indonesia and Brunei, exhibit negative values over the period. It is immediately clear that the positive momentum in these four outperforming

countries is not only sufficient to lift their respective national arable land totals, but, critically, exerts enough of a pull to tip the overall regional figure into positive territory. Without their expansion, Southeast Asia as a whole would have recorded net contraction in arable land, demonstrating how a handful of dynamic cases can shape regional aggregates.

Vietnam's case is unique with one truly outstanding anomaly: the year 2015, when Vietnam posted an extraordinary surge in arable land growth of nearly 10%. This single-year expansion exceeds any other annual growth figure recorded in the dataset, not only for Vietnam but for any country in the region.

The negative growth group, on the other hand, serves as an indicator of both early and late demographic-economic transition in Southeast Asia. Countries like **Laos**, often grouped with Cambodia because of early-period developmental similarities, actually conclude the 2011–2022 period with a substantial net contraction in arable land of over 14%. During the observed period, **Singapore**, a mature economy, recorded its most significant single-year decline in arable land in 2013, registering a reduction of nearly 10%. In contrast, **Brunei and Indonesia** maintained a stable arable land area, with zero growth throughout the entirety of the analysis.

6.3 Southeast Asia and key trading partners

6.3.1 Real GDP

The attached figure documents annual real GDP growth rates for ten major countries and regions, from 2011 to 2024. Table 05.06 (See Appendix)'s first row details the sequence of years, while the last row presents data for the world as a whole, serving as a pivotal benchmark for all comparative assessments. Each cell highlighted in green signals that the country or region's growth for that year surpassed the global average.

Looking across the fourteen years, a number of structural patterns are immediately evident. The global economy, as measured in the last row, experienced moderate but steady growth for most years before 2020, reflecting a broadly expansionary post-crisis environment until the disruptive COVID-19 pandemic. In 2020, the world economy contracted by -2.88%, followed by a strong rebound of 6.35% in 2021. This sequence, the sharp global downturn and

subsequent recovery, represents the defining shock of the period, with ramifications for every region. Taken as a whole, the world economy grew by 43.56% between 2011 and 2024.

Amid this shifting landscape, the table highlights a pronounced divergence in economic performance. **China & Hong Kong** stand out with the single most impressive cumulative growth rate of 114.71% over the period, more than doubling their aggregate output. While China's annual growth rates decline gradually from a torrid 7.66% in 2011 to a more modest 4.95% in 2024, they remain systematically higher than the global average. This outperformance is especially notable in the years leading up to the pandemic, but China's economy also led the global recovery in 2021, posting an extraordinary 8.41% growth rate, well above the world average. Growth slowed in 2019, which could be partly explained by President Trump's new tariffs on China.

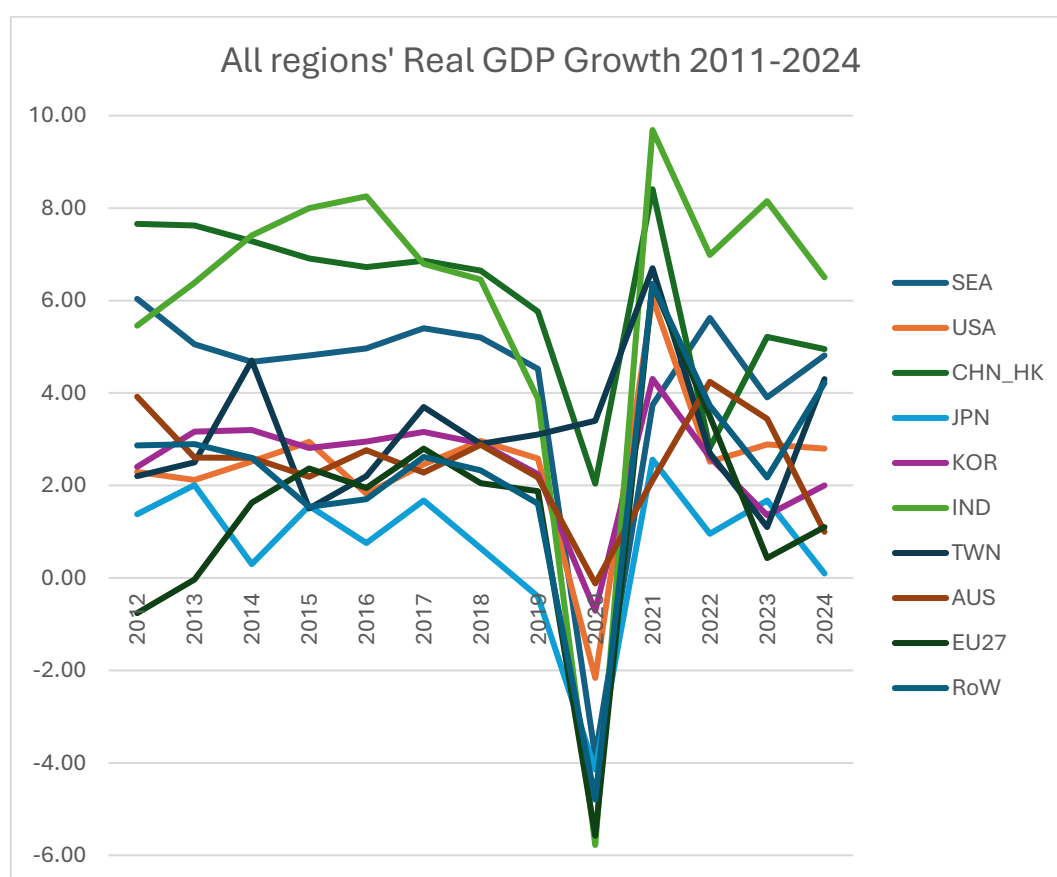


Figure 05.06: All regions' Real GDP Growth 2011-2024 (Author's own calculations)

India demonstrates a similarly powerful performance, with total growth of 111.89%, also more than doubling GDP over the period. India consistently posts annual growth rates that eclipse global benchmarks, especially during the mid-2010s, peaking with several years above 7% or 8%. Its rapid rebound from the pandemic's contraction is striking after a sharp -5.78% contraction in 2020, Indian growth surged to 8.95% in 2021, underlining the country's growing importance as a driver of global growth.

Southeast Asia emerges as another notable outperformer. With a cumulative regional GDP increase of 70.58%, it ranks far above the world average and is consistently marked by frequent green cells. Even as growth rates moderate somewhat in the late 2010s, Southeast Asia remains a dynamic part of the world economy. Most years feature a positive gap over the global average, with recoveries after 2020 particularly robust growth there reaching 5.63% in 2022. This steady, broad-based dynamism might reflect rapid industrialisation, integration into global value chains, and favourable demographics.

Turning to the more advanced economies, a stark contrast emerges. The **United States** posts a cumulative increase of 36.67%, slightly below the world's average. The data illustrate the cyclical, yet stable, nature of U.S. growth, with intermittent years of moderate expansion (such as 2%-3% growth) punctuated by occasional dips below the global rate. Nonetheless, the U.S. economy remains resilient, exemplified by its quick bounce-back to 6.06% growth in 2021 before settling back into moderate territory. Its recovery, though impressive, is more muted in comparison to China and India.

In contrast, the **EU-27** underperforms both the world and other major economies. The European trajectory is characterised by low or even negative annual growth in several years, punctuated by a harsh contraction in 2020 (-5.58%) and only a partial recovery thereafter. Green cells are rare, and the overall picture is one of subdued expansion, a potential reflection of demographic ageing and slower productivity growth.

Japan mirrors this pattern of stagnation, ending the period with just 9.26% total GDP growth, the lowest among the ten. Most years, Japan's growth rate lags the global average, with frequent negative years and only brief outperformance in 2021 (post-pandemic recovery). Structural headwinds, including an ageing population and longstanding deflationary pressures, potentially dominate its growth narrative.

Other advanced economies, such as **Korea, Taiwan, and Australia**, occupy an intermediate position. **Korea and Taiwan** each exhibit around 33% to 49% cumulative growth, consistently

achieving rates above the world average in many years, especially during recovery periods. **Australia** posts a total of 37.17%, competitive but slightly behind global aggregate growth; notable, however, is its resilience, showing only one negative annual growth rate in 2020. The rest of the world shows steady but unspectacular expansion, contributing to the world average but rarely leading it.

In summary, the table's comparative structure and visual cues illuminate the shifting centre of gravity in the world economy over the past decade and a half. The rising giants of Asia, especially China and India, have redefined the landscape, showing robust, sustained, and frequently superior growth. Southeast Asia as a whole, though not at the titanic scale of its neighbours, also emerges as a consistent outperformer.

6.3.2 Population

The figure presented provides a longitudinal, comparative perspective on population growth trends for ten regions spanning from 2011 to 2024 (Also see Table 05.07 in the Appendix).

From 2011 to 2024, the world's annual population growth rate shows a slow but clear deceleration, falling from about 1.27% in the early 2010s to below 1% by the early 2020s. Over the entire period, the world's cumulative population growth is 14.69%, which serves as a crucial benchmark.

Turning to regional trends, clear divergences emerge. **India**, the current most populous nation, stands out as one of the most robust demographic drivers among the set, boasting a total population increase of 14.84% during 2011–2024. India's annual growth rates persistently surpassed the world average until 2019 but gradually slowed, dropping below 1% since 2020.

Southeast Asia and the Rest of the World also register strong performances. **Southeast Asia** grows by 13.83% over the period, tracking closely with the world average, with a modest but steady downward trend in annual rates. **Rest of the World** posts the highest cumulative growth in the table at 22.95%, substantially boosting the global average and potentially reflecting persistent high growth in regions such as Sub-Saharan Africa and parts of South Asia. **Australia**, an advanced country, unexpectedly demonstrated high growth over the period, 20.68%, the second highest among all regions. Australia's annual figures are frequently well above the global average, potentially reflecting a continued openness to migration and somewhat higher fertility than most industrialised nations.

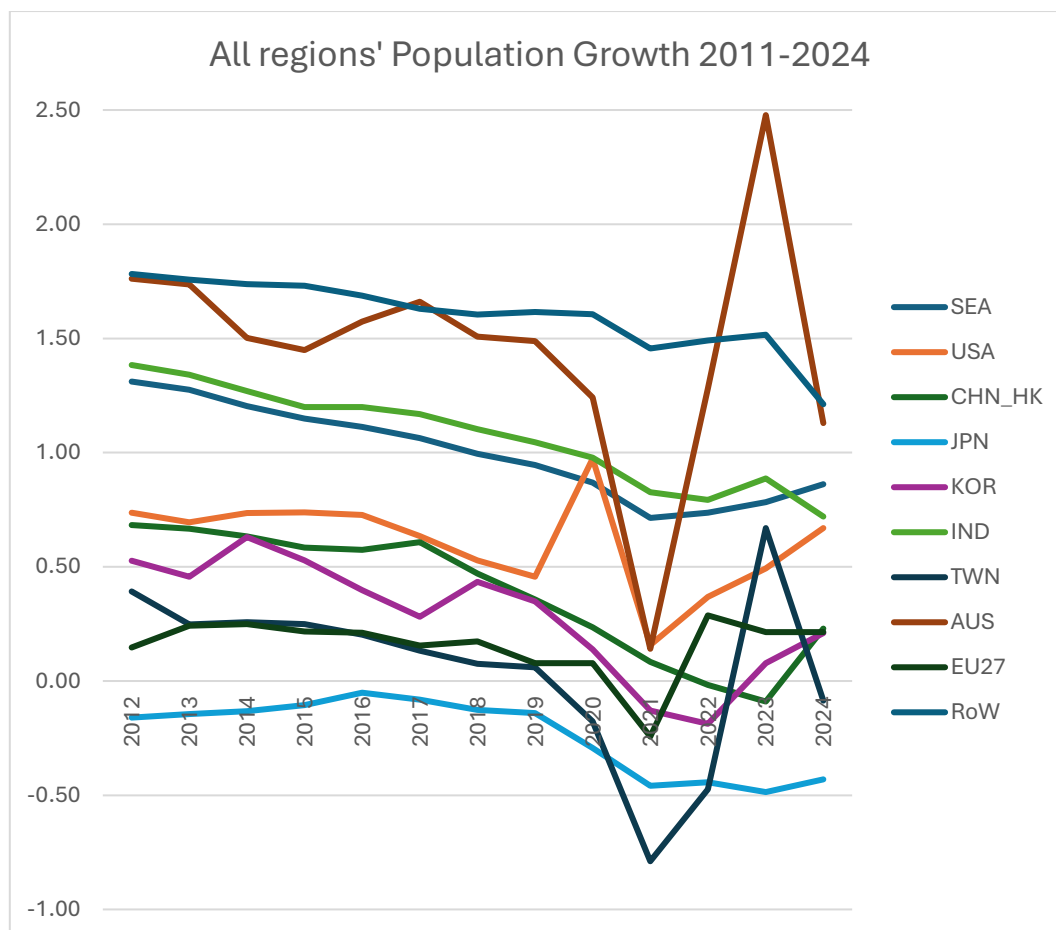


Figure 05.07: All regions' Population Growth 2011-2024 (Author's own calculations)

China & Hong Kong persistently underperformed the world's averages. By the early 2020s, China's population unexpectedly entered a negative growth territory, as evident in recent data for 2023 and 2024 showing -0.23% and -0.31%, respectively. The cumulative growth for 2011–2024 is a mere 5.13%. **The US** did not perform well either, posting just above 8%.

Japan and South Korea represent advanced economies at an even more pronounced demographic crossroads. **Japan** registers a total population decline of -3.11% for the period; virtually every year is in negative territory, with notable contraction from 2018 onward. **South Korea**, while not yet experiencing negative total population growth, shows cumulative growth of 3.77%, also indicating demographic contraction in the 2020s. Both countries highlight the demographic challenges facing developed Northeast Asia, ageing populations. The **European Union** and **Taiwan** also share this profile, with **the EU** growing only 2.48% and **Taiwan** a

mere 0.75% from 2011 to 2024. Their annual growth rates hover well below the global standard, and recent years show a decline.

In summary, the main axes of demographic change in the world since 2011 are as follows, India and Southeast Asia remain strongholds of population growth. Meanwhile, China has transitioned from positive to negative population growth within this window, marking a historic demographic turning point. In contrast, Japan, Korea, Taiwan, and the EU-27 are all firmly in the low or negative growth category, typifying the challenges of post-industrial societies struggling with shrinkage.

6.3.3 Labour Force

Figure 05.08 presents a comprehensive view of annual labour force growth across ten countries and regions from 2011 to 2024. The Table 05.08's horizontal axis (see Appendix) runs from 2011 to 2024, with each cell in a row corresponding to a specific year's growth rate for that country or region. The bottom row gives the global average labour force growth for each year, functioning as a baseline for comparison.

One of the first trends apparent from the table is the overall global deceleration of labour force growth. The world's annual labour force expansion slows slightly over the period, echoing broader demographic trends where population ageing, falling fertility, and, in many advanced economies, stagnating or shrinking populations create downward pressure on labour force participation.

Within this context, striking divergences emerge at the regional and national level. **Rest of the World** routinely posts higher-than-average growth rates. Its cumulative labour force expansion from 2011 to 2024 is substantially higher than that of other regions, underscoring the ongoing demographic momentum in regions such as Sub-Saharan Africa and parts of South Asia.

India features as another consistent outlier on the positive end of the spectrum, and its annual labour force growth rates are almost always above the global average. Notably, India's labour force growth picked up pace following the pandemic, averaging 3.36% annually from 2021 to 2024, which is significantly higher than the 1.5% average observed before 2020. Although the exact cause is uncertain, one plausible explanation is that a larger portion of the workforce, previously engaged in informal or unregistered employment, has transitioned into the formal sector to gain access to social security benefits during and after the COVID-19 pandemic.

Southeast Asia also tends to register above-average growth, although its relative performance is more nuanced. In the early 2010s, much of the region regularly surpassed the global average, but as the years passed, green highlights became less frequent. This gradual convergence towards the global mean signals that Southeast Asia, while still youthful compared to much of the developed world, is also entering a phase of slowing labour force expansion. **Australia's** labour force also consistently expands, with several years above the global average, but its pace moderates somewhat toward the end of the period.

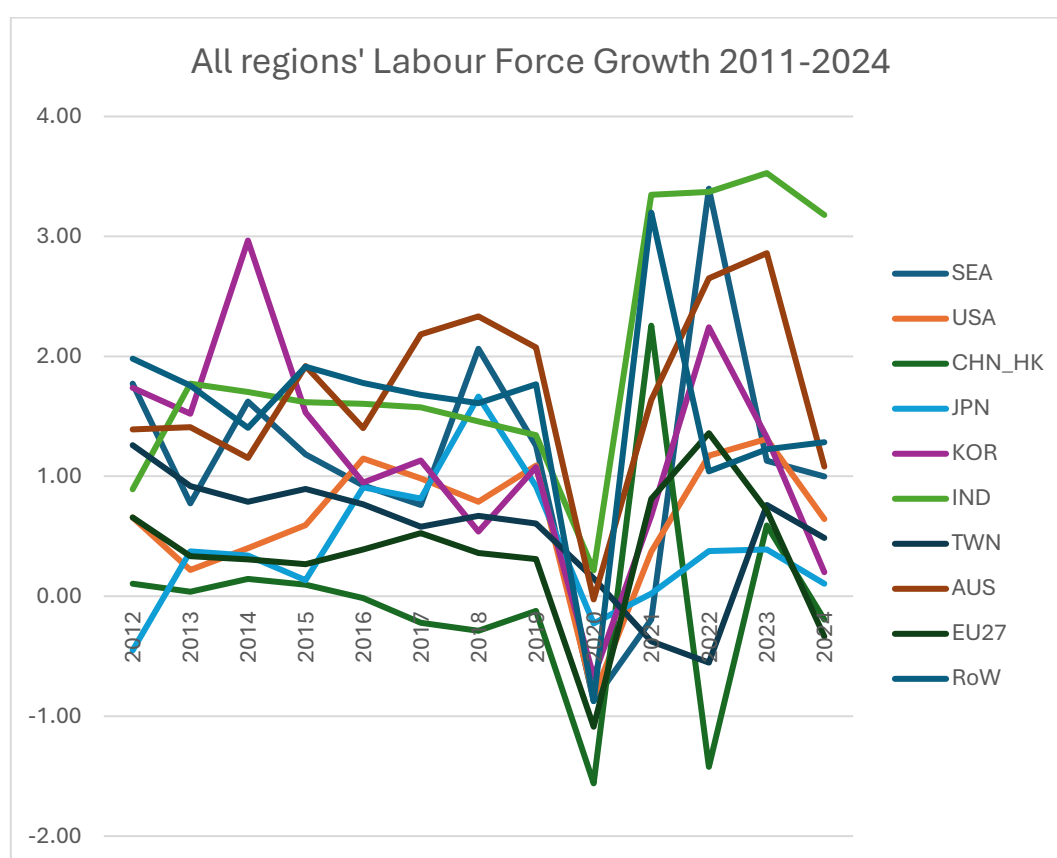


Figure 05.08: All regions' Labour Force Growth 2011-2024 (Author's own calculations)

The US often lags the global growth rate through much of the period. The growth rate remains subdued across the 2012–2015 period and briefly accelerates during 2018–2019 (notably 1.09% in 2019, slightly above the global average of 1.08%). The US recovery is tepid after the start of the COVID-19 pandemic in 2021 (0.37%), especially compared to the world's much stronger rebound (2.30%).

Turning to **China & Hong Kong**, a more nuanced story unfolds in the table. Although China's economy is often lauded for breakneck expansion, the data here show a much more moderate and decelerating trend across this period. Beginning with a near-zero growth rate in 2012 (0.11%), the country's figures have been persistently well below the global average in almost all years. Cumulatively, China & Hong Kong reported a -0.64% change over these fourteen years, meaning that China's labour force was actually below its 2011 level by 2024.

6.3.4 Physical Capital

The figure below provides a rigorous, comparative overview of annual physical capital growth across ten major countries and regions from 2011 through 2024. In these matrices of Table 05.09 (See Appendix), the final rows represent the global average for each year (serving as a dynamic benchmark), while the last column aggregates each entity's cumulative growth over the entire period. Critically, green-highlighted cells mark years when a country or region's physical capital growth outpaces the world average.

To anchor the analysis, it is helpful to partition the dataset into two groups based on the last column: those with above-average cumulative physical capital growth (relative to the world) and those that lag the global aggregate. This distinction immediately reveals striking divergence, both among advanced economies and within the emerging markets.

The above-average group is all led by Asian players, namely **Southeast Asia, China & Hong Kong, India, South Korea and Taiwan**, all of which show remarkably strong and sustained growth in physical capital stock from 2011 to 2024.

Southeast Asia emerges as one of the clear leaders. Not only does SEA show green highlights through all years, but the cumulative 2011–2024 figure stands among the highest in the table (nearly 96%). This reflects a regional focus on infrastructural upgrades, manufacturing capacity expansion, and continued inflows of Foreign Direct Investment even through uncertain global conditions.

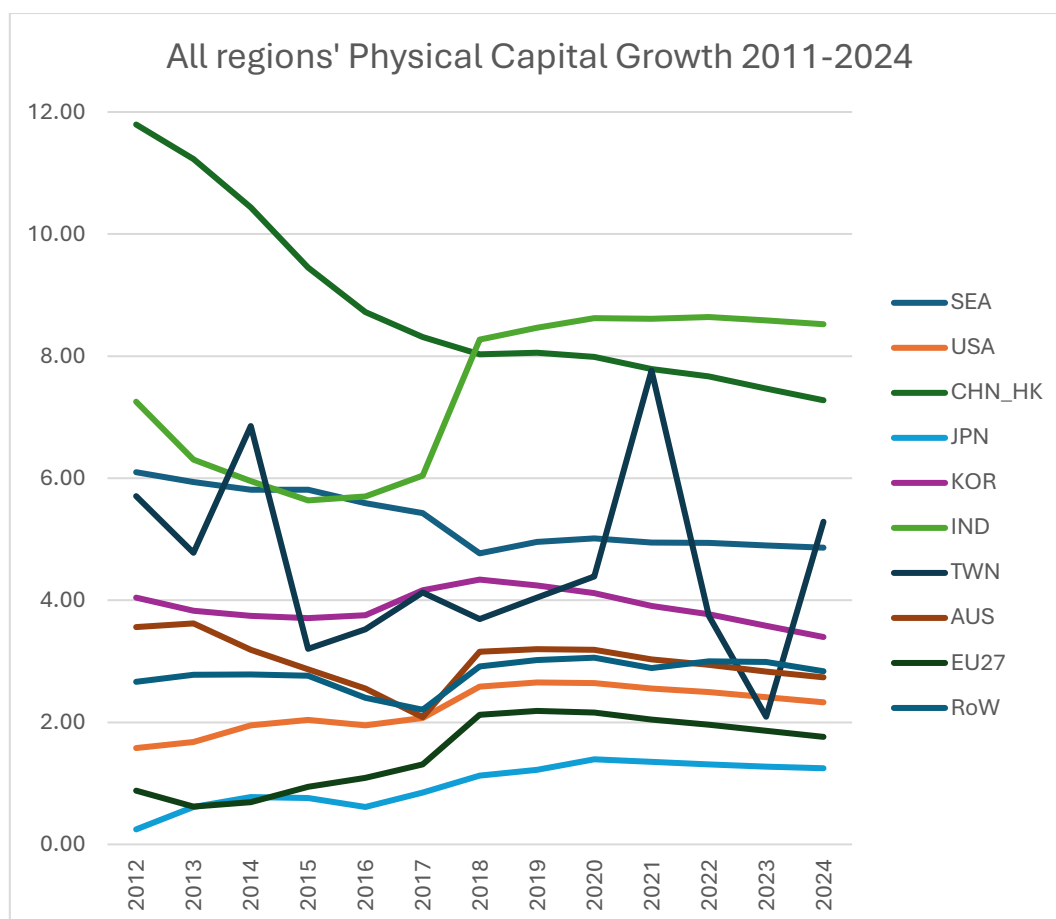


Figure 05.09: All regions' Physical Capital Growth 2011-2024 (Author's own calculations)

China & Hong Kong likewise stand out for exceptional capital formation, with cumulative growth of almost 200%, more than double Southeast Asia's figure. Although the annual growth rates exhibit a declining trend over time, the frequency of green highlights throughout the whole period attests to China's status as a world leader in capital accumulation.

India also belongs to the group of exceptional physical capital growth performers. Across the whole period, India frequently beats the world average, and the final column reflects a substantial cumulative increase (over 153%). The trajectory is one of acceleration, especially in the later years of the period after 2018. Although identifying the primary causes lies beyond the scope of this study, it is plausible that the Sino-US trade war during President Trump's first term has contributed to this shift, accelerating the trend whereby India's physical capital growth surpasses that of China for the first time since 2011.

Taiwan and Korea likewise record some of the highest cumulative growth rates in physical capital, with their performance distinguished by numerous years of above-average growth. This sustained outperformance aligns with their positions as prominent global leaders in high-technology manufacturing and exports, where substantial investments are made in both conventional infrastructure and cutting-edge capital assets. Notably, while many advanced economies experience stagnation, Taiwan and Korea consistently achieve significant capital accumulation.

In contrast, the below-average group, composed of the **United States, Japan, Australia, EU-27, and Rest of the World**, displays a markedly different pattern. Across these countries and regions, cumulative physical capital growth is generally subdued, with fewer green highlights dominating their rows and a greater prevalence of values below or just at the global mean. **The United States** illustrates the tendency toward capital formation moderation in mature economies. While showing positive growth in all years, the overall trend falls behind the world. **The EU-27** and **Australia** both trend toward the global average or (slightly) below, reflecting shared characteristics of advanced economy status that capital formation in these countries, too, might encounter diminishing returns, high maintenance needs, and less scope for breakthrough asset creation in mature economic environments. **Japan**, despite its advanced industrial bases, is similarly characterised by slow and somewhat stagnant capital growth.

6.3.5 Arable Land

The attached figure presents a rich comparative analysis of annual arable land growth for ten major countries and regions from 2011 to 2022 (The complete dataset is only available on FAO's website up to 2022, see Table 05.10 in the Appendix).

A critical interpretive framework emerges when dividing the dataset into two principal groups based on both the sign and magnitude of cumulative growth: (1) regions with above-average and positive cumulative growth, namely **Southeast Asia** and **Rest of the World**, and (2) those with below average (and, in all cases, negative or stagnating) cumulative growth, which encompass the United States, China & Hong Kong, Japan, Korea, India, Taiwan, Australia, and the EU-27.

Southeast Asia distinguishes itself as an exceptional outlier in this dataset. Its total arable land growth of 0.56% over the period not only surpasses the world average for the same period

(0.47%) but defies the near-universal trend of stagnation or decline seen elsewhere, outside the residual RoW category (4.37%). This above-average performance for SEA is largely singular and is, in fact, the product of a striking event: a dramatic one-year expansion in 2015, when the region recorded a 0.97% increase in arable land. Close scrutiny of the annual data reveals that this anomalous surge is almost entirely accounted for by **Vietnam**, which posted an unprecedented near 10% increase in arable land during 2015. This single event not only disrupts Vietnam's own long-term profile but is substantial enough to elevate Southeast Asia's aggregate performance throughout the 2011–2024 period. It stands as a powerful testament to the statistical weight a single country, and indeed a single year, can exert on regional indicators.

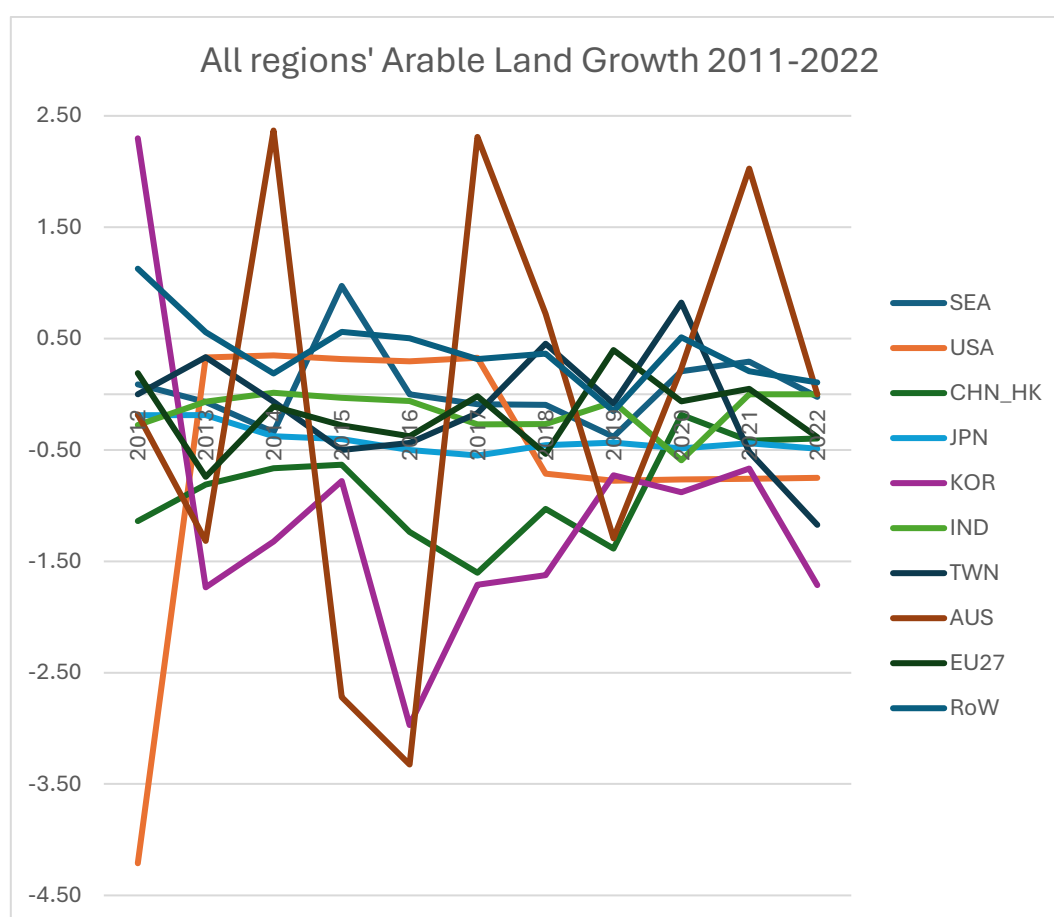


Figure 05.10: All regions' Arable Land Growth 2011-2022 (Author's own calculations)

The **RoW group** also shows a positive and, indeed, relatively strong cumulative increase in arable land by 4.37% over the period, consistently outperforming the world average in most

years. This likely reflects expansion in less developed or emerging economies elsewhere in the world, especially where agricultural extensification remains a route for rural livelihoods and economic growth. Here too, the narrative suggests regional heterogeneity within the global system, with direct agricultural expansion possible mainly on the periphery of the global economy.

By contrast, **the United States** and **the EU-27** show near-zero or slightly negative growth, aligning with mature and post-industrial land-use trends characterised by conversion of farmland into urban, infrastructural or protected uses rather than agricultural expansion. **Australia**'s negative growth also reflects similar pressures, compounded by environmental limits and land degradation. In **China & Hong Kong, Japan,** and **Korea**, regions that underwent major structural transformations in the twentieth and early twenty-first centuries, stagnation or decline in arable land is now common, with policy and demographic realities converging toward either stability or incremental attrition of the agricultural land base. **India**, while often perceived as an expanding agricultural giant, also underperforms global trends in this period. Its growth profile was dampened, possibly by a combination of rural-to-urban migration, consolidation of farming operations, and environmental constraints. **Taiwan** shows only minor annual variations, resulting in a negligible overall change.

In sum, the table reveals a global context where the scope for arable land expansion is increasingly rare and geographically concentrated. Southeast Asia's above-average performance for 2011–2024 is not the product of uniform regional dynamism but rather hinges on Vietnam's extraordinary one-off expansion in 2015. However, the potential for substantial increases in agricultural productivity must also be recognised, as these gains can effectively offset the contemporary reduction in arable land area.

6.4 Final inputs for CGE baseline projections

The two tables presented below detail the necessary inputs for projecting the economic database to the specific base year required for the policy simulations in Chapter 08. Following the initial calibration of the GTAP Database v09 to the target base year of 2017, the resulting dataset is saved before executing the second projection stage within the RunGTAP software.

No.	Code	Countries	Real GDP	Population	Labour Force	Physical capital	Area land
			qgdp	pop	qe	qe	qe
01	SEA	Southeast Asia	35.215	7.329	7.240	40.093	0.558
02	USA	United States	15.011	4.345	4.063	11.812	-2.651
03	CHN_HK	China & HK	51.570	3.809	0.147	77.001	-5.937
04	JPN	Japan	7.904	-0.674	2.126	3.917	-2.186
05	KOR	Korea, Republic of	19.038	2.854	10.232	25.616	-6.136
06	IND	India	50.459	7.805	9.519	43.041	-0.690
07	TWN	Taiwan	17.982	1.491	5.313	31.661	-0.836
08	AUS	Australia	17.487	10.083	9.827	19.255	-2.975
09	EU_27	EU_27	8.155	1.228	2.503	5.659	-1.327
10	RoW	Rest of the world	15.075	10.779	10.981	16.647	3.293

Table 05.11: Projections for baseline scenario, 2011 – 2017 (Author’s own calculations)

No.	Code	Countries	Real GDP	Population	Labour Force	Physical capital	Area land
			qgdp	pop	qe	qe	qe
01	SEA	Southeast Asia	26.156	6.055	7.974	39.892	-0.001
02	USA	United States	18.834	3.702	4.606	19.069	-3.707
03	CHN_HK	China & HK	41.660	1.275	-0.788	68.654	-3.371
04	JPN	Japan	1.253	-2.355	3.277	9.277	-2.283
05	KOR	Korea, Republic of	15.598	0.894	5.480	30.773	-5.492
06	IND	India	40.830	6.529	17.585	77.375	-0.928
07	TWN	Taiwan	26.755	-0.725	1.747	35.335	-0.506
08	AUS	Australia	16.754	9.627	13.275	23.095	1.668
09	EU_27	EU_27	9.715	0.804	2.130	14.984	-0.540
10	RoW	Rest of the world	16.280	10.985	9.575	22.644	1.043

Table 05.12: Projections for baseline scenario, 2017 – 2024 (Author’s own calculations)

6.5 Conclusion

This chapter details the methodology employed for the collection of macroeconomic data, including key variables such as GDP, population, labour force, physical capital, and arable land. These data points are essential for the rigorous process of calibrating and projecting the GTAP Database v09 to the required base year. This ensures the data is temporally relevant and accurately prepared for subsequent policy simulations within the model.

Based on the collected data, a comprehensive processing and analytical phase, using Microsoft Excel, was undertaken to offer the reader a thorough understanding of the economic structure and performance across the ten studied countries and regions. Notably, the aggregate analysis

demonstrates that Southeast Asia as a whole exhibited exceptionally strong performance across all five macroeconomic criteria, indicating a robust baseline economic state.

However, a critical final data requirement, the relevant tariff rates, still necessitates collection and meticulous calculation. Integrating these tariff data is indispensable for ensuring the baseline scenarios are as accurate a representation of the real-world trade environment as possible. The subsequent chapter will therefore be dedicated to discussing this final dataset required for the projection of the baseline scenario.

7 Chapter 07 – Data: Tariff Rates

7.1 Introduction

This chapter initiates the final stage of data preparation for the CGE analysis. While Chapters 05 and 06 outlined the process for updating the core GTAP v09 database and the macroeconomic aggregates necessary for the 2017 and 2024 base year projections, an equally critical step involves meticulously updating bilateral tariff rates. This revision is essential to accurately represent the structure of global trade and ensure the model captures the significant shifts in trade barriers that occurred over the last fifteen years. Crucially, this period includes the tumultuous trade policy environment during the first term of President Trump, which saw sharp increases in tariffs, especially with China, amidst a broader global trend.

Despite these targeted increases, the general trend observed between 2011 and 2024 has been a gradual, broad-based reduction in bilateral tariff rates across most regions of the world. Therefore, simply relying on the dated GTAP v09 tariff structure would introduce systemic bias into the baseline equilibrium. To mitigate this, a sophisticated methodology is required, as introduced in Chapter 04, to gather and process recent tariff data, thereby ensuring the model accurately reflects the net effect of these opposing policy forces, the general trend toward liberalisation versus specific instances of protectionism.

7.2 Regional Tariff Structures in 2017 and 2024

Chapter 04 details the specific procedures employed for data collection and calculation of these updated tariffs. This includes identifying reliable external data sources and outlining the computational steps used to translate raw tariff data into the model-compatible format. The R programming language, with the author's own code, is employed to facilitate such computation. This highly detailed and methodologically rigorous approach to tariff calculation is paramount, as this refined data will directly inform the model's base-year calibration before the execution of the policy simulations specified in the research agenda of Chapter 01. In addition, some limitations of the methodological approach used in this chapter have also been highlighted.

This section will delineate the tariff structure by specifying the rates imposed by each country or region under investigation on all other partners, as well as on the rest of the world, projected

through the close of 2017 and then 2024. In the subsequent tables, the entity imposing the tariffs is referred to as the "**Reporter**" and is identified in the top row.

For bilateral trade flows where tariff rates were not sourced from the MacMap database, the existing tariff rates from the GTAP Database v09 were employed. The use of this legacy data source is flagged by adding the notation "*GTAP v09*" in the top row. For the United States and China, where supplemental tariff rates required calculation, the author's derived figures were integrated into the existing v09 database and are consequently designated with "*OC*" (Own Calculation) in the top row. While the reporter column should theoretically contain zeros, reflecting that countries do not impose tariffs on their own trade, non-zero entries may still be observed in certain tables. This anomaly results from the aggregation of multiple countries or regions into a single entity, as is the case for composite groups like SEA, the grouping of CHN_HK, and the RoW aggregate. All tariff values different from zero are highlighted in the red colour.

This section only presents the tariff levels for the US, China and Southeast Asia. For other seven regions, please see the Appendix for detailed tariff levels.

					Reporter	GTAP v09					GTAP v09	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		China & HK	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.273	6.809	0.001	2.960	6.706	8.492	5.484	17.746	2.959	3.807	55.235
2	MeatLstk	Livestock and Meat Products	2.711	6.140	0.021	4.720	2.080	4.985	1.130	8.272	7.650	9.297	47.005
3	Extraction	Mining and Extraction	0.002	0.052	0.012	2.571	0.670	0.778	0.000	0.104	0.501	0.863	5.553
4	ProcFood	Processed Food	5.168	1.004	0.386	5.101	13.745	8.889	4.917	7.570	8.114	9.756	64.650
5	TextWapp	Textiles and Clothing	4.579	3.941	0.030	7.829	5.375	2.139	0.120	4.133	5.970	7.157	41.274
6	MotorVehicl_Parts	Motor vehicles and parts	3.921	2.455	0.050	14.872	12.038	4.126	2.539	6.881	21.993	18.634	87.509
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.601	1.314	0.131	6.342	3.818	4.612	0.139	0.697	2.955	4.812	25.420
8	Iron_Steel	Iron and Steel	0.256	0.738	0.011	4.020	4.136	2.808	0.000	2.448	2.217	4.710	21.344
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.342	1.139	0.015	5.372	2.176	1.509	0.263	2.745	4.098	5.054	22.712
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			17.854	23.591	0.657	53.787	50.744	38.337	14.592	50.595	56.457	64.090	370.704

Table 07.03.a: Tariff Structure in 2017 – China & Hong Kong (Author's own calculations)

					Reporter	GTAP v09					GTAP v09/OC	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		China & HK	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.000	6.755	0.001	2.960	4.816	8.492	4.157	17.746	15.116	3.807	63.850
2	MeatLstk	Livestock and Meat Products	0.000	6.134	0.021	4.720	0.144	4.985	1.098	8.272	31.890	9.297	66.562
3	Extraction	Mining and Extraction	0.000	0.042	0.012	2.571	0.310	0.778	0.000	0.104	8.883	0.863	13.563
4	ProcFood	Processed Food	0.210	0.114	0.386	5.101	11.139	8.889	4.872	7.570	25.341	9.756	73.377
5	TextWapp	Textiles and Clothing	0.000	3.834	0.030	7.829	2.284	2.139	0.120	4.133	25.689	7.157	53.215
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.000	0.456	0.050	14.872	10.403	4.126	1.581	6.881	30.690	18.634	87.694
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.000	0.741	0.131	6.342	1.272	4.612	0.117	0.697	9.285	4.812	28.009
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.000	0.474	0.011	4.020	2.955	2.808	0.000	2.448	21.578	4.710	39.004
9	HeavyMnfc_ex_IS	Iron and Steel	0.000	0.546	0.015	5.372	0.938	1.509	0.253	2.745	14.930	5.054	31.361
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			0.210	19.096	0.657	53.787	34.262	38.337	12.199	50.595	183.402	64.090	456.634

Table 07.03.b: Tariff Structure in 2024 – China & Hong Kong (Author's own calculations)

								GTAP v09	Reporter			GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		Southeast Asia	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	0.228	8.522	1.534	0.207	1.581	2.247	4.983	3.516	1.336	17.439	41.592
2	MeatLstk	Livestock and Meat Products	2.634	1.412	0.752	2.101	0.078	4.472	0.934	5.068	5.272	6.987	29.710
3	Extraction	Mining and Extraction	0.045	0.009	0.316	0.063	0.003	1.147	0.025	2.225	0.354	2.889	7.076
4	ProcFood	Processed Food	2.725	5.995	4.035	2.798	4.871	8.203	1.573	12.329	5.308	13.597	61.435
5	TextWapp	Textiles and Clothing	0.462	3.382	2.718	1.358	0.703	8.741	0.253	2.725	2.952	8.944	32.239
6	MotorVehicl_Parts	Motor vehicles and parts	1.078	3.547	4.908	9.861	9.855	15.890	0.094	9.770	2.424	16.823	74.250
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.217	0.218	1.273	1.303	1.186	9.843	0.128	1.342	0.319	3.639	19.468
8	Iron_Steel	Iron and Steel	0.126	0.223	1.046	1.290	2.301	10.960	0.094	2.443	0.987	5.409	24.879
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.202	0.195	0.679	0.275	0.347	2.361	0.242	0.599	0.403	2.467	7.770
10	Util_Cons	Utilities and Construction	0.000	0.160	0.000	0.000	0.222	0.000	0.658	0.000	0.250	0.000	1.290
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			7.717	23.663	17.262	19.256	21.147	63.864	8.984	40.018	19.604	78.194	299.710

Table 07.07.a: Tariff Structure in 2017 – Southeast Asia (Author's own calculations)

								GTAP v09	Reporter			GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Southeast Asia	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	0.187	7.615	1.513	0.080	1.577	2.247	4.173	2.606	1.233	17.439	38.672
2	MeatLstk	Livestock and Meat Products	1.948	0.181	0.388	1.848	0.068	4.472	0.023	3.265	5.224	6.987	24.404
3	Extraction	Mining and Extraction	0.035	0.008	0.138	0.031	0.003	1.147	0.020	1.931	0.317	2.889	6.518
4	ProcFood	Processed Food	2.054	4.997	3.621	1.432	4.739	8.203	1.018	12.031	3.714	13.597	55.407
5	TextWapp	Textiles and Clothing	0.016	2.993	1.162	0.229	0.269	8.741	0.000	1.905	2.943	8.944	27.203
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.409	1.201	3.987	9.222	9.036	15.890	0.000	9.568	2.102	16.823	68.237
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.114	0.030	0.769	0.907	0.364	9.843	0.004	1.029	0.219	3.639	16.917
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.063	0.070	0.885	1.033	2.269	10.960	0.000	2.202	0.232	5.409	23.123
9	HeavyMnfc_ex_IS	Iron and Steel	0.153	0.085	0.379	0.095	0.214	2.361	0.127	0.496	0.164	2.467	6.540
10	Util_Cons	Utilities and Construction	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.261
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			4.980	17.190	12.843	14.876	18.540	63.864	5.365	35.032	16.399	78.194	267.282

Table 07.07.b: Tariff Structure in 2024 – Southeast Asia (Author's own calculations)

					GTAP v09			GTAP v09			Reporter	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		United States	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	0.018	0.363	1.398	0.532	0.008	1.799	0.150	0.089	0.000	1.849	6.206
2	MeatLstk	Livestock and Meat Products	4.184	0.548	0.737	5.172	0.000	0.330	0.083	0.557	0.000	1.202	12.813
3	Extraction	Mining and Extraction	0.000	0.000	0.286	0.005	0.191	0.214	0.003	0.000	0.000	0.122	0.820
4	ProcFood	Processed Food	2.169	1.929	2.831	1.950	0.806	3.764	0.828	0.784	0.000	2.656	17.717
5	TextWapp	Textiles and Clothing	0.001	2.776	10.480	1.421	0.935	10.483	8.554	9.228	0.000	7.824	51.702
6	MotorVehicl_Parts	Motor vehicles and parts	0.000	0.038	0.863	0.991	2.081	0.943	0.432	0.037	0.000	1.139	6.525
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.000	0.030	4.403	0.140	0.435	2.518	1.253	0.271	0.000	1.070	10.120
8	Iron_Steel	Iron and Steel	0.000	0.009	1.031	0.000	0.174	0.276	0.106	0.007	0.000	0.210	1.813
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.000	0.041	1.091	0.183	0.512	0.857	0.060	0.299	0.000	1.168	4.211
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			6.372	5.734	23.120	10.393	5.141	21.184	11.470	11.271	0.000	17.240	111.926

Table 07.10.a: Tariff Structure in 2017 – United States (Author’s own calculations)

					GTAP v09/OC			GTAP v09			Reporter	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		United States	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.000	0.357	20.518	0.019	0.002	1.799	0.149	0.089	0.000	1.849	24.782
2	MeatLstk	Livestock and Meat Products	0.000	0.109	14.622	1.781	0.000	0.330	0.025	0.557	0.000	1.202	18.625
3	Extraction	Mining and Extraction	0.000	0.000	8.227	0.000	0.000	0.214	0.000	0.000	0.000	0.122	8.563
4	ProcFood	Processed Food	1.535	1.801	23.519	0.477	0.004	3.764	0.656	0.784	0.000	2.656	35.196
5	TextWapp	Textiles and Clothing	0.001	2.776	19.153	1.196	0.129	10.483	8.121	9.228	0.000	7.824	58.911
6	MotorVehicl_Parts	Motor vehicles and parts	0.000	0.038	23.727	0.979	2.081	0.943	0.321	0.037	0.000	1.139	29.265
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.000	0.030	16.491	0.001	0.424	2.518	1.173	0.271	0.000	1.070	21.977
8	Iron_Steel	Iron and Steel	0.000	0.009	29.044	0.000	0.171	0.276	0.061	0.007	0.000	0.210	29.777
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.000	0.041	14.241	0.045	0.435	0.857	0.046	0.299	0.000	1.168	17.131
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			1.536	5.161	169.541	4.497	3.246	21.184	10.552	11.271	0.000	17.240	244.228

Table 07.10.b: Tariff Structure in 2024 – United States (Author’s own calculations)

The final column and final row of each table above represent the aggregate tariff imposition on each sector and each partner country/region, respectively. While these non-weighted sums may not fully capture and, to some extent, distort the nuanced picture of global bilateral trade flows, the figures nonetheless provide a useful preliminary indication of which countries generally maintain lower tariff levels and which ones employ a relatively higher degree of protection.

The data presented in Table 07.11 below, for 2024, illustrates the heterogeneity in tariff imposition across the sampled regions. Australia exhibits the lowest overall level of trade protection, with the United States ranking second. Given the persistent and escalating US trade deficits observed over the past three decades (Federal Reserve Bank of St. Louis, 2025)¹⁰⁹, this low-tariff position lends credence to the trade concerns articulated by President Trump during both his administrations. Conversely, India and South Korea maintain high levels of trade protection, albeit driven by distinct sectoral concentrations. In South Korea, the elevated protection primarily stems from exceptionally high tariffs, often exceeding 100%, applied to Grains and Crops, while other sectors face very low duties. In contrast, India's high protection is more pervasive, notably affecting multiple sectors, particularly Processed Food and Light Manufacturing (excluding motor vehicles) as of 2024. Southeast Asia maintains relatively low level of tariffs, ranked 4th among ten regions. Even though, SEA has reduced its tariff levels in general during the studied period, SEA still imposes high tariffs for Processed Food and Motor Vehicles. China & Hong Kong region has relatively high tariff levels overall, entirely due to its retaliations against the US's tariffs.

Country	Non-weighted Total Tariffs
Australia	149.125
United States	244.228
EU_27	249.052
Southeast Asia	267.282
Japan	342.005
Taiwan	390.976
Rest of the world	428.495
China & HK	456.634
India	1026.258
Republic of Korea	1067.008

Table 07.11: Non-weighted Total Tariff Levels in 2024 (Author's own calculations)

¹⁰⁹ Federal Reserve Bank of St. Louis. Trade Balance: Goods and Services, Balance of Payments Basis (BOPGSTB). Available at: <https://fred.stlouisfed.org/series/BOPGSTB>. Accessed on 09-Nov-2025.

7.3 Regional Tariff Structures in 2025

On 02 April 2025, also known as the Liberation Day, President Donald J. Trump announced reciprocal tariffs¹¹⁰ on 57 trading partners of at least 11% (Annex I, see Table 07.12 below) while any other countries face a 10% tariff. According to the official US Trade Representative department, reciprocal tariff is defined as “*the tariff rate necessary to balance bilateral trade deficits between the U.S. and each of our trading partners*” ranging from 9% to 99%. While the trade war has been widely expected between the US and China and also between the US and a few other partners following Donald J. Trump’s first presidency, this is the first time such comprehensive and systematic tariff measures have been announced. Southeast Asia seems to be the most impacted region with Myanmar being charged additionally 44%, Vietnam (46%), Laos (48%), Cambodia (49%). Given that Vietnam has the third largest trade surplus with the US, after China and Mexico, Vietnam’s export-driven economy is expected to be badly hit if this newly announced tariff to go ahead.

The Trump’s administration criticises some models of international trade which assume balanced trades in the long run, despite the fact that the US has been running trade deficit for five decades. Even though no economic models being specified, modern textbook neoclassical models are generally used to explain the above theoretical point. Such a model is briefly explained as follow: when country A (e.g., Vietnam) runs a trade surplus with country B (e.g., the US), country A will then receive a net inflow of country B’s currency being used to pay for B’s net import from A which is generally the US dollars, causing an increase in supply of the US dollars within A’s economy. Exporting firms operating in country A also needs to convert those foreign currencies into the domestic ones for its operations such as paying workers, buying materials and paying taxes etc, causing an increase in demand for the domestic currency of country A. Such phenomena with these two currencies lead to an appreciation of the domestic currency of country A against the foreign currency of country B (the US dollar in this case), making country’s A export increasingly more expensive in the longer term but at the same time cheapening country B’s export. As a result, it is expected that country A’s trade surplus with country B would gradually reduce and eventually be eliminated as country A’s currency appreciates. However, whether a country’s own currency depreciation or appreciation would improve and worsen that country’s trade balance might depend on several factors, one

¹¹⁰ The White House’s executive order announcement on reciprocal tariff: <https://www.whitehouse.gov/presidential-actions/2025/04/regulating-imports-with-a-reciprocal-tariff-to-rectify-trade-practices-that-contribute-to-large-and-persistent-annual-united-states-goods-trade-deficits/>. Accessed on 05-Apr-2025.

of which is the widely known Marshall Lerner condition (Rose and Yellen, 1989). However, the discussion of these models and conditions are beyond the scope of this research.

To explain for such divergence between theory and reality, both tariffs and non-tariff economic factors were pointed out by the Trump's administration such as differences in regulations, tax rates, currency manipulation.

7.3.1 President Trump's mathematical approach to reciprocal tariffs

The foundation for President Trump's recent tariff cardboard announcement relies on the following formula ¹¹¹ which, as acknowledged by the administration, to only proxy for the tariff rates which could drive the US's persistent trade deficits to zero with individual trade partners.

$$\Delta \tau_i = \frac{x_i - m_i}{\varepsilon \times \varphi \times m_i}$$

In which τ_i is a tariff imposed by the US on country i and $\Delta \tau_i$ demonstrate the tariff rate change. The price elasticity of import demand is represented by ε with $\varepsilon < 0$ while a positive φ represents the elasticity of import prices with respect to tariffs or the passthrough rate to import price due to higher tariffs. The total export by the US to country i is recorded in x_i while the US's import from country i is shown in m_i .

ε is estimated using trade data published by the US Census Bureau for 2024 and currently calculated at 4. While the long-run rate of only 2 for the price elasticity of import demand was estimated by Boehm et al (2023), the Trump's administration deliberately ("*to be conservative*") relied on studies with higher value for the price elasticity of import demand. φ is estimated to 0.25, with Cavallo et al (2021)'s study was referenced upon. Technically speaking, with the chosen values for ε and φ of 4 and 0.25 respectively, the two parameters cancel out each other which means that President Trump's newly announced tariffs only rely on the reduced formula which basically represents the ratio between the US's trade deficit with country i over its import from country i and then divide it for 2. However, since the US has

¹¹¹ Office of the United States Trade Representative. Reciprocal Tariff Calculations. Available at: <https://ustr.gov/trade-topics/presidential-tariff-actions>. Accessed on 15-Apr-2025.

trade deficits with most countries, $x_i - m_i < 0$, hence only absolute values of $x_i - m_i$ are accepted.

$$\Delta \tau_i = \frac{|x_i - m_i|}{m_i} \div 2 = \frac{|x_i - m_i|}{2m_i}$$

Based on this reduced formula, the tariff for Vietnam is calculated as follow: $x_i = 13.1$ bn USD and $m_i = 149.6$ bn USD (both in 2024)¹¹². Hence

$$\Delta \tau_i = \frac{|13.1 - 149.6|}{2 \times 149.6} = 0.456 \approx 46\%$$

However, as mentioned earlier, the choice of parameters would play a major role in working out the final tariff rates as while the data for trade cannot be randomly chosen, both ε and φ can be set at the Trumpian administration's disposal. For example, if ε were to be set at the long-run rate of 2, while φ remains at 0.25, all announced tariff rates would be doubled, at around 92%. On the other hand, if ε is set at 4 and φ is set at 0.5, all the announced tariff rates would be reduced by a factor of 2 to 23%, which is much closer to the newly announced tariff rate of 20% that Vietnam has successfully negotiated with the President Trump on 02 July 2025¹¹³.

Additionally, like many economic models, certain assumptions need to be employed to simplify the complex nature of the main issue being addressed. For the original model announced by the Trump's administration, two assumptions are specified which disregard the impacts of the changes in “*exchange rate*” and “*general equilibrium effects*”. Firstly, regarding the impacts of the exchange rate, the higher tariffs announced by the US government are expected to discourage the US consumers from buying foreign commodities, which might then lead to reductions in the amount of exports from foreign countries to the US. A lower level of export

¹¹² Office of the United States Trade Representative. Vietnam. Available at: <https://ustr.gov/countries-regions/southeast-asia-pacific/vietnam>. Accessed on 14-Jul-2025.

¹¹³ CNN. “Trump announces a US trade deal with Vietnam”. Available at: <https://edition.cnn.com/2025/07/02/business/trade-deal-vietnam-trump>, accessed on 10-July-2025.

means a lower level of US dollar flow coming into the export countries and therefore lowering the supply for US dollar as well as the demand for the domestic currency to be exchanged for such inflow of the US dollar. As a result, the value of the exporting country's currency is expected to depreciate against the US dollar which in theory makes export from a foreign country more affordable post-tariff for Americans and partly offset the impact of the announced tariffs by the US. In reality, foreign governments could also deliberately depreciate their own currencies to weather their exporting sectors from any tariff shocks, making President Trump's reciprocal tariffs less effective. Secondly, in terms of the negligible general equilibrium assumption, the Trump's team technically assumes that any changes in tariff rates would only impact m_i or import side of the US and not on any other part of the economy, especially its exports. This is a partial equilibrium analysis and oversimplifies the unintended consequences of the new tariffs on the US's export. This can be partly explained as follows: higher tariff rates would make imported factors of production for the US's exporting sectors more expensive which might push up prices of the US exports in order to protect the profit margins of the US exporting companies. Higher US export prices make the US exports less competitive in the international markets and might reduce the overall US exports. However, the final impacts also depend on the elasticity of substitution between domestic, and foreign commodities being used in the US exporting sectors as well as the price elasticity of demand for the US export internationally. If the US exports might fall faster relative to the US import post-tariff, the overall US trade deficit would unintentionally worsen and goes against the initial expectation of President Trump to reduce the US's persistent trade deficits. It is worth noting that both of the assumptions tend to reserve for relatively small economies which have negligible influences on the international market (e.g., price takers). The mighty size of the US economy makes both assumptions somewhat irrational and potentially makes President Trump's trade policy and his basic mathematical approach less reliable.

7.3.2 Other significant tariffs

Given that the temporal scope of this research is confined to policy developments up to and including the announcement of reciprocal tariffs by President Trump on April 2, 2025, any subsequent amendments or adjustments to the prevailing tariff regime enacted after this date fall outside the analytical framework of this study and are therefore excluded from

consideration. This study will also account for the following tariff measures announced in early 2025:

- **A 20% comprehensive tariff on all imports from China** in response to fentanyl-related concerns, effective March 4, 2025.
- **A 25% tariff on all imports from Canada and Mexico** was introduced due to issues related to fentanyl and immigration, also effective March 4, 2025.
- **A 25% tariff applied to all imported motor vehicles**, commencing April 2, 2025.
- **A 25% tariff on steel and aluminium imports**, effective March 12, 2025.

The methodology for determining the reciprocal tariffs applied by the US to the Rest of the World (RoW) grouping, which comprises nations subject to varied tariff rates, requires a weighted aggregation. This was accomplished using UN Comtrade data detailing all US bilateral trade flows alongside the total import value into the US. By leveraging these import values and the officially announced reciprocal tariff rates, a weighted average reciprocal tariff for the RoW was calculated, intentionally excluding the nine specific countries and regions under direct study. This approach simultaneously allows for the accurate incorporation of the 25% blanket tariffs imposed on Canada and Mexico. A similar weighted-average methodology was subsequently applied to calculate the reciprocal tariff rate for the Southeast Asia region. Finally, the specific announced tariffs targeting China, motor vehicles, and steel and aluminium were applied additively atop the 2024 tariff baseline established in the preceding section.

As a reminder, this research will examine four policy scenarios:

- **Scenario 1 (S1):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners, and other trading partners do not retaliate.
- **Scenario 2 (S2):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners (**S1**) and only China retaliates with an equivalent tariff of **34%**.
- **Scenario 3 (S3):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners (**S1**) and China retaliates with an equivalent tariff of **34% (S2)**. Southeast Asia (SEA) also retaliates against the US with an equivalent tariff of **34.44%**.
- **Scenario 4 (S4):** The US under President Trump imposes fully the reciprocal tariffs on all trading partners (**S1**), apart from SEA, and only China retaliates with an equivalent tariff

of 34% **(S2)**. SEA reduces all non-service tariffs to **0%** in exchange for a **2.3 times** reduction from **34.44% to 14.97%**.

Based on the foregoing policy scenarios, only three principal economic entities, the United States, China, and Southeast Asia, are modelled to experience a change in their tariff structures. The precise nature of these changes is detailed across the five subsequent tables.

Country	Reciprocal Tariff	Country	Reciprocal Tariff	Country	Reciprocal Tariff
Lesotho	50%	North Macedonia	33%	Vanuatu	22%
Cambodia	49%	Angola	32%	Côte d'Ivoire	21%
Laos	48%	Fiji	32%	Namibia	21%
Madagascar	47%	Indonesia	32%	European Union	20%
Vietnam	46%	Taiwan	32%	Jordan	20%
Myanmar (Burma)	44%	Libya	31%	Nicaragua	18%
Sri Lanka	44%	Moldova	31%	Zimbabwe	18%
Falkland Islands	41%	Switzerland	31%	Israel	17%
Syria	41%	Algeria	30%	Malawi	17%
Mauritius	40%	Nauru	30%	Philippines	17%
Iraq	39%	South Africa	30%	Zambia	17%
Guyana	38%	Pakistan	29%	Mozambique	16%
Bangladesh	37%	Tunisia	28%	Norway	15%
Botswana	37%	Kazakhstan	27%	Venezuela	15%
Liechtenstein	37%	India	26%	Nigeria	14%
Serbia	37%	South Korea	25%	Chad	13%
Thailand	36%	Brunei	24%	Equatorial Guinea	13%
Bosnia and Herzegovina	35%	Japan	24%	Cameroon	11%
China	34%	Malaysia	24%	Democratic Republic of the Congo	11%

Table 7.12: President Trump's Annex I reciprocal tariff list ¹¹⁴

¹¹⁴ Office of the United States Trade Representative. Presidential Tariff Actions (Annex I). Available at: <https://ustr.gov/trade-topics/presidential-tariff-actions>. Accessed on 02-Apr-25.

					Main Target					Reporter			
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2025		United States	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	10.000	22.607	74.208	24.019	25.002	33.799	34.590	26.089	0.000	21.849	272.163
2	MeatLstk	Livestock and Meat Products	10.000	22.359	68.312	25.781	25.000	32.330	34.466	26.557	0.000	21.202	266.006
3	Extraction	Mining and Extraction	10.000	22.250	61.917	24.000	25.000	32.214	34.441	26.000	0.000	20.122	255.944
4	ProcFood	Processed Food	11.535	24.050	77.209	24.477	25.004	35.764	35.097	26.784	0.000	22.656	282.577
5	TextWapp	Textiles and Clothing	10.001	25.026	72.843	25.196	25.129	42.483	42.561	35.228	0.000	27.824	306.292
6	MotorVehicl_Parts	Motor vehicles and parts	25.000	25.038	48.727	25.979	27.081	25.943	25.321	25.037	0.000	26.139	254.265
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	10.000	22.280	70.181	24.001	25.424	34.518	35.613	26.271	0.000	21.070	269.358
8	Iron_Steel	Iron and Steel	19.958	24.284	67.869	24.922	25.171	26.090	27.580	25.589	0.000	24.564	266.026
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	10.637	22.320	67.848	24.047	25.435	32.775	34.463	26.290	0.000	21.189	265.004
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			117.131	210.214	609.114	222.420	228.246	295.917	304.132	243.844	0.000	206.615	2437.634

Table 07.13: Tariff Structure in 2025 – United States – S1, S2, S3 (Author's own calculations)

						GTAP v09					GTAP v09/OC	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		China & HK	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.000	6.755	0.001	2.960	4.816	8.492	4.157	17.746	49.116	3.807	97.850
2	MeatLstk	Livestock and Meat Products	0.000	6.134	0.021	4.720	0.144	4.985	1.098	8.272	65.890	9.297	100.562
3	Extraction	Mining and Extraction	0.000	0.042	0.012	2.571	0.310	0.778	0.000	0.104	42.883	0.863	47.563
4	ProcFood	Processed Food	0.210	0.114	0.386	5.101	11.139	8.889	4.872	7.570	59.341	9.756	107.377
5	TextWapp	Textiles and Clothing	0.000	3.834	0.030	7.829	2.284	2.139	0.120	4.133	59.689	7.157	87.215
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.000	0.456	0.050	14.872	10.403	4.126	1.581	6.881	64.690	18.634	121.694
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.000	0.741	0.131	6.342	1.272	4.612	0.117	0.697	43.285	4.812	62.009
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.000	0.474	0.011	4.020	2.955	2.808	0.000	2.448	55.578	4.710	73.004
9	HeavyMnfc_ex_IS	Iron and Steel	0.000	0.546	0.015	5.372	0.938	1.509	0.253	2.745	48.930	5.054	65.361
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			0.210	19.096	0.657	53.787	34.262	38.337	12.199	50.595	489.402	64.090	762.634

Table 07.14: Tariff Structure in 2025 – China – S2, S3, S4 (Author's own calculations)

					Main Target					Reporter			
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2025		United States	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	10.000	22.607	74.208	24.019	25.002	33.799	15.123	26.089	0.000	21.849	252.696
2	MeatLstk	Livestock and Meat Products	10.000	22.359	68.312	25.781	25.000	32.330	15.000	26.557	0.000	21.202	246.539
3	Extraction	Mining and Extraction	10.000	22.250	61.917	24.000	25.000	32.214	14.974	26.000	0.000	20.122	236.477
4	ProcFood	Processed Food	11.535	24.050	77.209	24.477	25.004	35.764	15.630	26.784	0.000	22.656	263.110
5	TextWapp	Textiles and Clothing	10.001	25.026	72.843	25.196	25.129	42.483	23.095	35.228	0.000	27.824	286.825
6	MotorVehicl_Parts	Motor vehicles and parts	25.000	25.038	48.727	25.979	27.081	25.943	25.321	25.037	0.000	26.139	254.265
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	10.000	22.280	70.181	24.001	25.424	34.518	16.147	26.271	0.000	21.070	249.891
8	Iron_Steel	Iron and Steel	19.958	24.284	67.869	24.922	25.171	26.090	22.387	25.589	0.000	24.564	260.834
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	10.637	22.320	67.848	24.047	25.435	32.775	15.045	26.290	0.000	21.189	245.587
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			117.131	210.214	609.114	222.420	228.246	295.917	162.722	243.844	0.000	206.615	2296.225

Table 07.15: Tariff Structure in 2025 – United States – S4 (Author's own calculations)

								GTAP v09			Main Target	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Southeast Asia	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.187	7.615	1.513	0.080	1.577	2.247	4.173	2.606	35.673	17.439	73.112
2	MeatLstk	Livestock and Meat Products	1.948	0.181	0.388	1.848	0.068	4.472	0.023	3.265	39.665	6.987	58.845
3	Extraction	Mining and Extraction	0.035	0.008	0.138	0.031	0.003	1.147	0.020	1.931	34.758	2.889	40.959
4	ProcFood	Processed Food	2.054	4.997	3.621	1.432	4.739	8.203	1.018	12.031	38.155	13.597	89.848
5	TextWapp	Textiles and Clothing	0.016	2.993	1.162	0.229	0.269	8.741	0.000	1.905	37.384	8.944	61.643
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.409	1.201	3.987	9.222	9.036	15.890	0.000	9.568	36.542	16.823	102.677
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.114	0.030	0.769	0.907	0.364	9.843	0.004	1.029	34.659	3.639	51.358
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.063	0.070	0.885	1.033	2.269	10.960	0.000	2.202	34.673	5.409	57.564
9	HeavyMnfc_ex_IS	Iron and Steel	0.153	0.085	0.379	0.095	0.214	2.361	0.127	0.496	34.605	2.467	40.981
10	Util_Cons	Utilities and Construction	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.261
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			4.980	17.190	12.843	14.876	18.540	63.864	5.365	35.032	326.365	78.194	577.248

Table 07.16: Tariff Structure in 2025 – Southeast Asia – S3 (Author's own calculations)

								GTAP v09			Main Target	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Southeast Asia	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.187	7.615	1.513	0.080	1.577	2.247	4.173	2.606	0.000	17.439	37.438
2	MeatLstk	Livestock and Meat Products	1.948	0.181	0.388	1.848	0.068	4.472	0.023	3.265	0.000	6.987	19.180
3	Extraction	Mining and Extraction	0.035	0.008	0.138	0.031	0.003	1.147	0.020	1.931	0.000	2.889	6.201
4	ProcFood	Processed Food	2.054	4.997	3.621	1.432	4.739	8.203	1.018	12.031	0.000	13.597	51.693
5	TextWapp	Textiles and Clothing	0.016	2.993	1.162	0.229	0.269	8.741	0.000	1.905	0.000	8.944	24.259
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.409	1.201	3.987	9.222	9.036	15.890	0.000	9.568	0.000	16.823	66.135
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.114	0.030	0.769	0.907	0.364	9.843	0.004	1.029	0.000	3.639	16.699
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.063	0.070	0.885	1.033	2.269	10.960	0.000	2.202	0.000	5.409	22.891
9	HeavyMnfc_ex_IS	Iron and Steel	0.153	0.085	0.379	0.095	0.214	2.361	0.127	0.496	0.000	2.467	6.376
10	Util_Cons	Utilities and Construction	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			4.980	17.190	12.843	14.876	18.540	63.864	5.365	35.032	0.000	78.194	250.883

Table 07.17: Tariff Structure in 2025 – Southeast Asia – S4 (Author's own calculations)

7.4 Conclusion

This chapter presents the tariff outputs by following the methodology, as detailed in Chapter 04, used for collecting and computing the tariff levels across all ten countries and regions, and twelve sectors under investigation. A key finding is the general trend of gradual tariff reduction observed across all studied regions from 2011 to 2024, with the notable exception of the United States. Despite this deviation, the US continues to maintain one of the lowest overall tariff regimes globally, exclusive of its tariffs targeted at China. Conversely, nations such as South Korea and India exhibit relatively higher average tariff levels, while the Southeast Asian region generally positions itself toward the lower spectrum of trade protectionism.

The data extracted from the initial twenty tariff tables will first be utilised for data calibration, aligning the model inputs to the reference years of 2017 and 2024. Subsequently, the data contained within the final five tables will be employed to execute the four defined policy scenario simulations in 2025.

8 Chapter 08: Simulation Results

8.1 Introduction

Building upon the methodological groundwork established in Chapter 04, which detailed the distinct datasets utilised as inputs for the standard GTAP Model, version 7, this chapter will present the corresponding simulation outputs and subsequent comparative analysis. The results will also be compared against the four hypotheses outlined in Chapter 04.

This presentation aims to provide readers with a clear visualisation of the resulting economic impact, specifically highlighting the nations experiencing macro-level gains or losses and identifying the sectors poised to benefit or suffer from the trade conflict. Given the substantial volume of sectoral output results, the discussion will focus particular attention on the outcomes observed within the United States, China, and Southeast Asia.

8.2 Simulation Results

These four scenarios listed in Chapter 01 will allow comparisons between different options that SEA could take in response to the global trade war, as well as to establish the best strategy for SEA to navigate and minimise any potential negative impacts in an increasingly turbulent world.

To better understand how each scenario impacts all 10 regions, the below variables from the GTAP models are selected. The total welfare changes are also discussed in the last section.

Variable	Description in the GTAP model	Measurement
qgdp	GDP quantity index	% change in GDP
qpa	private household demand for commodity c in region r	% change in private household demand or consumption
qpd	private household demand for domestic commodity c in region r	% change in private household demand or consumption for domestic commodities

qpm	private household demand for imported commodity c in region r	% change in private household demand or consumption for import commodities
qga	government household demand for commodity c in region r	% change in public demand or consumption
qgd	government demand for domestic commodity c in region r	% change in public demand or consumption for domestic commodities
qgm	government demand for imported commodity c in region r	% change in public demand or consumption for import commodities
qinv	demand for investment/capital goods in region r	% change in investment demand
qxw	aggregate exports of c from region r, FOB weights	% change in exports
qmw	aggregate imports of c into region s, CIF weights	% change in imports
qo	output of activity a in region r	% change in outputs
qds	domestic sales of commodity c in r	% change in domestic sales

Table 08.01: Key economic indicators under investigation

Prior to undertaking a detailed analysis of the elements described above, it is important to note that both data tables and line charts (see Appendix) will be utilised, where appropriate, to enable rapid visualisation of potential trends across all four scenarios. For data tables containing relatively small values, primarily percentages rounded to three decimal places, this level of precision aids in capturing subtle differences. In contrast, for tables involving larger magnitude figures, the data will be presented in millions of USD at constant 2011 prices, ensuring clarity and comparability across figures with larger absolute scales. Cells which are highlighted in light pink colour indicate positive values.

Additionally, Scenario 0 (S0) is introduced to represent the initial baseline condition prior to the implementation of any policy interventions, thereby providing a clear reference point for subsequent scenario comparisons. Although there are ten different regions in this study, more

attention will be paid to three regions, namely Southeast Asia (SEA), China & Hong Kong (CHN_HK) and the United States (USA).

A common challenge in visualising comparative data, particularly in contexts such as cross-country scenario analysis in this study, arises from the fact that underlying output values can be extremely small and closely clustered around some values. This compression results in line charts where multiple series appear almost indistinguishable, masking meaningful but subtle differences between countries, regions, or experimental scenarios. In such cases, standard plotting of raw data can obscure underlying patterns, outliers, or shifts in relative performance that are analytically important but visually lost due to scale.

To address this limitation, normalisation or standardisation, specifically z-score normalisation, is used in this chapter as an effective statistical technique. In this approach, each value is standardised within each scenario by subtracting that scenario's mean (calculated as a simple arithmetic average across all countries, without weighting) and dividing by the standard deviation (the measure of dispersion among those values for that scenario). This transforms the raw data into z-scores, which express how far each country's or each sector's value for a given scenario departs from the scenario average in units of standard deviations. For example, if Southeast Asia (SEA) has a normalised value of 0.335 in Scenario 1, this means SEA's result is 0.335 standard deviations above the mean of all countries in that scenario, indicating slightly above-average performance, but not an outlier. The result is a set of standardised scores for each country or each sector across scenarios, which, when visualised, clearly distinguish relative positions and allow trends and anomalies to stand out, even when the original data is tightly clustered around zero.

The principal benefits of this method include enhanced visual clarity, direct comparability across disparate countries, sectors or scenarios, and the ability to meaningfully interpret deviations in a standardised metric. By anchoring each comparison on the unweighted scenario mean and its standard deviation, this approach provides a transparent and robust foundation for nuanced, high-resolution analysis of complex, otherwise visually intractable, datasets. All line charts are included in the Appendix.

8.2.1 GDP quantity index - qgdp

8.2.1.1 Impact on China's economy

Across all simulated scenarios, apart from the US, CHN_HK (China and Hong Kong) consistently registers the most substantial and persistent negative impacts on real GDP. These losses are shown to deepen markedly when China engages in retaliatory measures (S2 to S4). The most severe GDP decline is observed in S4 (-0.416%), demonstrating that the detrimental effects of the US-China trade conflict are dominant, even when Southeast Asia (SEA) pursues trade liberalisation. Furthermore, the marginal differences between scenarios S2, S3, and S4 suggest that the primary determinant of CHN_HK's GDP loss is its own retaliation, rather than the actions or policy responses of SEA. This pronounced negative impact underscores China's significant vulnerability to both US tariffs and its subsequent counter-measures, a consequence likely attributed to its extensive bilateral trade linkages with the United States.

qgdp	S1	S2	S3	S4
AUS	-0.064	-0.053	-0.044	-0.029
RoW	0.023	0.024	0.024	0.012
CHN_HK	-0.313	-0.414	-0.412	-0.416
JPN	-0.037	-0.036	-0.035	-0.033
KOR	-0.044	-0.030	-0.018	-0.035
TWN	-0.031	-0.030	-0.029	-0.019
SEA	-0.055	-0.054	-0.209	0.080
IND	-0.029	-0.031	-0.034	-0.074
USA	-0.595	-0.605	-0.619	-0.691
EU_27	-0.014	-0.016	-0.017	-0.027

Table 08.02: All regions' real GDP growth (%) (qgdp) (Author's own calculations)

8.2.1.2 Impact on the US economy

The USA faces the largest GDP decline among all regions in every scenario. The negative impact intensifies as retaliation broadens from -0.595% in S1 (no retaliation) to -0.691% in S4 (China retaliates, SEA liberalises). The data suggest that the US economy is highly sensitive to retaliatory tariffs, especially from major trading partners like China and SEA. Notably, even when SEA liberalises in S4, the US GDP loss is the greatest. One possible explanation when looking at the trade flow between the US and SEA is that even when SEA reduces all non-services tariffs for the US to 0%, exports from the USA to SEA unexpectedly fall by 26,561.83

million USD, while exports from SEA to USA increase by 147,727.56 million USD, exacerbating trade deficit between the two nations by additional 174,289.39 million USD in S4. This could be further explained that the total exports from all other countries to the US are projected to fall by 170,198.12 million USD; the US domestic production outputs need to be directed away from exports and towards domestic needs, leaving little room for further exports even when SEA eliminates all tariffs for the USA. At the same time, the new 14.97% tariff imposed by the US on SEA (S4) makes SEA's commodities relatively cheaper than many other partners, further boosting SEA's exports to the US. This result rejects hypothesis 3 (H3) and more trade information can be seen in later sections.

8.2.1.3 Impact on the SEA's economy

In S1 and S2, SEA's GDP loss is modest, suggesting limited direct exposure to initial US tariffs or China's retaliation. In S3, when SEA retaliates against the US, the region's GDP loss deepens sharply (-0.209%), indicating that reciprocal tariffs against the US are costly for SEA. In S4, SEA's GDP turns positive (+0.080%) when it reduces tariffs for the US to 0%, despite the ongoing US-China trade war. This can be partly explained by a significant increase in exports to the US, thanks to a lower tariff imposed by the US as discussed above. The positive outcome in S4 highlights the potential for unilateral trade liberalisation to mitigate or even reverse the negative effects of global trade tensions for smaller, more open economies which are heavily dependent on exports.

Taken together, these results provide full support for Hypothesis 1 in terms of GDP growth. The hypothesis correctly anticipates that President Trump's reciprocal tariff policies, when combined with retaliation by Southeast Asia, generate net macroeconomic losses for the region, and the simulations confirm that the largest GDP loss occurs in Scenario 3. This is consistent with the theoretical expectation that reciprocal tariff escalation amplifies distortions and reduces welfare in small open economies. However, SEA's economic growth appears to be quite small in S4.

Apart from RoW and SEA in S4, no other countries experience positive economic growth. Even though AUS faces the lowest reciprocal tariff level (10%) among all regions listed in the study, AUS could not grow its economy in any scenario.

Other elements of SEA's GDP, such as changes in private, public and investment consumptions, will also be examined below to provide a better understanding of why SEA unexpectedly expands in this S4.

8.2.2 Private and Public consumption - qpa, qpd, qpm and qga, qgd, qgm

At the national level, the US's private consumption sees growth in almost all sectors across the first three scenarios, while this broad-based growth moderates in S4, where only two-thirds of all sectors continue to exhibit expansion. In stark contrast, CHN_HK's qpa experiences a pervasive contraction, with no sector projected to achieve positive growth under any scenario. A similar pattern of sectoral stagnation is observed for SEA throughout the initial three scenarios, underscoring the vulnerability of these economies' qpa to adverse external shocks and restrictive trade environments. However, the dynamic shifts markedly in S4 when SEA implements unilateral trade liberalisation in conjunction with the US. This policy reversal catalyses a comprehensive sectoral resurgence, resulting in positive growth across all sectors within SEA. The breadth and uniformity of this expansion are distinctive, setting SEA apart from other regions. Analogous patterns can also be observed for public consumption (qga) in these three regions.

8.2.2.1 At the sectoral level:

The most notable sectoral changes are discussed below.

8.2.2.1.1 Extraction

The US consistently experiences the largest positive changes in extraction (qpa), with gains peaking above 9% in S2 and S3, though slightly reduced in S4. In contrast, CHN_HK faces increasing losses as trade tensions escalate, indicating its high vulnerability. SEA moves from moderate losses in S1–S3 to significant gains in S4, highlighting the sector's sensitivity to trade policy shifts.

8.2.2.1.2 Meat & Livestock

The US shows major positive gains in all scenarios, making it a clear beneficiary of the trade dynamics, while CHN_HK and SEA both suffer substantial losses in S1–S3, but SEA sees a dramatic reversal to strong gains in S4 (0.719%), emphasising the impact of tariff liberalisation.

8.2.2.1.3 Iron and Steel

CHN_HK's private household demand (qpa) for iron and steel experiences the most severe and persistent negative impacts across all scenarios, with losses exceeding -2% in S2–S4. As expected, SEA's qpa shifts from losses in S1–S3 to a strong gain in S4. The USA's qpa gains in S1–S3 but turns slightly negative in S4 (-0.024%). This is an interesting case and can be partly explained by looking at qpd and qpm. While qpd increases by 1.6 percentage points between S1 (5.9%) and S4 (7.5%), qpm falls by 5.5 percentage points from -3.3% in S1 to -8.8% in S4.

These results partly confirm Hypothesis 2 (H2) about the heterogeneous sectoral effects in Southeast Asia caused by President Trump's tariffs.

	S1			S2			S3			S4		
qpa	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-1.105	-0.825	0.072	-1.397	-0.851	0.077	-1.416	-1.168	0.078	-1.376	0.588	0.060
MeatLstk	-1.087	-0.836	4.152	-1.323	-0.853	4.368	-1.339	-1.078	4.434	-1.310	0.719	3.589
Extraction	-0.947	-0.302	9.792	-1.095	-0.309	9.638	-1.092	-0.404	9.168	-1.165	1.644	6.863
ProcFood	-1.090	-0.754	2.626	-1.329	-0.764	2.595	-1.340	-0.991	2.499	-1.333	0.814	1.999
TextWapp	-0.961	-0.507	-0.405	-1.136	-0.510	-0.641	-1.138	-0.618	-0.944	-1.143	1.160	-0.268
mvh	-0.960	-0.665	1.559	-1.088	-0.650	1.341	-1.084	-0.733	1.057	-1.103	1.553	-0.065
LightMnfc	-0.932	-0.552	0.008	-1.066	-0.542	-0.209	-1.064	-0.631	-0.492	-1.092	1.370	-1.160
i_s	-1.907	-0.658	1.670	-2.073	-0.655	1.449	-2.056	-0.779	1.163	-2.085	1.325	-0.024
HeavyMnfc	-1.010	-0.544	1.586	-1.147	-0.535	1.371	-1.142	-0.640	1.073	-1.194	1.671	0.188
Util_Cons	-0.846	-0.470	3.178	-0.965	-0.462	3.097	-0.962	-0.523	2.989	-0.993	1.061	2.510
TransComm	-1.049	-0.676	3.495	-1.194	-0.664	3.415	-1.191	-0.743	3.318	-1.212	1.090	2.867
OthServices	-1.040	-0.686	3.214	-1.179	-0.670	3.149	-1.174	-0.718	3.075	-1.197	0.941	2.708

Table 08.03: Private household demand, aggregate (%) (Author's own calculations)

	S1			S2			S3			S4		
qpd	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-0.286	-0.110	8.126	-0.120	-0.215	9.635	-0.155	0.188	10.639	-0.160	0.414	10.212
MeatLstk	-0.662	-0.193	4.590	-0.917	-0.225	4.917	-0.930	-0.439	5.076	-0.926	0.222	4.354
Extraction	-0.797	-0.231	12.020	-0.935	-0.239	11.942	-0.933	-0.331	11.478	-1.012	1.632	9.171
ProcFood	-0.799	-0.155	3.516	-1.058	-0.163	3.619	-1.060	-0.324	3.676	-1.017	0.397	3.161
TextWapp	-0.415	-0.551	11.840	-0.624	-0.480	12.318	-0.634	-0.666	12.947	-0.586	-1.791	8.992
mvh	0.026	-0.019	4.461	-0.012	-0.009	4.554	-0.015	0.024	4.684	-0.105	0.099	5.438
LightMnfc	-0.248	-0.126	11.674	-0.341	-0.134	12.055	-0.347	-0.109	12.582	-0.340	-0.980	13.017
i_s	2.572	1.934	5.873	2.656	1.948	6.088	2.627	2.362	6.355	2.235	-4.939	7.474
HeavyMnfc	-0.020	-0.079	9.175	-0.092	-0.103	9.309	-0.097	-0.050	9.442	-0.021	-0.489	8.749
Util_Cons	-0.817	-0.325	2.590	-0.935	-0.317	2.522	-0.933	-0.372	2.430	-0.965	0.911	2.023
TransComm	-0.862	-0.435	2.612	-1.003	-0.425	2.550	-1.001	-0.497	2.477	-1.012	0.698	2.142
OthServices	-0.942	-0.323	2.851	-1.077	-0.307	2.794	-1.074	-0.342	2.731	-1.094	0.663	2.409

Table 08.04: Private household demand, domestic (%) (Author's own calculations)

	S1			S2			S3			S4		
qpm	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-10.010	-4.891	-16.253	-15.134	-4.473	-19.120	-14.984	-8.814	-21.007	-14.472	1.586	-20.256
MeatLstk	-9.309	-6.349	-5.839	-9.175	-6.242	-8.111	-9.239	-6.538	-10.101	-8.726	5.061	-13.650
Extraction	-2.834	-2.452	-24.020	-3.113	-2.418	-25.271	-3.096	-2.621	-25.810	-3.102	1.994	-28.059
ProcFood	-6.167	-3.146	-3.651	-6.059	-3.165	-4.611	-6.220	-3.652	-5.761	-6.831	2.502	-6.160
TextWapp	-5.236	-0.388	-9.756	-5.143	-0.593	-10.520	-5.081	-0.486	-11.509	-5.492	9.254	-7.389
mvh	-8.998	-2.047	-2.932	-9.829	-2.022	-3.624	-9.782	-2.352	-4.536	-9.225	4.699	-8.475
LightMnfc	-9.187	-1.746	-10.492	-9.806	-1.687	-11.228	-9.712	-2.087	-12.214	-10.145	8.058	-13.831
i_s	-3.716	-0.700	-3.311	-3.985	-0.696	-4.041	-3.946	-0.829	-4.968	-3.831	1.427	-8.802
HeavyMnfc	-6.047	-1.241	-10.287	-6.502	-1.183	-11.031	-6.447	-1.518	-11.980	-7.143	4.944	-13.149
Util_Con	-6.588	-4.227	53.292	-6.906	-4.215	52.039	-6.850	-4.413	50.435	-6.718	5.022	43.425
TransComm	-5.518	-3.732	47.255	-5.777	-3.699	46.208	-5.723	-3.866	44.770	-5.989	6.170	38.200
OthServices	-9.315	-6.033	45.601	-9.732	-6.006	44.520	-9.624	-6.257	43.093	-9.782	5.144	37.069

Table 08.05: Private household demand, import (%) (Author's own calculations)

	S1			S2			S3			S4		
qga	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-4.694	-3.218	10.344	-6.524	-3.389	11.700	-6.597	-4.991	12.382	-6.282	0.502	9.861
MeatLstk	-2.145	-1.919	5.240	-2.764	-2.004	5.597	-2.828	-2.643	5.743	-2.673	0.411	4.695
Extraction	-1.558	0.526	12.366	-1.780	0.492	12.202	-1.765	0.473	11.618	-2.050	5.159	8.727
ProcFood	-2.315	-1.478	3.406	-2.982	-1.527	3.424	-3.027	-2.188	3.359	-2.948	0.907	2.731
TextWapp	-1.445	-0.481	1.585	-1.758	-0.479	1.444	-1.764	-0.593	1.267	-1.748	1.770	1.253
mvh	-1.183	-0.401	2.037	-1.261	-0.367	1.874	-1.243	-0.327	1.664	-1.295	1.920	0.894
LightMnfc	-1.211	-0.295	0.677	-1.337	-0.271	0.495	-1.329	-0.251	0.260	-1.399	1.899	-0.345
i_s	-1.164	-0.380	2.504	-1.280	-0.353	2.368	-1.264	-0.316	2.189	-1.418	2.152	1.436
HeavyMnfc	-1.714	-0.264	-0.660	-1.855	-0.240	-0.995	-1.834	-0.273	-1.448	-2.035	3.248	-2.488
Util_Con	-0.859	-0.160	3.253	-0.916	-0.134	3.172	-0.902	-0.049	3.062	-0.991	1.516	2.568
TransComm	-0.792	-0.304	4.019	-0.854	-0.276	3.932	-0.843	-0.209	3.827	-0.871	0.613	3.322
OthServices	-0.422	-0.186	3.063	-0.399	-0.150	3.008	-0.383	0.012	2.950	-0.411	0.101	2.631

Table 08.06: Government household demand, aggregate (%) (Author's own calculations)

	S1			S2			S3			S4		
qgd	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-0.699	-2.427	10.756	-0.297	-2.686	12.190	-0.457	-3.511	12.923	-0.353	0.306	10.370
MeatLstk	-2.028	-1.525	5.285	-2.652	-1.619	5.653	-2.715	-2.254	5.809	-2.568	0.103	4.774
Extraction	-1.380	0.996	12.503	-1.590	0.953	12.343	-1.577	0.958	11.759	-1.868	5.081	8.868
ProcFood	-2.195	-1.430	3.682	-2.871	-1.478	3.742	-2.912	-2.133	3.724	-2.819	0.872	3.091
TextWapp	-1.127	-0.486	2.773	-1.459	-0.475	2.696	-1.471	-0.599	2.601	-1.424	1.424	2.167
mvh	-0.604	-0.400	2.661	-0.630	-0.365	2.565	-0.616	-0.325	2.442	-0.709	1.917	2.065
LightMnfc	-0.441	-0.179	7.082	-0.523	-0.160	7.217	-0.521	-0.110	7.407	-0.556	1.248	7.379
i_s	-1.137	0.140	3.300	-1.252	0.169	3.245	-1.236	0.313	3.168	-1.392	0.813	2.834
HeavyMnfc	0.492	0.133	14.103	0.493	0.129	14.471	0.491	0.229	14.887	0.576	1.373	14.225
Util_Con	-0.748	-0.103	2.968	-0.801	-0.077	2.893	-0.788	0.011	2.791	-0.881	1.456	2.332
TransComm	-0.631	-0.279	2.363	-0.689	-0.251	2.310	-0.680	-0.183	2.251	-0.698	0.572	1.962
OthServices	-0.342	-0.124	3.050	-0.316	-0.088	2.996	-0.301	0.075	2.939	-0.329	0.054	2.620

Table 08.07: Government household demand, domestic (%) (Author's own calculations)

	S1			S2			S3			S4		
qgm	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-10.382	-7.097	-14.217	-15.285	-6.839	-17.239	-15.241	-12.181	-19.381	-14.637	1.477	-20.145
MeatLstk	-10.555	-7.599	-5.213	-10.764	-7.552	-7.467	-10.873	-8.239	-9.473	-10.237	4.936	-13.302
Extraction	-3.405	-1.253	-23.693	-3.754	-1.251	-25.004	-3.725	-1.361	-25.622	-3.940	5.455	-28.247
ProcFood	-7.488	-4.382	-3.496	-7.779	-4.440	-4.498	-7.975	-5.401	-5.717	-8.527	2.987	-6.225
TextWapp	-5.913	-0.323	-17.073	-5.940	-0.589	-18.185	-5.880	-0.419	-19.614	-6.288	12.831	-13.188
mvh	-9.572	-2.420	-4.605	-10.385	-2.372	-5.459	-10.322	-2.692	-6.581	-9.773	6.600	-11.403
LightMnfc	-9.362	-1.799	-14.173	-9.970	-1.712	-15.062	-9.870	-2.086	-16.249	-10.339	10.488	-18.130
i_s	-7.198	-2.448	-5.660	-7.643	-2.429	-6.612	-7.564	-2.815	-7.816	-7.246	7.564	-12.739
HeavyMnfc	-5.567	-1.032	-6.237	-5.956	-0.953	-6.830	-5.896	-1.241	-7.600	-6.589	6.907	-8.775
Util_Con	-6.523	-4.013	53.856	-6.780	-3.985	52.590	-6.714	-4.045	50.966	-6.639	5.590	43.859
TransComm	-5.298	-3.581	46.898	-5.478	-3.531	45.866	-5.416	-3.563	44.451	-5.691	6.036	37.957
OthServices	-8.766	-5.846	45.883	-9.039	-5.800	44.803	-8.919	-5.865	43.382	-9.083	4.507	37.352

Table 08.08: Government household demand, import (%) (Author's own calculations)

A salient feature of the US response to reciprocal tariff policies is the divergent trajectory of private household demand across domestic and imported commodities. Specifically, private consumption of all domestically produced sectors (qpd) registers a broad-based expansion, reflecting a substitution effect as consumers pivot towards home-produced goods and services. In contrast, private household demand for all imported non-service commodities (qpm) contracts markedly, underscoring the efficacy of tariffs in curbing foreign competition within these sectors.

Conversely, private household demand for imported service sector commodities (qpm) exhibits a pronounced surge, averaging approximately 50% growth, with the most substantial increases observed under Scenario 1. This phenomenon can be attributed to the targeted application of reciprocal tariffs, which predominantly affect non-service imports. As tariffs render non-service imports less competitive, domestic production is stimulated to fill the resultant supply gap. This reallocation of demand necessitates a reallocation of labour and capital away from service sectors towards non-service sectors, thereby constraining the domestic service sector's capacity to accommodate rising consumption needs. This is in line with the CGE theoretical anticipation.

Simultaneously, foreign service providers, unencumbered by reciprocal tariffs, could offer their services at relatively more attractive prices compared to their non-service counterparts. This price differential amplifies the appeal of imported services, catalysing a significant upswing in US household demand for overseas service sector imports.

Similar patterns emerge in the domain of public consumption, where US demand for imported service commodities rises in tandem with a contraction in imports of non-service commodities. These dynamics collectively illustrate the nuanced and sector-specific impacts of tariff regimes on the composition of both private and public consumption in the United States.

8.2.3 Investment - qinv

To better explain the fall or rise in investment demand, two other variables are considered, namely del_tbl (change in trade balance) and rorc (rate of return on capital). The theory that captures the relationships between the three variables goes as follows. When a region imposes tariffs (the US in this case), the resultant contraction in its trade deficit, or, equivalently, the expansion of its trade surplus (as reflected in the del_tbl variable), necessarily entails a

corresponding reduction in its capital account surplus, or an increase in its capital account deficit, due to the fundamental balance of payments identity.

qinv	S1	S2	S3	S4
AUS	-2.579	-2.112	-1.737	-1.241
RoW	-1.987	-1.713	-1.500	-1.544
CHN_HK	-6.198	-6.626	-6.456	-6.011
JPN	-3.616	-3.315	-3.027	-2.597
KOR	-1.947	-1.553	-1.236	-1.724
TWN	-6.396	-6.149	-5.930	-6.207
SEA	-4.564	-4.395	-4.776	3.925
IND	0.546	0.633	0.694	0.257
USA	-3.286	-3.352	-3.536	-3.928
EU_27	-2.035	-1.790	-1.571	-1.171

Table 08.09: All regions' real investment consumption growth (%) (qinv) (Author's own calculations)

Under the standard model closure, global savings are allocated in pursuit of the highest expected rates of return on capital (rorc). This process drives international capital flows, reallocating investment across regions until expected returns are equalised. Should a region experience a widening capital account deficit, which indicates net capital outflows, this signals that its expected rate of return on capital has declined relative to those in other economies, prompting investors to redirect funds elsewhere.

Such capital outflows manifest as a reduction in domestic investment demand (qinv), which in turn exacerbates the decline in GDP that accompanies the imposition of tariffs. This mechanism underscores the interconnectedness of trade and capital flows that protectionist measures not only disrupt external balances but also depress domestic investment through their impact on relative returns to capital.

del_tbal	S1	S2	S3	S4
AUS	9,748.79	7,916.63	6,441.41	4,372.15
RoW	44,183.52	34,854.57	27,426.79	28,875.54
CHN_HK	68,032.75	83,053.73	80,199.55	75,565.77
JPN	31,980.33	29,153.57	26,503.50	22,400.38
KOR	-2,429.74	-3,105.76	-3,581.13	-2,332.78
TWN	-2,229.68	-2,352.69	-2,412.08	-1,912.39
SEA	17,735.32	16,883.67	20,021.07	-23,760.72
IND	9,090.71	8,129.97	7,379.29	8,022.73
USA	-258,133.97	-248,145.44	-227,961.06	-161,293.23
EU_27	82,023.45	73,572.70	65,908.13	49,955.47

Table 08.10: Trade Balance (\$ million) (Author's own calculations)

rorc	S1	S2	S3	S4
AUS	0.470	0.640	0.760	0.610
RoW	1.020	1.040	1.030	0.510
CHN_HK	-2.020	-2.460	-2.480	-2.660
JPN	0.380	0.390	0.390	0.120
KOR	1.430	1.450	1.440	0.730
TWN	-1.180	-1.200	-1.230	-1.860
SEA	-0.800	-0.830	-1.230	4.160
IND	2.880	2.820	2.740	1.760
USA	-0.630	-0.840	-1.140	-1.960
EU_27	0.960	0.960	0.960	0.720

Table 08.11: Rate of return on capital (%) (Author's own calculations)

8.2.3.1 Impact on China's economy

CHN_HK's demand for investment/capital goods (qinv) suffers the steepest decline in investment demand among all regions in every scenario, at around -6.3%. The negative impact is most severe in S2 and S3, reflecting the compounded effect of US tariffs and China's own retaliation. Even when SEA liberalises tariffs in S4, CHN_HK's investment demand remains deeply negative, though the loss is slightly reduced. It can be seen that China alone has the largest increase by value in its net trade balance, with the highest value in S2 of more than 83 billion USD. As explained above, its capital account surplus falls, and the rate of return on capital must fall as a result. A falling rorc reduces demand for investment in China and partly contributes to economic contractions in all four scenarios. This persistent contraction highlights the vulnerability of China's investment climate to trade tensions.

8.2.3.2 Impact on the US economy

The United States experiences persistent and substantial declines in investment demand across all examined trade war scenarios, with the magnitude of contraction intensifying as retaliatory measures escalate. Notably, the most pronounced reduction in investment demand occurs under S4, wherein SEA unilaterally liberalises its tariffs, reducing them to zero for US imports. This scenario paradoxically coincides with the deepest investment contraction, underscoring complex interactions within global trade and capital flows.

A particularly intriguing phenomenon emerges when analysing the US trade balance dynamics amid its own trade conflict. Contrary to conventional expectations, as explained above and also applicable to China, the US trade deficit deteriorates as exports suffer a markedly sharper decline in value relative to imports. This deterioration is most severe in S1 and least pronounced in S4. The worsening net trade balance despite tariff imposition reflects the multifaceted and sometimes counterintuitive consequences of protectionist policies.

Consequently, the US capital account surplus exhibits improvement across scenarios, suggesting increased capital inflows. However, this improvement is accompanied by an unexpected decline in the US expected rate of return on capital (rorc), which in turn exacerbates the contraction in investment demand. This counterintuitive outcome highlights the decoupling that can occur between capital inflows and domestic investment incentives under adverse economic conditions.

The underlying driver of this investment decline might appear to be rooted in widespread output contractions. Two-thirds of all US's aggregated economic sectors, as represented by the output variable (q_o) in this study, experience declines across all scenarios. Reduced sectoral outputs naturally diminish the demand for investment goods, thereby reinforcing the overall economic contraction observed in the US. The forthcoming section will provide a detailed examination of the sectoral output values (q_o) to clarify their role in shaping investment dynamics.

8.2.3.3 Impact on SEA's economy

SEA endures pronounced contractions in investment demand throughout S1, S2, and S3, with the sharpest decline materialising in S3, where both China and SEA engage in retaliatory tariff

measures. This persistent investment weakness reflects the region's heightened exposure to adverse external shocks and the disruptive effects of escalating trade barriers.

A remarkable inflection occurs in S4 when SEA's investment demand not only recovers but surges to a robust positive growth rate (+3.925%), distinguishing SEA as the sole region to achieve such a dramatic reversal. This turnaround is intimately linked to SEA's unilateral adoption of trade liberalisation with the US, which fundamentally alters its macroeconomic trajectory amid ongoing global trade tensions.

A detailed examination of SEA's trade balances reveals that, unlike the preceding scenarios where the net trade surplus (del_tbal) expands, S4 is characterised by a contraction in the trade surplus. This reduction in net trade surplus is mirrored by an associated narrowing of the capital account deficit, signalling a shift in the region's external financing dynamics from a net capital outflow to a net capital inflow. Crucially, these developments are accompanied by a substantial rise in SEA's expected rate of return to capital (rorc) relative to those of other regions. The magnitude of this shift is underscored by the sizeable swing in del_tbal from around 20 billion USD improvement in S3 to around 23 billion USD decrease in S4, which causes a marked increase in rorc from -1.23% to 4.16%. This surge in the expected return to capital acts as a powerful attractor for international capital inflows, thereby catalysing the observed expansion in investment demand (qinv), and subsequently real GDP.

SEA's emergence as the fastest-growing region in S4 provides compelling empirical support for the efficacy of open trade policies in fostering capital formation and economic dynamism, even amidst pervasive global trade frictions. The unexpected findings highlight the capacity of unilateral liberalisation to insulate economies from external shocks and to reposition them as attractive destinations for global investment during periods of heightened uncertainty. Taken together, these results provide full support for Hypothesis 1 in terms of investment demand.

8.2.3.4 Impact on India's and Taiwan's economies

India stands out as the only region to exhibit consistently positive investment demand across all four scenarios, with gains intensifying from S1 through S3. This pattern positions India as a relative beneficiary of the shifting global trade landscape, likely owing to trade diversion effects and its limited direct exposure to US-China tariff disputes. However, S4 reveals a potential vulnerability that if other regions (SEA in this case) succeed in negotiating

preferential trade arrangements with the United States, India's favourable trajectory could be threatened, with key economic indicators such as investment demand at risk of significant deterioration.

A closer examination of India's trade balance reveals that, as one of the few trade-deficit countries in this analysis, its net trade deficit (as indicated by `del_tbal`) narrows across all scenarios. Notably, India's experience diverges from conventional theoretical expectations set out above that despite a declining trade deficit and a corresponding reduction in capital account surplus, the expected rate of return on capital (`rorc`) rises in every scenario, but at a diminishing rate. This is accompanied by a sustained increase in investment demand, underscoring a complex interplay between trade, capital flows, and domestic economic dynamics.

Taiwan emerges as a particularly vulnerable case, frequently ranking among the most adversely affected economies in terms of investment demand, especially in S1 and S4, where its performance closely mirrors that of China and Hong Kong. This pronounced sensitivity highlights the acute exposure of Taiwan's investment climate to global trade tensions, suggesting that its economic structure is highly susceptible to the disruptive effects of escalating trade conflicts.

8.2.4 Export and Import - `qxw` and `pxw`

8.2.4.1 Export at the national level

At the national scale, China & Hong Kong (`CHN_HK`) demonstrate remarkable resilience in export performance across the trade war scenarios (See Table 08.12). Despite the adverse macroeconomic environment and the imposition of reciprocal tariffs, export output expands in 10 out of 12 sectors in every scenario, with Extraction and Light Manufacturing being the sole exceptions. This might be explained that the export prices (`pxw`) (See Table 08.13) of China fall relatively to other countries due to relatively higher tariffs from the US, making Chinese goods and services more attractive.

Southeast Asia (SEA) exhibits a broadly similar pattern in the initial three scenarios, with export growth projected in approximately eight to nine sectors. This indicates a substantial degree of export robustness in the face of external shocks. However, S4 marks an inflection point when export expansion becomes highly concentrated, with only three sectors, namely Textiles & Wearing Apparel (`TextWapp`), Light Manufacturing (`LightMnfc`), and Heavy

Manufacturing (HeavyMnfc), continuing to record positive growth. The surge in TextWapp is particularly striking, with export growth approaching 18%, underscoring the sector's exceptional responsiveness to the altered trade regime. It is noteworthy that TextWapp and LightMnfc, which emerge as leading growth sectors in S4, are conversely the only sectors in SEA to experience negative export growth in Scenarios 1 through 3, highlighting a dramatic reversal in their export fortunes.

In stark contrast, the United States registers substantial declines in export output across all sectors and scenarios. This pervasive contraction can be partially attributed to the evolution of export prices (pxw). The US is unique in experiencing significant increases in export prices across all sectors, whereas all other regions face declining export prices. This divergence reflects the internal reallocation of resources within the US economy, as reciprocal tariffs and trade war frictions diminish the attractiveness of overseas markets and further incentivise the redirection of productive capacity away from export-oriented activities toward domestic consumption, exacerbating the contraction in US export volumes.

Collectively, these patterns illuminate the complex interplay between trade policy, sectoral competitiveness, and resource allocation in shaping national export trajectories during periods of heightened global economic tension. Taken together, these export simulation results (q_xw) provide strong support for Hypothesis 2 regarding Southeast Asia's heterogeneous sectoral impacts, in particular SEA's key export-competing manufacturing sectors (Textiles & Wearing Apparel, Light Manufacturing, Heavy Manufacturing).

8.2.4.2 Export at the sectoral level

The most notable sectoral changes are discussed below.

8.2.4.2.1 Meat & Livestock

The USA's export flow experiences a catastrophic collapse in meat & livestock exports in all scenarios, with losses averaging almost 63% in the first three scenarios. The imposition of reciprocal tariffs and subsequent retaliation devastate US competitiveness. On the other hand, CHN_HK sees substantial export gains (17–21%), indicating strong trade diversion effects. As US exports plummet, China & Hong Kong might be able to partly fill the void in global meat supply, especially in markets previously dominated by the US. In real value terms, the US's

export of Meat & Livestock falls by almost 12.5 bn USD, while China and Hong Kong's export of the same products is projected to increase by almost 270 million USD in S3.

SEA demonstrates a pattern of consistently positive export performance in Meat & Livestock across the first three scenarios, achieving moderate gains of approximately 6.8%. However, in S4, SEA unexpectedly registers a sharp decline in Meat & Livestock exports, contracting by nearly 8%.

This downturn may reflect a strategic reallocation of resources within SEA's export economy. Notably, the Textiles and Clothing sector experiences a substantial surge in S4, with export growth approaching 18%, the highest sectoral increase for SEA in that scenario. Such a pronounced shift suggests that factors of production may be redirected away from Meat & Livestock to capitalise on more lucrative opportunities in Textiles and Clothing.

Additionally, the contraction in Meat & Livestock exports could also be attributed to intensifying international competition, particularly from China. In S4, China's export price for Meat & Livestock is projected to decrease by 5%, compared to a more modest decline of approximately 0.8% for SEA. This relative price movement may erode SEA's competitiveness in global markets, further contributing to the observed decline in Meat & Livestock exports.

	S1			S2			S3			S4		
qxw	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	13.704	3.320	-31.179	9.954	4.933	-38.067	17.575	3.554	-42.082	11.657	-0.630	-34.391
MeatLstk	21.010	7.536	-63.114	18.047	7.574	-62.688	18.365	5.243	-62.631	17.294	-7.935	-56.370
Extraction	-2.779	1.481	-71.634	-2.960	1.580	-74.975	-2.886	1.677	-75.237	-1.972	-2.221	-74.057
ProcFood	5.337	0.025	-51.245	3.320	0.090	-51.381	3.800	-1.723	-53.363	3.866	-3.053	-45.209
TextWapp	1.561	-6.340	-76.956	0.953	-6.350	-76.684	0.743	-7.384	-76.566	0.579	17.821	-71.109
mvh	19.499	6.914	-64.470	20.030	6.976	-64.679	19.775	7.226	-64.296	18.209	-7.729	-60.149
LightMnfc	-0.801	-4.669	-76.702	-0.577	-4.813	-77.282	-0.798	-4.804	-77.821	-1.848	5.485	-72.375
i_s	11.507	2.813	-66.041	11.738	2.819	-66.317	11.669	3.329	-67.534	11.327	-11.506	-61.487
HeavyMnfc	1.328	-4.071	-73.833	1.646	-4.207	-74.051	1.564	-4.112	-74.584	1.367	0.686	-69.839
Util_Con	18.710	11.503	-58.320	19.299	11.565	-57.582	19.062	11.917	-56.638	18.225	-6.527	-51.953
TransComm	15.862	8.503	-34.767	15.980	8.355	-34.336	15.605	8.330	-33.734	14.764	-4.855	-30.553
OthServices	29.172	17.673	-48.599	29.791	17.532	-47.889	29.204	17.906	-46.934	27.036	-4.816	-42.499

Table 08.12: Aggregate exports, quantity (%) (Author's own calculations)

	S1			S2			S3			S4		
pxw	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-5.320	-3.730	7.130	-4.390	-3.400	5.470	-4.100	-1.930	4.390	-3.650	-0.890	4.770
MeatLstk	-6.360	-4.830	12.470	-5.810	-4.620	11.740	-5.570	-3.850	11.120	-5.040	-0.780	10.110
Extraction	-6.910	-7.110	5.330	-6.750	-6.960	5.150	-6.590	-6.800	5.260	-5.640	-5.330	6.020
ProcFood	-6.210	-5.150	14.340	-5.610	-4.980	13.940	-5.390	-4.200	13.520	-4.790	-1.340	12.060
TextWapp	-7.070	-6.080	16.170	-6.810	-5.960	15.950	-6.630	-5.710	15.650	-5.980	-2.110	13.610
mvh	-7.430	-6.160	15.760	-7.420	-6.070	15.560	-7.260	-5.960	15.290	-6.530	-2.340	13.820
LightMnfc	-7.410	-6.290	15.590	-7.350	-6.190	15.340	-7.180	-6.070	15.000	-6.450	-2.150	13.340
i_s	-7.260	-6.340	15.180	-7.200	-6.250	14.950	-7.040	-6.170	14.640	-6.220	-2.130	13.150
HeavyMnfc	-7.330	-6.400	14.450	-7.280	-6.290	14.270	-7.130	-6.150	14.040	-6.340	-3.080	12.930
Util_Con	-7.590	-6.410	14.800	-7.580	-6.310	14.530	-7.420	-6.250	14.180	-6.670	-1.930	12.550
TransComm	-7.680	-6.260	14.770	-7.670	-6.170	14.490	-7.510	-6.090	14.110	-6.820	-1.050	12.380
OthServices	-7.980	-6.390	14.870	-8.050	-6.300	14.570	-7.890	-6.310	14.160	-7.200	-0.540	12.360

Table 08.13: Aggregate exports, price (%) (Author's own calculations)

	S1			S2			S3			S4		
qmw	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	-7.216	-4.593	-16.901	-9.147	-4.185	-19.837	-9.052	-6.394	-21.785	-8.577	1.607	-20.978
MeatLstk	-7.566	-5.923	-7.144	-6.954	-5.824	-9.368	-7.065	-5.181	-11.301	-6.629	4.876	-14.511
Extraction	-1.143	-3.580	-19.872	-1.019	-3.648	-20.360	-1.016	-3.538	-20.302	-0.916	-0.194	-20.291
ProcFood	-5.047	-2.619	-3.812	-4.438	-2.635	-4.691	-4.598	-2.707	-5.767	-5.184	1.538	-6.010
TextWapp	-3.632	-3.496	-6.632	-3.566	-3.622	-7.339	-3.563	-4.035	-8.265	-3.944	14.327	-3.569
mvh	-9.225	-1.201	-6.093	-9.734	-1.124	-6.662	-9.621	-1.235	-7.448	-8.992	2.011	-10.683
LightMnfc	-9.369	-3.176	-9.809	-9.657	-3.097	-10.586	-9.563	-3.291	-11.636	-10.062	7.087	-12.755
i_s	-6.702	-2.682	-7.866	-6.900	-2.703	-8.353	-6.828	-2.704	-9.011	-6.371	2.294	-11.857
HeavyMnfc	-6.054	-2.713	-9.679	-6.271	-2.687	-10.276	-6.202	-2.681	-11.054	-6.848	3.062	-11.268
Util_Cons	-9.658	-6.049	47.639	-10.140	-5.975	46.473	-9.992	-6.293	44.904	-9.555	6.122	38.342
TransComm	-4.939	-2.890	41.904	-5.137	-2.873	41.004	-5.089	-3.015	39.754	-5.320	5.114	34.008
OthServices	-9.049	-5.155	39.577	-9.428	-5.144	38.653	-9.308	-5.342	37.409	-9.390	4.170	32.212

Table 08.14: Aggregate imports, quantity (%) (Author's own calculations)

8.2.4.2.2 Extraction

The US experiences a pronounced and sustained contraction in extraction exports across all scenarios, with losses consistently hovering near 74%. These declines intensify under retaliatory conditions in S2 and S3, underscoring the compounded impact of tariffs, counter-tariffs, and rising export prices (pxw) on the international competitiveness of the US extraction sector.

China & Hong Kong endure steady, moderate declines in extraction exports throughout the scenarios. Notably, the magnitude of these losses diminishes in S4, where the contraction moderates to just under -2%, indicating a slight easing of adverse effects as trade dynamics shift.

Southeast Asia generally achieves modest gains in extraction exports from S1 to S3. However, this trend is unexpectedly reversed in S4, coinciding with SEA's reduction of tariffs for US imports. The earlier gains may be attributed to relatively larger declines in SEA's extraction export prices (pxw) compared to those of China, enhancing SEA's competitiveness. Yet, when China's export price subsequently falls slightly more than that of SEA, SEA's extraction export contracts, reflecting heightened sensitivity to relative price movements. This decline in SEA's extraction exports in S4 may also signal an internal reallocation of productive resources. As SEA's Textiles and Clothing sector, alongside Light Manufacturing, experiences significant export expansion in S4, factors of production may be redirected from extraction to these rapidly growing sectors, amplifying the contraction in extraction exports.

8.2.4.2.3 Iron and Steel

The US experiences pronounced and persistent declines in iron and steel exports across all scenarios, with average losses approximating -65%. The most acute contraction occurs in S3, when both China and Southeast Asia implement retaliatory tariffs. A modest improvement is observed in S4, coinciding with SEA's reduction of tariffs on US exports. This trajectory aligns with US policy objectives under the Trump administration, which sought to stimulate domestic steel production by curtailing reliance on foreign steel imports.

In contrast, China & Hong Kong consistently records robust export growth in iron and steel, maintaining gains of approximately 11% across all scenarios. This sustained expansion might be indicative of substantial trade diversion away from US suppliers toward alternative markets.

The strong performance of CHN_HK is further supported by a pronounced decline in China's iron and steel export prices, the steepest among all regions, enhancing its competitiveness in international markets.

SEA, meanwhile, posts moderate export gains in S1 through S3. However, this trend reverses sharply in S4, where SEA's iron and steel exports contract by 11.5% following the liberalisation of trade with the US. This reversal highlights how sensitive SEA's export performance is to changes in tariff policies and the competitive forces in the global steel market. It may also simply show that resources were re-allocated to better-performing export sectors, such as TextWapp.

8.2.4.2.4 Textiles & Wearing Apparel

The sector's export follows the same patterns above when the US faces catastrophic declines in textile exports in all scenarios (on average -75%), reflecting the sector's vulnerability to tariff escalation and retaliation. CHN_HK maintains small but positive export gains, though these diminish slightly as scenarios escalate. SEA experiences significant losses in S1–S3, but a dramatic reversal to a +17.8% gain in S4. This indicates that trade liberalisation enables SEA to rapidly expand textile exports and also SEA's dependency on this sector for economic growth, further confirms H2.

8.2.4.3 Import - qmw

In S4, Southeast Asia distinguishes itself through widespread positive import growth across nearly all sectors. This outcome is a direct consequence of tariff liberalisation with the United States, which unilaterally eliminates all tariffs. The most pronounced increases are observed in Textiles & Wearing Apparel: +14.327%, Light Manufacturing: +7.087%, and Utilities & Construction: +6.122%. These substantial gains reflect a vigorous resurgence in import demand, encompassing both private (qpm) and public (qgm) consumption. The broad-based sectoral expansion aligns with SEA's strongest overall economic performance, as indicated by positive GDP growth (qgdp) in S4. However, this surge in imports, particularly when outpacing export growth, leads to a narrowing of SEA's net trade surplus. This contraction in trade surplus exerts upward pressure on the expected rate of return to capital (rorc), which in turn stimulates

higher investment demand (q_{inv}), reinforcing the region's growth momentum as explained in the previous section for q_{inv} .

In contrast, the United States exhibits a clear bifurcation in import trends; firstly, non-service sectors' imports are projected to decline across all scenarios, reflecting the impact of reciprocal tariffs that raise the relative cost of imported goods. On the other hand, service sectors' imports consistently rise in every scenario. This pattern is attributable to the exemption of service imports from reciprocal tariffs, rendering them relatively more affordable than goods imports. Additionally, as domestic resources are reallocated toward non-service sectors, the diminished capacity of domestic service industries necessitates increased reliance on imported services to satisfy domestic demand.

China & Hong Kong continue to experience negative import growth across all sectors and scenarios. Paradoxically, this persistent contraction in imports contributes to an improvement in China's net trade surplus, even as the broader economic environment is adversely affected by the ongoing trade war and reciprocal tariff measures.

	S1			S2			S3			S4		
qo	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	1.720	0.629	-8.867	2.320	0.684	-10.849	2.382	1.049	-11.972	2.249	-0.153	-9.141
MeatLstk	-0.494	0.206	-0.830	-0.700	0.192	-0.514	-0.698	-0.097	-0.354	-0.713	-0.142	-0.338
Extraction	0.161	-0.078	-2.772	0.195	-0.068	-2.742	0.195	-0.039	-2.585	0.229	-0.740	-1.822
ProcFood	0.086	0.167	0.110	-0.168	0.187	0.242	-0.153	-0.553	0.244	-0.108	-1.093	0.312
TextWapp	2.093	-4.816	10.057	1.726	-4.771	10.656	1.612	-5.604	11.436	1.833	10.820	7.307
mvh	1.755	2.474	-4.236	1.732	2.529	-4.062	1.756	2.631	-3.813	1.588	-3.342	-2.170
LightMnfc	-0.664	-2.501	2.222	-0.614	-2.554	2.472	-0.689	-2.544	2.780	-1.012	1.362	3.389
i_s	-0.112	1.052	-4.542	-0.118	1.049	-4.162	-0.115	1.477	-3.787	-0.128	-6.959	-1.472
HeavyMnfc	0.103	-2.794	-2.311	0.200	-2.900	-2.057	0.185	-2.771	-1.810	0.260	-0.536	-1.248
Util_Cons	-4.954	-2.977	-2.296	-5.304	-2.862	-2.340	-5.168	-3.121	-2.465	-4.810	2.577	-2.728
TransComm	1.261	0.819	-0.597	1.202	0.800	-0.595	1.164	0.723	-0.599	1.110	-0.467	-0.593
OthServices	0.234	1.860	0.978	0.192	1.862	0.955	0.186	1.930	0.932	0.141	-0.363	0.805

Table 08.15: Output change by sector (%) (Author's own calculations)

	S1			S2			S3			S4		
qds	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA	CHN_HK	SEA	USA
GrainsCrops	1.572	0.406	4.878	2.226	0.332	5.917	2.195	0.841	6.572	2.134	-0.114	6.413
MeatLstk	-0.531	0.043	2.180	-0.732	0.027	2.492	-0.731	-0.216	2.656	-0.744	0.031	2.371
Extraction	0.184	-1.117	11.346	0.219	-1.166	12.066	0.218	-1.181	12.313	0.246	0.244	12.986
ProcFood	-0.076	0.232	2.728	-0.276	0.231	2.874	-0.275	-0.019	2.977	-0.231	-0.199	2.632
TextWapp	1.183	-2.798	11.920	0.932	-2.680	12.527	0.859	-3.242	13.321	0.986	1.552	8.987
mvh	-0.804	-0.374	1.228	-0.906	-0.324	1.437	-0.842	-0.317	1.673	-0.807	-0.530	3.089
LightMnfc	-0.606	-1.150	4.541	-0.631	-1.145	4.817	-0.642	-1.136	5.150	-0.649	-1.207	5.616
i_s	-0.725	0.152	0.679	-0.743	0.143	1.114	-0.736	0.530	1.625	-0.731	-4.633	3.623
HeavyMnfc	-0.371	-1.040	5.384	-0.363	-1.103	5.689	-0.352	-0.930	6.024	-0.162	-2.222	6.132
Util_Cons	-5.091	-3.232	-2.222	-5.445	-3.116	-2.267	-5.308	-3.385	-2.393	-4.943	2.737	-2.662
TransComm	-0.484	-0.664	-0.010	-0.563	-0.659	-0.014	-0.561	-0.747	-0.029	-0.521	0.381	-0.077
OthServices	-0.600	0.223	1.444	-0.661	0.240	1.414	-0.650	0.276	1.382	-0.634	0.098	1.212

Table 08.16: Domestic sales of commodity (%) (Author's own calculations)

8.2.5 Output - qo

Despite being subjected to substantially higher tariffs than most other countries, China demonstrates the greatest sectoral output resilience among the regions analysed, surpassing both Southeast Asia (SEA) and the United States (USA) in the number of sectors exhibiting output growth (See Table 08.15). Specifically, China records positive output growth in 8 out of 12 aggregated sectors under S1 and maintains positive growth in 7 sectors across S2 to S4. In S2, S3, and S4, the composition of growing sectors remains consistent, with positive output observed in the following areas: Grains and Crops, Mining and Extraction, Textiles and Clothing, Motor Vehicles and Parts, Heavy Manufacturing (excluding Iron & Steel), Transport and Communication, and Other Services. However, it is important to note that, notwithstanding this broad-based sectoral growth, China continues to experience negative economic growth in all four scenarios. This outcome might imply that the expanding sectors constitute a relatively smaller portion of the overall economic structure compared to those sectors experiencing contraction. Consequently, the negative performance of the larger, shrinking sectors outweighs the gains from the growing sectors, resulting in an overall decline in economic activity.

Southeast Asia emerges as the second-strongest performer among the three focal regions, registering positive output growth in seven sectors in both S1 and S2, reducing to five sectors in S3, but narrowing to just three sectors in S4. While growth rates across most sectors remain modest, generally below 2% in the first three scenarios, S4 is marked by a pronounced concentration of growth in the Textiles and Clothing sector, which exceeds 10%. A detailed examination of the underlying demand components, private household demand (qpa, qpd, qpm), public demand (qga, qgd, qgm), and domestic sales (qds), reveals that the expansion in SEA's Textiles and Clothing sector is not driven by domestic consumption. Instead, the growth is attributable to increased trade activity, specifically higher imports and exports of Textiles and Clothing. SEA might import raw materials and intermediate goods for Textiles and Clothing from abroad, processes them, and subsequently exports finished products, predominantly to the US market. Additionally, while SEA's exports of Textiles and Clothing (by volume) to most regions decline, exports to the US (by volume) surge by approximately 30 bn USD. Simultaneously, all regions except India and the US record increased exports of Textiles and Clothing to SEA, indicating a robust inflow of inputs for SEA's export-oriented production. These trends suggest that SEA's growth in Textiles and Clothing might be highly dependent on its role as a processing and export hub within global value chains, especially

during periods of heightened trade tensions between the US and China. Collectively, this confirms hypothesis 2 (H2).

The US exhibits the smallest number of sectors with projected output growth across all four trade war scenarios, limited to just four: Processed Food, Textiles and Clothing, Light Manufacturing (excluding Motor Vehicles and Heavy Equipment), and Other Services. Despite these isolated pockets of expansion, the persistent negative trajectory of aggregate economic growth in the US under each scenario indicates that these sectors might constitute a relatively minor share of the overall economy. As a result, their positive performance is insufficient to offset the broader contraction, and they exert limited influence on the nation's macroeconomic outcome, paralleling the situation observed in China, where sectoral gains are similarly outweighed by declines in larger, more significant sectors.

8.2.6 Domestic Sales - qds

The US demonstrates robust expansion in domestic sales, with growth observed in 10 out of 12 sectors across all four scenarios (see Table 08.16). The only exceptions are Utilities & Construction and Transport & Communication, which do not experience positive growth. This widespread increase can be attributed to the impact of reciprocal tariffs, which reduce US imports and necessitate greater reliance on domestic production and sales to satisfy internal demand.

In contrast, China exhibits a markedly weaker performance in domestic sales, with only three sectors projected to achieve growth. This disparity reflects the structural orientation of the Chinese economy, which is heavily export-driven. The redirection of output from international to domestic markets proves challenging, limiting the capacity for domestic sales to offset losses in export demand. Consequently, China experiences the most pronounced declines in export prices across nearly all sectors, further exacerbating the difficulty of stimulating domestic sales growth.

Southeast Asia achieves the highest number of sectors with expanding domestic sales in S4, with six sectors recording positive growth. Notably, Grains & Crops, Iron and Steel, and Other Services emerge as the most resilient sectors, displaying relative stability and minimal negative impact during the trade war episodes in S1, S2, and S3.

8.2.7 Terms of Trade - tot

Terms of trade (ToT) measures the purchasing power of a country's export in terms of its import. ToT is measured by dividing the price of export by price of import. In the standard GTAP model, the percentage change in ToT (tot) equals psw minus pdw in which psw is the price index received by an exporting country or region for its exports, while pdw is the price index paid by an importing country for its imports.

tot	S1	S2	S3	S4
AUS	-0.850	-0.680	-0.580	-0.670
RoW	-0.900	-0.840	-0.828	-0.900
CHN_HK	-1.790	-1.740	-1.731	-1.870
JPN	0.000	0.020	0.031	-0.280
KOR	0.520	0.550	0.558	0.220
TWN	-0.810	-0.810	-0.822	-1.120
SEA	-0.730	-0.720	-0.539	1.670
IND	2.000	1.970	1.925	1.110
USA	19.020	18.520	17.972	15.930
EU_27	0.470	0.470	0.471	0.310

Table 08.17: Terms of Trade (%) (Author's own calculations)

Australia (AUS), Rest of World (RoW), China & Hong Kong (CHN_HK), and Taiwan (TWN) all register persistent declines in terms of trade (ToT) across the four trade war scenarios. Among these, CHN_HK endures the most pronounced deterioration, with the largest losses. The adverse impact on China's ToT is especially acute in S4, where it contracts by nearly 1.9%, a decline coinciding with Southeast Asia's complete elimination of tariffs for US imports.

In contrast, South Korea (KOR), India (IND), the United States (USA), and the European Union (EU_27) all experience improvements in their ToT. The United States, in particular, achieves exceptionally large gains, with ToT increases averaging close to 18% across all scenarios. The most substantial US improvement occurs in S1, where the US is able to impose reciprocal tariffs unilaterally, without facing retaliatory measures from its trading partners. These ToT gains are expected to translate into significant welfare improvements, as discussed in subsequent analysis.

Southeast Asia (SEA) exhibits a nuanced pattern. ToT declines in S1, S2, and S3, reflecting the adverse effects of trade tensions. However, in S4, SEA's ToT rises sharply by 1.67%, surpassing all other regions except the United States. This turnaround is directly linked to SEA's unilateral tariff liberalisation for US imports, which fundamentally alters its trade position and relative price dynamics. Overall, these results provide full support for Hypothesis 1 (H1) in terms of terms of trade.

8.2.8 Welfare decomposition - WELFARE

Welfare decomposition provides a structured assessment of welfare gains and losses experienced by each region following a policy intervention. In this framework (Corong et al, 2017), overall welfare (WELFARE) is disaggregated into seven distinct components:

1. **Allocative Efficiency Effect (ALLOC):** Measures the efficiency costs or gains arising from distortions such as taxes or tariffs.
2. **Endowment Effect (ENDW):** Captures welfare changes due to shifts in factor endowments' quantities (e.g., labour, capital).
3. **Technology Effect (TECH):** Reflects welfare changes stemming from technological progress or productivity shocks.
4. **Population Effect (POP):** Quantifies the impact of demographic changes.
5. **Commodity Terms of Trade Effect (TOT):** Assesses welfare changes resulting from shifts in the relative prices of exports and imports.
6. **Investment-Savings Terms of Trade Effect (IS):** Evaluates the welfare impact of changes in the relative price of investment goods versus savings in the global bank.
7. **Preference Change Effect (PREF):** Accounts for welfare changes due to shifts in shares consumption preferences (e.g., between private, public, and savings).

Since the four scenarios do not involve shocking exogenous variables such as endowment (QE), technology (productivity), population (POP), as well as preference (shares of private,

public and savings consumption), the contributions of the ENDW, TECH, POP, and PREF components are zero for all regions. Consequently, all observed welfare changes are attributable to Allocative efficiency (excess burdens caused by tax / tariff changes), commodity terms-of-trade effect and investment-savings terms-of-trade effect.

A detailed examination of the welfare decomposition tables (Table 08.18) reveals that every country experiences welfare losses in at least one component. The Rest of World (RoW) consistently achieves positive allocative efficiency gains in all scenarios, while South Korea (KOR), India (IND), the United States (USA), and the European Union (EU_27) register positive gains in terms of trade, outcomes that align with the positive terms of trade results discussed previously. Southeast Asia (SEA) only records positive outcomes in allocative efficiency and terms of trade under S4, when it undertakes tariff liberalisation with the United States. Despite these isolated gains, the United States stands as the sole country to realise an overall increase in welfare across all four scenarios. This exceptional outcome is primarily attributable to the US's substantial gains in the Investment-Savings terms of trade effect (IS), which average approximately 557 bn USD, peaking in S1 and reaching their lowest in S4. For SEA, welfare losses are minimised in S4, resulting in a loss of roughly 3.8 billion USD, the smallest among all regions in that scenario. Notably, China also experiences its least severe welfare loss in S4, a result largely driven by an improvement in the Investment-Savings terms of trade effect (IS) relative to the preceding scenarios, facilitated by SEA's trade liberalisation with the US.

From the standpoint of Southeast Asia, S4 emerges as the most advantageous response to the ongoing US trade war, while S1 is the least favourite option, particularly given the reciprocal tariff measures implemented by the United States. Under this scenario, SEA's welfare improves markedly, with total gains approaching 49 billion USD between S1 and S4. This outcome highlights the significant benefits that unilateral trade liberalisation and strategic engagement with the US can deliver to the region.

However, when considering the aggregate welfare impact globally, the picture becomes more nuanced. Despite SEA's substantial welfare improvement in S4, this gain is insufficient to offset the pronounced decline in US welfare between Scenarios 3 and 4, which amounts to approximately 83 billion USD. As a result, the overall welfare position of the world actually deteriorates slightly in Scenario 4, as SEA's positive gains do not compensate for the larger losses incurred by the US.

Consequently, from a global perspective, Scenario 1 or a one-shot game, where the world acquiesces to the US's reciprocal tariff policy without mounting any retaliatory response, appears to be the least detrimental. In this scenario, the total welfare loss for the world is minimised, registering at approximately 243,65 billion USD. This counterintuitive outcome underscores the complexity of international welfare dynamics in the context of trade wars, where regional gains may not always translate into global improvements, and the optimal strategy for one region may not align with the best outcome for the world as a whole. Hypothesis 4 (H4) is therefore confirmed.

	S1				S2			
WELFARE	1 alloc_A1	5 tot_E1	6 IS_F1	Total	1 alloc_A1	5 tot_E1	6 IS_F1	Total
1 AUS	-1,203.001	-3,603.406	-18,448.598	-23,255.004	-992.974	-2,924.995	-18,312.631	-22,230.599
2 RoW	5,249.599	-63,335.070	-190,424.141	-248,509.611	5,452.000	-58,787.258	-188,400.594	-241,735.847
3 CHN_HK	-36,560.066	-99,988.781	-229,124.250	-365,673.098	-48,391.289	-99,493.766	-223,895.375	-371,780.425
4 JPN	-1,893.601	-420.149	-22,751.941	-25,065.692	-1,883.768	-224.591	-22,492.199	-24,600.557
5 KOR	-478.171	4,107.218	-13,526.005	-9,896.958	-325.997	4,333.459	-13,379.354	-9,371.891
6 TWN	-165.989	-4,522.350	-8,454.145	-13,142.483	-160.969	-4,521.222	-8,335.223	-13,017.414
7 SEA	-1,657.312	-15,065.572	-36,559.164	-53,282.047	-1,621.385	-14,761.377	-36,097.680	-52,480.442
8 IND	-862.666	16,205.734	-32,943.406	-17,600.337	-905.027	15,955.148	-32,518.117	-17,467.996
9 USA	-137,826.109	125,047.609	585,410.250	572,631.738	-140,169.375	119,285.906	577,237.813	556,354.352
10 EU_27	-2,225.972	31,005.836	-88,637.469	-59,857.604	-2,604.778	31,261.543	-87,469.391	-58,812.627
Total	-177,623.289	-10,568.931	-55,458.868	-243,651.096	-191,603.562	-9,877.151	-53,662.750	-255,143.446

	S3				S4			
WELFARE	1 alloc_A1	5 tot_E1	6 IS_F1	Total	1 alloc_A1	5 tot_E1	6 IS_F1	Total
1 AUS	-826.471	-2,478.483	-17,954.340	-21,259.293	-546.422	-2,756.319	-15,962.311	-19,265.051
2 RoW	5,562.014	-57,515.059	-184,158.188	-236,111.236	2,725.905	-64,382.289	-160,327.594	-221,983.975
3 CHN_HK	-48,124.902	-98,384.234	-218,248.109	-364,757.249	-48,609.891	-102,305.766	-188,175.688	-339,091.344
4 JPN	-1,829.609	-69.929	-21,987.301	-23,886.837	-1,732.092	-3,524.413	-19,324.510	-24,581.014
5 KOR	-193.780	4,409.187	-13,081.957	-8,866.550	-373.678	1,385.599	-11,170.930	-10,159.009
6 TWN	-155.120	-4,549.508	-8,118.143	-12,822.771	-103.050	-5,811.398	-7,013.075	-12,927.524
7 SEA	-6,326.441	-11,697.690	-35,183.344	-53,207.475	2,430.538	30,947.707	-37,208.176	-3,829.931
8 IND	-1,016.550	15,544.415	-31,755.598	-17,227.734	-2,183.667	9,235.248	-28,764.293	-21,712.713
9 USA	-143,369.500	114,324.297	564,888.750	535,843.548	-159,883.031	108,490.094	503,959.375	452,566.430
10 EU_27	-2,689.296	31,173.660	-85,371.102	-56,886.739	-4,357.795	20,369.020	-75,947.703	-59,936.479
Total	-198,969.654	-9,243.344	-50,969.330	-259,182.335	-212,633.185	-8,352.517	-39,934.903	-260,920.609

Table 08.18: Welfare decomposition (million USD) (Author's own calculations)

8.3 Conclusion

This chapter presents the simulation results derived from the four distinct policy scenarios detailed in Chapter 01. Analysis reveals that Scenario 4 yields the most favourable outcome for Southeast Asia in terms of real economic growth and welfare, as the region experiences economic contraction across the other three scenarios. Furthermore, in Scenario 4, Southeast Asia demonstrates superior macroeconomic performance relative to all other modelled regions.

At the sectoral level, Scenario 4 is also characterised by a beneficial environment, as evidenced by an aggregate increase in both public and private consumption across all sectors. Analysing the resultant exporting patterns, however, reveals distinct sectoral winners and losers across the different scenarios. Specifically, while exports from Textiles & Wearing Apparel (TextWapp), Light Manufacturing (LightMnfc), and Heavy Manufacturing (HeavyMnfc) all experience contraction under Scenarios 1 through 3, they emerge as the sole beneficiaries under the trade liberalisation scenario with the United States. Even within this advantageous scenario, the gains are highly heterogeneous: TextWapp records the most significant benefit, achieving a growth approaching 18%. LightMnfc occupies the intermediate position with growth of nearly 5.5%, while HeavyMnfc registers the most marginal improvement, with growth just under 1%.

While Scenario 4 emerges as the optimal strategic response for Southeast Asia in mitigating the impact of the US's reciprocal tariffs, it may not align with maximising global welfare. This divergence is evident when considering Scenario 1, which, despite resulting in a decline in total world welfare, generates the smallest welfare loss across all four simulated scenarios.

Overall, Hypotheses 1, 2, and 4 (H1, H2, H4) receive strong empirical confirmation from the GTAP simulations, whereas the results reject Hypothesis 3 (H3). Specifically, H3 erroneously predicted that US exports to Southeast Asia would increase under SEA's unilateral tariff liberalisation (S4); instead, US exports to SEA contract significantly.

9 Chapter 09: Conclusion

This thesis set out to examine the economic implications of President Trump 2.0's reciprocal tariff policies for Southeast Asia and to identify the most effective strategic response for the region. Using a computable general equilibrium (CGE) framework and four forward-looking policy scenarios, the study analysed how these tariffs affect macroeconomic performance, sectoral output, trade flows, and welfare across ten regions and twelve aggregated sectors. The results provide clear answers to the three research questions and allow the hypotheses developed in Chapter 4 to be evaluated directly.

9.1 Summary of Findings and Hypothesis Testing

Hypothesis 1 (H1): Macroeconomic impact in SEA

H1 predicted that Southeast Asia would experience net macroeconomic losses under Scenarios 1–3, with the largest losses occurring when the region retaliates (S3), and that unilateral liberalisation in S4 might reverse these effects. The results fully support this hypothesis. SEA's GDP and investment contract in S1–S3, with the deepest losses in S3. In contrast, Scenario 4 produces positive GDP growth and a strong rebound in investment, confirming that liberalisation yields better macroeconomic outcomes than retaliation.

Hypothesis 2 (H2): Sectoral impacts in SEA

H2 anticipated heterogeneous sectoral effects, with most non-service sectors contracting in S1–S3 and key manufacturing sectors expanding in S4. This hypothesis is strongly supported. Textiles & Wearing Apparel, Light Manufacturing, and Heavy Manufacturing all suffer losses in S1–S3 but become the fastest-growing sectors in S4. Other sectors show mixed or opposite patterns, confirming that tariff shocks reshape sectoral competitiveness in complex ways.

Hypothesis 3 (H3): US exports to SEA after tariff removal

H3 predicted that US exports to SEA would increase significantly once SEA removed all tariffs on US goods in Scenario 4. This hypothesis is rejected. Despite SEA eliminating all non-service tariffs for the US, American exports to SEA fall sharply in S4, while SEA's exports to the US rise substantially. General equilibrium adjustments, including domestic reallocation of US

production and SEA's improved competitiveness (via relatively lower US tariffs), explain this counterintuitive outcome.

Hypothesis 4 (H4): Optimal strategic response for SEA

H4 proposed that unilateral liberalisation (S4) would give SEA a comparative advantage over S1–S3, even if this outcome worsened global welfare relative to the non-retaliatory baseline (S1). The results support this hypothesis. Scenario 4 delivers the strongest macroeconomic and selectively sectoral performance for SEA, outperforming all other scenarios. However, global welfare lost is highest in S4 and smallest in S1, confirming that SEA's optimal strategy does not align with global welfare maximisation.

9.2 Overall Interpretation

Taken together, the findings show that reciprocal tariffs generate widespread economic losses, with the United States and China experiencing the largest contractions. Southeast Asia is negatively affected under most scenarios, but the region can avoid these losses, and even achieve modest gains, by adopting unilateral tariff liberalisation rather than retaliation. Scenario 4 consistently delivers the best outcomes for Southeast Asia across GDP, investment, consumption, and key export-oriented sectors.

However, the scenario that benefits Southeast Asia most does not maximise global welfare. Scenario 1 produces the smallest global welfare loss, highlighting a tension between regional strategy and global efficiency. What is optimal for Southeast Asia is not necessarily optimal for the world economy.

9.3 Limitations and Directions for Future Research

Several limitations of the study point to opportunities for further work. First, the static GTAP model does not capture dynamic adjustment processes, long-run investment behaviour, or financial market interactions. Incorporating a financial module or using a dynamic CGE model would allow richer analysis of intertemporal effects. Second, the GTAP v9 database, even after calibration, may not fully reflect the structure of

economies in 2024. Future research should take advantage of updated databases such as GTAP v12 which will be released in 2026. Third, the representative household assumption prevents distributional analysis. A multi-household specification would allow examination of how tariff shocks affect different income groups. Fourthly, trade elasticities should also be updated along the tariff levels in future works. Finally, the assumption of perfect competition may understate the role of strategic behaviour in industries such as electronics, automotive, and textiles. Models incorporating imperfect competition or firm heterogeneity could provide more realistic insights.

9.4 Policy Implications

Despite these limitations, the thesis offers a clear policy message that for Southeast Asia, unilateral tariff liberalisation is the most effective strategy to mitigate the negative effects of renewed US protectionism. Retaliation consistently worsens economic outcomes, while liberalisation strengthens competitiveness, attracts investment, and supports key export-oriented sectors. In a period of rising geopolitical uncertainty, this strategy positions Southeast Asia as a resilient and attractive participant in global value chains.

9.5 Closing Remarks

This thesis contributes new evidence on the economic consequences of the return of President Trump to the White House as well as his 2025 reciprocal tariff proposal and provides a structured framework for evaluating strategic responses by smaller, trade-dependent economies. By combining detailed data preparation, rigorous CGE modelling, and scenario-based analysis, it offers timely insights for policymakers navigating an increasingly complex global trading environment.

10 Bibliography:

- Adams, J., Khan, H., Raeside, R., and White, D. (2007) *Research Methods for Graduate Business and Social Science Students*, New Delhi: Response Books.
- Adelman, I. and Robinson, S. (1978) *Income distribution policy in developing countries: a case study of Korea*. London: Oxford University Press.
- Aguiar, A., Chepeliev, M., Corong, E., & van der Mensbrugghe, D. (2023). The Global Trade Analysis Project (GTAP) Data Base: Version 11. *Journal of Global Economic Analysis*, 7(2). <https://doi.org/10.21642/JGEA.070201AF> (Original work published 2022)
- Aguiar, A., Narayanan, B., & McDougall, R. (2016). An Overview of the GTAP 9 Data Base. *Journal of Global Economic Analysis*, 1(1), 181-208. <https://doi.org/10.21642/JGEA.010103AF>
- Anderson, J. E., & van Wincoop, E. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. *The American Economic Review*, 93(1), 170–192. <http://www.jstor.org/stable/3132167>
- ANDERSON, K., DIMARAN, B., FRANCOIS, J., HERTEL, T., HOEKMAN, B. and MARTIN, W. (2003). 'The Cost of Rich (and Poor) Country Protection to Developing Countries' *Journal of African Economies* 10, 3: 227-257
- ANDERSON, K., W. MARTIN and VAN DER MENSBRUGGHE (2005) 'Market and Welfare Implications of the Doha Reform Scenarios', Ch 12 in *Agricultural Trade Reform and the Doha Development Agenda*, edited by K. Anderson and W. Martin, Washington D.C.: World Bank.
- Apt, K.R. and Grädel, E. (eds.) (2011) *Lectures in Game Theory for Computer Scientists*. Cambridge: Cambridge University Press.
- Arrow, K. J., & Debreu, G. (1954). Existence of an Equilibrium for a Competitive Economy. *Econometrica*, 22(3), 265–290.
- Asian Development Bank (2023) *ASEAN global value chains: resilience and sustainability*. Manila: Asian Development Bank. Available at: <https://www.adb.org/sites/default/files/publication/871976/asean-global-value-chains-resilience-sustainability.pdf>. Accessed on: 20-Mar-2025.
- Bagwell, K. and Staiger, R.W. (2003) *The economics of the world trading system*. Cambridge, MA: MIT Press.

- Bagwell, Kyle, and Robert W. Staiger. 1990. “A Theory of Managed Trade.” *American Economic Review* 80 (4): 779–95.
- Balassa, B. (1980) *The Tokyo Round and the Developing Countries*. World Bank Staff Working Paper No. 370. Washington, DC: World Bank. Available at: <https://documents1.worldbank.org/curated/en/974711468741383068/pdf/multi0page.pdf>. Accessed on 25-Jan-2024.
- Baldwin, R. and Jaimovich, D. (2010) *Are free trade agreements contagious?* NBER Working Paper No. 16084. Cambridge, MA: National Bureau of Economic Research. Available at: <https://www.nber.org/papers/w16084>. Accessed on: 22-Mar-2025.
- Balistreri, E.J. and Hillberry, R. (2017) “21st century trade wars,”. Available at: <https://ageconsearch.umn.edu/record/332857/?v=pdf>. Accessed on 15-Apr-25.
- Bank of England. (2019) *Monetary Policy Report: November 2019*. Available at: <https://www.bankofengland.co.uk/-/media/boe/files/monetary-policy-report/2019/november/monetary-policy-report-november-2019.pdf>. Accessed on 22-Mar-2025.
- Baylis, J. et al. (2017). *The Globalization of World Politics* (7th ed.). Oxford: Oxford University Press.
- Behar, A. and Nelson, B.D. (2012) “Trade Flows, Multilateral Resistance, and Firm Heterogeneity”. IMF Working Paper WP/12/297. Available at: <https://www.imf.org/external/pubs/ft/wp/2012/wp12297.pdf>. Accessed on 15-Jun-2025.
- Bhagwati, J. (2008) *Termites in the trading system: how preferential agreements undermine free trade*. Oxford: Oxford University Press.
- Bickerdike, C. F. (1906). *The Theory of Incipient Taxes*. *The Economic Journal*, 16(64), 529–535. <https://doi.org/10.2307/2221475>
- Bjerkholt, O., Førsund, F.R. and Holmøy, E. (2016) “Commemorating Leif Johansen (1930–1982) and his pioneering computable general equilibrium model of 1960,” *Journal of policy modeling*, 38(3), pp. 415–420. Available at: <https://doi.org/10.1016/j.jpolmod.2016.02.008>.
- Blink, J. and Dorton, I. (2020) *Oxford IB Diploma Programme: IB Economics course book*. Oxford: Oxford University Press.

- Boehm, C.E., Levchenko, A.A. and Pandalai-Nayar, N. (2023) “The Long and Short (Run) of Trade Elasticities,” *The American economic review*, 113(4), pp. 861–905. Available at: <https://doi.org/10.1257/aer.20210225>.
- Boer, L. and Rieth, M. (2024) The macroeconomic consequences of import tariffs and trade policy uncertainty. IMF Working Paper No. 2024/013. Washington, DC: International Monetary Fund. Available at: <https://www.elibrary.imf.org/view/journals/001/2024/013/article-A001-en.xml>. Accessed on: 21-Apr-2025.
- Bown, C.P. (ed.) (2011) *The Great Recession and import protection: the role of temporary trade barriers*. Washington, DC: World Bank. Available at: <https://openknowledge.worldbank.org/entities/publication/99c63024-6a74-5bb2-a868-fa80535ebd4c>. Accessed on: 12-Apr-2024.
- Bown, C.P. and Crowley, M.A. (2013) “Self-Enforcing Trade Agreements: Evidence from Time-Varying Trade Policy,” *The American economic review*, 103(2), pp. 1071–1090. Available at: <https://doi.org/10.1257/aer.103.2.1071>.
- Brander, J.A. and Spencer, B.J. (1984) “Export Subsidies and International Market Share Rivalry,” NBER Working Paper Series, p. 1464. Available at: <https://doi.org/10.3386/w1464>.
- Broda, C. and Weinstein, D.E. (2006) “Globalization and the Gains From Variety,” *The Quarterly journal of economics*, 121(2), pp. 541–585. Available at: <https://doi.org/10.1162/qjec.2006.121.2.541>.
- Brouwer, L.E.J. (1911). Über Abbildung von Mannigfaltigkeiten. *Math. Ann.* 71, 97–115.
- BROWN, D. K., DEARDORFF, A. V. and STERN, R. M. (2003) 'Multilateral, Regional and Bilateral Trade Policy Options for the United States and Japan' *The World Economy*, 26,6: 803-828.
- Bryman, A., and Bell, E. (2007) *Business Research Methods*, Second Edition, Oxford, Oxford University Press.
- Burfisher, M.E. (2021) *Introduction to Computable General Equilibrium Models*. 3rd edn. Cambridge: Cambridge University Press.
- Capling, A. & Low, P. (eds.) (2010) *Governments, Non-State Actors and Trade Policy-Making : Negotiating Preferentially or Multilaterally?* / Edited by Ann Capling, Patrick Low. Cambridge: Cambridge University Press.

- Chaney, T. (2018) “The Gravity Equation in International Trade: An Explanation,” *The Journal of political economy*, 126(1), pp. 150–177. Available at: <https://doi.org/10.1086/694292>.
- Chang, H.J. (2014) *Economics: the user's guide*. London: Pelican
- Cheong, I and Tongzon, J. (2013). Comparing the Economic Impact of the Trans-Pacific Partnership and the Regional Comprehensive Economic Partnership. *Asian Economic Papers*; 12 (2): 144–164. doi: https://doi.org/10.1162/ASEP_a_00218
- Chepeliev, M. (2020b). “The GTAP 10A Data Base with Agricultural Production Tar-geting Based on the Food and Agricultural Organization (FAO) Data.” *Global Trade Analysis Project (GTAP)*, Department of Agricultural Economics, Purdue University, West Lafayette, IN, GTAP Research Memorandum No. 35
- Chepeliev, M. 2022a. “An Energy Data Base for GTAP.” In *Global Trade, Assistance, and Production: The GTAP 10 Data Base*, edited by A. Aguiar. Department of Agri-cultural Economics, Purdue University, West Lafayette, IN, center for global trade analysis 11.
- CLINE, W. R. (2004) *Trade Policy and Poverty* Washington, D. C.: Institute for International Economics.
- Clower, R.W. (1965) *The Keynesian Counterrevolution: A Theoretical Appraisal*. In: Hahn, F.H. and Brechling, F.P.R., Eds., *The Theory of Interest Rate*, Macmillan, London, 103-125.
- Colacicco, R. (2024) “Strategic trade policy in general oligopolistic equilibrium: The case of import tariffs,” *Research in economics*, 78(2). Available at: <https://doi.org/10.1016/j.rie.2024.100959>.
- Collis, J. and Hussey, R. (2003) *Business Research: A Practical Guide for Undergraduate and Postgraduate Students*, 2nd ed., New York, Palgrave Macmillan.
- Condon, T., Dahl, H. and Devarajan, S. (1987) *Implementing a computable general equilibrium model on GAMS: the Cameroon model*. Development Research Department discussion paper no. DRD 290. Washington, DC: World Bank. Available at: <http://documents.worldbank.org/curated/en/867181468236660050>. Accessed on 15-May-2025.

- Corong, E. L., Hertel, T. W., McDougall, R., Tsigas, M. E., & van der Mensbrugghe, D. (2017). The Standard GTAP Model, Version 7. *Journal of Global Economic Analysis*, 2(1), 1–119. <https://doi.org/10.21642/JGEA.020101AF>
- Craig R. MacPhee and Wanasin Sattayanuwat (2014) ‘Consequence of Regional Trade Agreements to Developing Countries’, *Journal of economic integration*, 29(1), pp. 64–94.
- Crawford, J. and Fiorentino, R.V. (2005) The changing landscape of regional trade agreements. WTO Discussion Paper No. 8. Geneva: World Trade Organization. Available at: https://www.wto.org/english/res_e/booksp_e/discussion_papers8_e.pdf. Accessed on 21-Feb-2024.
- Creswell J.W (2009) *Research design: Qualitative, Quantitative and Mixed Methods Approaches* (3rded.) Thousand Oaks, CA: Sage
- Cuddington, J. T. (1988). [Review of *The Michigan Model of World Production and Trade: Theory and Applications*, by A. V. Deardorff & R. M. Stern]. *Journal of Economic Literature*, 26(1), 119–120. <http://www.jstor.org/stable/2726631>
- Currall, S. C., and Inkpen, A. C. (2002). “A Multilevel Approach to Trust in Joint Ventures”. *Journal of International Business Studies*, 33(3), 479-495.
- Deardorff, A. V. and Stern, R. M. (1986) *The Michigan Model of World Production and Trade: Theory and Applications*, Cambridge: MIT Press.
- Denslow, D. (1982). [Review of *Models of Growth and Distribution for Brazil*, by L. Taylor, E. L. Bacha, E. A. Cardoso, & F. J. Lysy]. *The Journal of Developing Areas*, 16(3), 447–449. <http://www.jstor.org/stable/4191036>
- Denzin, N. K. and Lincoln, Y. S. (2000a) *Handbook of Qualitative Research*. Sage Publications, Inc., California.
- Department for Business and Trade (2024) *Impact assessment of the accession of the United Kingdom of Great Britain and Northern Ireland to the Comprehensive and Progressive Agreement for Trans-Pacific Partnership*. London: HM Government. Available at: https://assets.publishing.service.gov.uk/media/667563a13f6733e8c91666ff/cptpp_impact_assessment.pdf. Accessed on: 22-Mar-2025.
- Department for Business and Trade. (2025) *Partial equilibrium trade models: modelling paper*. Available at:

<https://www.gov.uk/government/publications/partial-equilibrium-trade-models-modelling-paper>. Accessed on: 21-May-2025).

- Dixon, J. (2017) 'The Impact on Australia of Trump's 45 Percent Tariff on Chinese Imports', *Economic Papers* 36(3), 266–274.
- Dixon, Peter B. & Rimmer, Maureen T., 2016. "Johansen's legacy to CGE modelling: Originator and guiding light for 50 years," *Journal of Policy Modeling*, Elsevier, vol. 38(3), pages 421-435.
- Eichengreen, B. and Irwin, D.A. (2010) 'The Slide to Protectionism in the Great Depression: Who Succumbed and Why?', *The Journal of economic history*, 70(4), pp. 871–897. Available at: <https://doi.org/10.1017/S0022050710000756>.
- Espitia, A., Mimouni, M., Pichot, X., Rocha, N. and Mattoo, A. (2018). *How Preferential is Preferential Trade?*. Washington, DC: World Bank. Available at: <http://hdl.handle.net/10986/29854>. Accessed on 22-Mar-2025.
- European Central Bank (2019) 'The economic implications of rising protectionism: a euro area and global perspective', *ECB Economic Bulletin*, (3). Available at: https://www.ecb.europa.eu/press/economic-bulletin/articles/2019/html/ecb.ebart201903_01~e589a502e5.en.html. Accessed on 22-Mar-2025.
- Evans, J.W. (1968) 'The General Agreement on Tariffs and Trade', *International organization*, 22(1), pp. 72–98. Available at: <https://doi.org/10.1017/S0020818300013473>.
- Foley, D.K. (2010) "What's wrong with the fundamental existence and welfare theorems?," *Journal of economic behavior & organization*, 75(2), pp. 115–131. Available at: <https://doi.org/10.1016/j.jebo.2010.03.023>.
- Fontagné, L., Perego, E., et Santoni, G. (2022), *MaGE 3.1: Long-Term Macroeconomic Projections of the World Economy*, *International Economics*, vol.172, p. 168-189.
- FRANCOIS, J. F., MCDONALD, B. and NORDSTROM, H. (1996) 'The Uruguay Round: A Numerically based Qualitative Assessment' in W. Martin and L. A. Winters (eds.) *The Uruguay Round and the Developing Economies*, New York: Cambridge University Press

- FRANCOIS, J., VAN MEIJL, H. and VAN TONGEREN, F. (2003) 'Trade Liberalization and Developing Countries under the Doha Round' CEPR Discussion Paper No. 4032.
- Freund, C. and Ornelas, E. (2010) Regional Trade Agreements. Policy Research Working Paper 5314. Washington, DC: World Bank. Available at: <https://openknowledge.worldbank.org/server/api/core/bitstreams/b4c4f907-7cef-52ad-a509-4365356c5b2e/content>. Accessed: 03-Nov-2024.
- Friedman, M. (1955). Leon Walras and His Economic System. *The American Economic Review*, 45(5), 900–909.
- Fudenberg, D. and Tirole, J. (1991) *Game Theory*. Cambridge, MA: MIT Press.
- Fudenberg, D., & Maskin, E. (1986). The Folk Theorem in Repeated Games with Discounting or with Incomplete Information. *Econometrica*, 54(3), 533–554.
<https://doi.org/10.2307/1911307>
- Gehlhar, M., Aguiar, A., McDougall, R. and Narayanan, B. (2014) 'Construction of the Trade Data for the GTAP Data Base'. Paper presented at the 22nd International Input-Output Conference, Lisbon, Portugal, 14-18 July. Available at: https://www.iioa.org/conferences/22nd/papers/files/1803_20140510051_ConstructionofTradeDataforGTAPI-IOConference.pdf. Accessed: 23-Jan-2025.
- Gibson, P., Wainio, J., Whitley, D. and Bohman, M. (2001) Profiles of tariffs in global agricultural markets. Agricultural Economic Report No. 796. Washington, DC: U.S. Department of Agriculture, Economic Research Service. Available at: <https://ers.usda.gov/publications/pub-details?pubid=41257>. Accessed on 22-Sep-2025.
- Giesecke, J.A., Waschik, R. and Tran, N.H. (2019) Modelling the consequences of the U.S.-China trade war and related trade frictions for the U.S., Chinese, Australian and global economies. CoPS Working Paper No. G-294. Melbourne: Centre of Policy Studies, Victoria University. Available at: <https://www.copsmodels.com/ftp/workpaper/g-294.pdf>. Accessed on 30-Apr-2025.
- GOLDIN, I. and VAN DER MENSBRUGGHE, D. (1996) 'Assessing Agricultural Tariffication under the Uruguay Round' in W. Martin and L. A. Winters (eds.) *The Uruguay Round and the Developing Economies*, New York: Cambridge University Press.

- Greenwald, B.C. and Stiglitz, J.E. (1986) “Externalities in Economies with Imperfect Information and Incomplete Markets,” *The Quarterly journal of economics*, 101(2), pp. 229–264. Available at: <https://doi.org/10.2307/1891114>.
- Gujarati, D.N. and Porter, D.C. (2010) *Essentials of Econometrics*. 4th Edition, McGraw-Hill/Irwin, New York.
- Hallren, R. and Riker, D. (2017) *An introduction to partial equilibrium modeling of trade policy*. Washington, DC: U.S. International Trade Commission, Office of Economics Working Paper 2017-07-B. Available at: https://www.usitc.gov/publications/332/working_papers/an_introduction_to_partial_equilibrium_modeling_of_trade_policy_0.html. Accessed on: 21-Apr-2025)
- HARRISON, G. W., TARR, D. and RUTHERFORD, T. F. (1995) 'Quantifying the Outcome of the Uruguay Round' *Finance & Development* 32, 4: 38-41
- Hayakawa, K., Kimura, F. and Laksanapanyakul, N. (2018) “Measuring the usage of preferential tariffs in the world,” *Review of world economics*, 154(4), pp. 705–723. Available at: <https://doi.org/10.1007/s10290-018-0321-9>.
- Head, K., and T. Mayer. 2014. “Gravity Equations: Workhorse, Toolkit, and Cookbook” in G. Gopinath, E. Helpman, and K. Rogoff (eds.) *Handbook of International Economics Vol. IV*, Amsterdam: Elsevier.
- Helleiner, E. (2019) “Varieties of American neomercantilism: From the first years of the Republic to Trumpian economic nationalism,” *European review of international studies*, 6(3), pp. 7–29. Available at: <https://doi.org/10.3224/eris.v6i3.02>.
- HERTEL, T., MARTIN, W., YANAGISHIMA, K., DIMANARAN, B. (1996) 'Liberalizing Manufactures in a Changing World Economy' in W. Martin and L. A. Winters (eds.) *The Uruguay Round and the Developing Economies*, New York: Cambridge University Press
- Hirschman, A. (1958) *The Strategy of Economic Development*. Yale University Press, New Haven.
- Hörner, J., Sugaya, T., Takahashi, S. and Vieille, N. (2011) ‘Recursive methods in discounted stochastic games: An algorithm for $\delta \rightarrow 1$ and a folk theorem’, *Econometrica*, 79(4), pp. 1277–1318.
- Horridge, M. (2000). *ORANI-G: A General Equilibrium Model of the Australian Economy*.

- Hudson, E.A. and Jorgenson, D.W. (1974) “US energy policy and economic growth, 1975–2000,” *Bell Journal of Economics and Management Science*, 5(2), p. 461. Available at: <https://doi.org/10.2307/3003118>.
- Humphrey, T.M. (1987) ‘Classical and Neoclassical Roots of The Theory of Optimum Tariffs’, *Economic Review*, 73(4), pp. 17–28. Available at: https://www.richmondfed.org/publications/research/economic_review/1987/er730402. Assessed on 24-Apr-2025.
- IMF. (2011) The multilateral aspects of policies affecting capital flows. Washington, D.C.: International Monetary Fund. Available at: <https://www.imf.org/external/np/pp/eng/2011/111611.pdf>. Accessed on: 21 January 2026.
- IMF. (2011). The WTO Doha Trade Round—Unlocking the Negotiations and Beyond. Washington, D.C.: International Monetary Fund. Available at: <https://www.imf.org/external/np/pp/eng/2011/111611.pdf>. Accessed on: 22-Mar-2025.
- Itakura, K. (2020) “Evaluating the Impact of the US–China Trade War,” *Asian economic policy review*, 15(1), pp. 77–93. Available at: <https://doi.org/10.1111/aepr.12286>.
- Ivanic, M. (2020) “The GTAP model in R: The benefits of involving the community in the development of general equilibrium tools for the future,” in. Available at: <https://ageconsearch.umn.edu/record/333157/?ln=en&v=pdf>. Accessed on 15-Jun-2025.
- Cogan, J.K. (2024) “President Biden Adds, Increases, and Maintains Tariffs on Chinese Goods Levied by President Trump,” *The American journal of international law*, 118(4), pp. 727–733. Available at: <https://doi.org/10.1017/ajil.2024.57>.
- Ji, X. et al. (2018) “Post-TPP Trade Policy Options for ASEAN and its Dialogue Partners: ‘Preference Ordering’ Using CGE Analysis,” *East Asian economic review*, 22(2), pp. 177–215. Available at: <https://doi.org/10.11644/KIEP.EAER.2018.22.2.342>.
- Johansen, L. (1960). A multi-sectoral study of economic growth. Amsterdam: North-Holland Publishing Company.
- Johnson, H. G. (1953). Optimum Tariffs and Retaliation. *The Review of Economic Studies*, 21(2), 142–153. <https://doi.org/10.2307/2296006>

- Johnson, R. B. and Onwuegbuzie, A. J., (2004) Mixed Methods Research: A Research Paradigm whose time has come, *Educational Researcher*, 33(7), 14-26
- Kerlinger, F.N., (1979) *Behavioural Research: A Conceptual Approach*. New York: Holt, Rinehart, and Winston.
- Keynes, J. M. (1936) *The general theory of employment, interest and money*. London: Macmillan.
- Kimura, F., Thangavelu, S. M. and Narjoko, D. (eds) (2022) *Regional Comprehensive Economic Partnership: implications, challenges, and future growth of East Asia and ASEAN*. Jakarta: Economic Research Institute for ASEAN and East Asia (ERIA). Available at: <https://www.eria.org/uploads/media/Books/2022-RCEP-Book1/RCEP-Implications-Challenges-Future-Growth.pdf>. Accessed on: 21-Mar-2024).
- Krugman, P. R., Obstfeld, M., & Melitz, M. J. (2012). *International Economics: Theory and Policy* (9th ed.). Pearson Addison-Wesley.
- Kuenzel, D.J. and Sharma, R.R. (2021) "Preferential trade agreements and MFN tariffs: Global evidence," *European economic review*, 138. Available at: <https://doi.org/10.1016/j.eurocorev.2021.103850>.
- Latina, J., Piermartini, R. and Ruta, M. (2011) "Natural resources and non-cooperative trade policy," *International economics and economic policy*, 8(2), pp. 177–196. Available at: <https://doi.org/10.1007/s10368-011-0194-z>.
- Lee, H. and Itakura, K. (2018) "The welfare and sectoral adjustment effects of mega-regional trade agreements on ASEAN countries," *Journal of Asian economics*, 55, pp. 20–32. Available at: <https://doi.org/10.1016/j.asieco.2017.09.001>.
- Lee, H., Owen, R.F. and van der Mensbrugghe, D. (2009) "Regional integration in Asia and its effects on the EU and North America," *Journal of Asian economics*, 20(3), pp. 240–254. Available at: <https://doi.org/10.1016/j.asieco.2009.02.001>.
- Lee, H. and Itakura, Ken, 2017. "Potential Costs of U.S. Withdrawal from the Trans-Pacific Partnership," Conference papers 332825, Purdue University, Center for Global Trade Analysis, Global Trade Analysis Project.
- Leontief, W.W. (1941) *The Structure of the American Economy, 1919-1929: An Empirical Application of Equilibrium Analysis*. Harvard University Press, Cambridge, MA.

- Li, C. and Whalley, J. (2014) “China and the Trans-Pacific Partnership: A Numerical Simulation Assessment of the Effects Involved,” *World economy*, 37(2), pp. 169–192. Available at: <https://doi.org/10.1111/twec.12123>.
- Li, Q., Scollay, R. and Gilbert, J. (2017) “Analyzing the effects of the Regional Comprehensive Economic Partnership on FDI in a CGE framework with firm heterogeneity,” *Economic modelling*, 67, pp. 409–420. Available at: <https://doi.org/10.1016/j.econmod.2017.07.016>.
- Lim, S. and Nguyen, A.P.T. (2024) “Shifting Trade Winds: Southeast Asia’s Response to the United States–People’s Republic of China Trade Dispute,” *Asian development review*, 41(2), pp. 57–80. Available at: <https://doi.org/10.1142/S0116110524400134>.
- Lockwood, B. and Wong, K. (2000) “Specific and ad valorem tariffs are not equivalent in trade wars,” *Journal of international economics*, 52(1), pp. 183–195. Available at: [https://doi.org/10.1016/S0022-1996\(99\)00053-7](https://doi.org/10.1016/S0022-1996(99)00053-7).
- Lucas, Robert Jr, 1976. "Econometric policy evaluation: A critique," *Carnegie-Rochester Conference Series on Public Policy*, Elsevier, vol. 1(1), pages 19-46.
- Maggi, G. (1999) “Strategic Trade Policy Under Incomplete Information,” *International economic review*, 40(3), pp. 571–594. Available at: <https://doi.org/10.1111/1468-2354.00029>.
- Mailath, G.J. and Samuelson, L. (2006) *Repeated Games and Reputations: Long Run Relationships*. Oxford: Oxford University Press.
- Marshall, A. (1890/1920) *Principles of economics*. 8th ed. London: Macmillan.
- McDonald, S. and Thierfelder, K. (2004) “Deriving A Global Social Accounting Matrix From GTAP Versions 5 And 6 Data.” Available at: <https://doi.org/10.22004/ag.econ.28716>.
- Mueller, L.M. (2019) “ASEAN centrality under threat - the cases of RCEP and connectivity,” *Journal of contemporary East Asia studies*, 8(2), pp. 177–198. Available at: <https://doi.org/10.1080/24761028.2019.1691703>.
- Myrdal, G. (1957). *Economic Theory and Underdeveloped Regions*. London: Gerald Duckworth.
- Naito, T. (2019). A larger country sets a lower optimal tariff. *Review of International Economics*, 27(2), 643–665. <https://doi.org/10.1111/roie.12391>

- Narayanan, B.G., Hertel, T.W. and Horridge, J.M. (2010) “Disaggregated data and trade policy analysis: The value of linking partial and general equilibrium models,” *Economic modelling*, 27(3), pp. 755–766. Available at: <https://doi.org/10.1016/j.econmod.2010.01.018>.
- Nash, J. (1951) “Non-Cooperative Games,” *Annals of mathematics*, 54(2), pp. 286–295. Available at: <https://doi.org/10.2307/1969529>.
- Nelson, D.R. (2019) “Facing up to Trump administration mercantilism: The 2018 WTO trade policy review of the United States,” *World economy*, 42(12), pp. 3430–3437. Available at: <https://doi.org/10.1111/twec.12875>.
- Ngavozafy, A. et al. (2020) “Tariff reduction schedules: a global database offering all EPAs in force [2014-2050],” in. Available at: <https://ageconsearch.umn.edu/record/333166/?v=pdf>. Accessed on 09-Apr-2025.
- OECD (2003) *The Doha Development Agenda: Welfare Gains from Further Multilateral Trade Liberalization with Respect to Tariffs* TD/TC/WP(2003)10/FINAL, Paris: OECD
- O'Regan, N. and Ghobadian, A. (2004) Testing the Homogeneity of SMEs: The Impact of Size on Managerial and Organisational Processes. *European business review*, 16(1), 64-79.
- Park, C.-Y., Petri, P. and Plummer, M.G. (2021) “Economic Implications of the Regional Comprehensive Economic Partnership for Asia and the Pacific,” ADB Economics Working Paper Series [Preprint], (639).
- Pauwelyn, J. and Pelc, K. (2022) “Who Guards the ‘Guardians of the System’? The Role of the Secretariat in WTO Dispute Settlement,” *The American journal of international law*, 116(3), pp. 534–566. Available at: <https://doi.org/10.1017/ajil.2022.20>.
- Petri, P.A. and Plummer, M.G. (2014) “ASEAN Centrality and the ASEAN-US Economic Relationship,” *Policy studies (East-West Center Washington)*, (69), p. 0_1.
- Petri, P.A. and Plummer, M.G. (2020) *East Asia decouples from the United States: trade war, COVID-19, and East Asia's new trade blocs. Working Paper 20-9*. Washington, DC: Peterson Institute for International Economics. Available at: <https://www.piie.com/publications/working-papers/east-asia-decouples-united-states-trade-war-covid-19-and-east-asias-new>. Accessed on: 20-Mar-2025.

- Petri, P.A. and Plummer, M.G. (2023) ‘Chapter 6: Navigating the new trade landscape’, in Asian Development Bank (ed.) ASEAN and global value chains: locking in resilience and sustainability. Manila: Asian Development Bank, pp. 200–235. Available at: <https://www.adb.org/sites/default/files/publication/871976/asean-global-value-chains-resilience-sustainability.pdf>. Accessed on 22-Mar-2025.
- Piermartini, R. and Teh, R. (2005) Demystifying modelling methods for trade policy. WTO Discussion Paper No. 10. Geneva: World Trade Organization. Available at: https://www.wto.org/english/res_e/booksp_e/discussion_papers10_e.pdf. Accessed on: 15-Jan-2023.
- Poissonnier, A. (2016) Solving for structural gravity in panels: yes we can. European Economy Discussion Paper 040. Available at: https://economy-finance.ec.europa.eu/document/download/775bce01-98b4-4da0-8d34-83979c3eaefc_en?filename=dp040_en.pdf. Accessed on: 27-Aug-2025.
- Powell, B. (Ed.). (2018). Economic Freedom and Prosperity: The Origins and Maintenance of Liberalization (1st ed.). Routledge. <https://doi.org/10.4324/9780429443817>
- Pretorius, L. (2024) “Demystifying Research Paradigms: Navigating Ontology, Epistemology, and Axiology in Research,” Qualitative report, 29(10), pp. COV1-2715. Available at: <https://doi.org/10.46743/2160-3715/2024.7632>. Accessed on 22-Mar-2025.
- Pujolas, P. and Roszbach, J. (2024) “Trade Wars with Trade Deficits”. SSRN. Available at: <https://doi.org/10.48550/arxiv.2411.15092>.
- Pyatt, G. (1991) “Fundamentals of Social Accounting,” Economic systems research, 3(3), pp. 315–341. Available at: <https://doi.org/10.1080/09535319100000024>.
- Raihan, S., Khorana, S., & Uddin, M. (2024). Navigating LDC graduation: modelling the impact of RCEP and CPTPP on Bangladesh. Journal of the Asia Pacific Economy, 29(3), 1599–1621. <https://doi.org/10.1080/13547860.2022.2114227>
- Ricardo, D. (1817) On the principles of political economy and taxation. London: John Murray.

- Rose, A. K. and Yellen, J. L. (1989) ‘Is there a J-curve?’, *Journal of Monetary Economics*, 24(1), pp. 53–68.
- Rosyadi, S.A. and Widodo, T. (2018) “Impact of Donald Trump’s tariff increase against Chinese imports on global economy: Global Trade Analysis Project (GTAP) model,” *Journal of Chinese economic and business studies*, 16(2), pp. 125–145. Available at: <https://doi.org/10.1080/14765284.2018.1427930>.
- Round, J. (2003) “Constructing SAMs for Development Policy Analysis: Lessons Learned and Challenges Ahead,” *Economic systems research*, 15(2), pp. 161–183. Available at: <https://doi.org/10.1080/0953531032000091153>.
- Rubinstein, A. (1982) “Perfect equilibrium in a bargaining model,” *Econometrica*, 50(1), pp. 97–109.
- Ruggles, R. (1995) “System of national accounts, 1993,” *Journal of government information*, 22(4), pp. 349–351. Available at: [https://doi.org/10.1016/1352-0237\(95\)90103-5](https://doi.org/10.1016/1352-0237(95)90103-5).
- Saggi, K. (2004) “Tariffs and the most favored nation clause,” *Journal of international economics*, 63(2), pp. 341–368. Available at: [https://doi.org/10.1016/S0022-1996\(03\)00057-6](https://doi.org/10.1016/S0022-1996(03)00057-6).
- Santos Silva, J., and S. Tenreyro. 2006. “The Log of Gravity.” *Review of Economics and Statistics*, 88(4): 641-658
- Saunders, M. N. K., Lewis, P., & Thornhill, A. (2023). *Research Methods for Business Students* (9th ed.). Pearson.
- Sayer, R. (1992) *Method in Social Science: A Realist Approach*. Routledge, London.
- Scarf, H. (1967) “The Approximation of Fixed Points of a Continuous Mapping,” *SIAM journal on applied mathematics*, 15(5), pp. 1328–1343. Available at: <https://doi.org/10.1137/0115116>.
- Sharma, S.K. et al. (2023) “Evaluating the Reasons for India’s Withdrawal from RCEP: A General Equilibrium Analysis,” *Indian economic journal*, 71(3), pp. 508–531. Available at: <https://doi.org/10.1177/00194662231159847>.
- Shepherd, B., Doytchinova, H. S. and Kravchenko, A. (2019) *The gravity model of international trade: a user guide [R version]*. Bangkok: United Nations ESCAP. Available at: <https://www.unescap.org/resources/gravity-model-international-trade-user-guide-r-version>. Accessed: 16-Feb-2022.

- Shimizu, K. (2021) “The ASEAN Economic Community and the RCEP in the world economy,” *Journal of contemporary East Asia studies*, 10(1), pp. 1–23. Available at: <https://doi.org/10.1080/24761028.2021.1907881>.
- Shimizu, K. (2021) “The ASEAN Economic Community and the RCEP in the world economy,” *Journal of contemporary East Asia studies*, 10(1), pp. 1–23. Available at: <https://doi.org/10.1080/24761028.2021.1907881>.
- Simonovska, I. and Waugh, M.E. (2014) “The elasticity of trade: Estimates and evidence,” *Journal of international economics*, 92(1), pp. 34–50. Available at: <https://doi.org/10.1016/j.jinteco.2013.10.001>.
- Sinko, P. (1992). *Computable General Equilibrium Models in Economics: A Survey on Theoretical Foundations and Applications*. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-92-026
- Smith, A. (1776/2012) *An inquiry into the nature and causes of the wealth of nations*. Ware: Wordsworth Editions.
- Soderbery, A. (2018) “Trade elasticities, heterogeneity, and optimal tariffs,” *Journal of international economics*, 114, pp. 44–62. Available at: <https://doi.org/10.1016/j.jinteco.2018.04.008>.
- Sun, K. et al. (2023) “Estimating the effects of regional value chains of the RCEP in a GVC-CGE model,” *Journal of Asian economics*, 88. Available at: <https://doi.org/10.1016/j.asieco.2023.101647>.
- Taylor L., Bacha E.L., Cardoso E.A., & Lysy F.J. (1980). *Models of Growth and Distribution for Brazil (a World Bank Research Publication)*, London - New York. Oxford University Press. Available at: <https://documents1.worldbank.org/curated/en/275661468743788902/pdf/multi0page.pdf>. Accessed on 16-Feb-25.
- Tinbergen, J. (1962) *Shaping the World Economy: Suggestions for an International Economic Policy*. The Twentieth Century Fund, New York.
- UNCTAD (2003) *Back to Basics: Market Access Issues in the Doha Agenda* Geneva: UNCTAD
- United Nations (1947). *Measurement of National Income and the Construction of Social Accounts Report*. Available at: <https://unstats.un.org/unsd/nationalaccount/hsna.asp>. Accessed on 22-Mar-2025.

- United Nations (1957). A System of National Accounts and Supporting Tables Report. Available at:
<https://unstats.un.org/unsd/nationalaccount/docs/1953SNA.pdf>. Accessed on 22-Mar-2025.
- United Nations (1968). A System of National Accounts Report. Available at:
<https://unstats.un.org/unsd/nationalaccount/docs/1968SNA.pdf>. Accessed on 22-Mar-2025.
- United Nations (1993). System of National Accounts Report. Available at:
<https://unstats.un.org/unsd/nationalaccount/docs/1993sna.pdf>. Accessed on 22-Mar-2025.
- United Nations (2018) Handbook on Supply, Use and Input-Output Tables with Extensions and Applications. Studies in Methods (Series F), No. 74, Rev.1. New York: United Nations. Available at:
https://unstats.un.org/unsd/nationalaccount/docs/SUT_IOT_HB_Final_Cover.pdf. Accessed on 02--Jul-2024.
- United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank (2009). System of National Accounts Report. Available at:
<https://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf>. Accessed on 22-Mar-2025.
- VanGrasstek, C. (2013) The history and future of the World Trade Organization. Geneva: WTO Publications.
- VanGrasstek, C. (2013) The history and future of the World Trade Organization. Geneva: WTO Publications.:
https://www.wto.org/english/res_e/booksp_e/historywto_e.pdf
- Vanzetti, D., Do, H. and Peters, R. (2020) "Trade wars and their implications for developing countries," Available at:
<https://ageconsearch.umn.edu/record/333130/?v=pdf>. Accessed on 15-Apr-25.
- Viner, J. (1950/2014) The Customs Union Issue, edited and with an introduction by Paul Oslington. Oxford: Oxford University Press.
- Vos, R.P. & Ganuza, E. & Morley, S. & Robinson, S. & Pineiro, V., 2004. "Are export promotion and trade liberalization good for Latin America's poor? : a comparative macro-micro CGE analysis," ISS Working Papers - General Series

19158, International Institute of Social Studies of Erasmus University Rotterdam (ISS), The Hague.

- Walras, L. (1954) *Elements of Pure Economics or the Theory of Social Wealth*. Translated by William Jaffé. London: George Allen & Unwin.
- Wettstein, S., A. Liberatore, J. Magdeleine, and A. Maurer. 2021. “A GLOBAL TRADE IN SERVICES DATA SET BY SECTOR AND BY MODE OF SUPPLY.” WTO, Report.
- Whalley, J. (1996) “Why Do Countries Seek Regional Trade Agreements?,” NBER Working Paper Series, p. 5552. Available at: <https://doi.org/10.3386/w5552>.
- Winters, L. A. (1987). [Review of *The Michigan Model of World Production and Trade: Theory and Applications*, by A. Deardorff & R. M. Stern]. *The Economic Journal*, 97(385), 233–234. <https://doi.org/10.2307/2233337>
- World Bank (2010). *East Asia and Pacific Economic Update, November 2009: Transforming the Rebound into Recovery*. Washington, DC: World Bank. Available at: <https://openknowledge.worldbank.org/entities/publication/1cf599f5-257a-5846-b68a-f9023df800ac>. Accessed on: 25-Apr-2024.
- WTO, ITC and UNCTAD (2025) *World Tariff Profiles 2025*. Available at: https://www.wto.org/english/res_e/booksp_e/world_tariff_profiles25_e.pdf. Accessed on 22-Mar-2025.
- WTO. (2009) *World trade report 2009: trade policy commitments and contingent protection*. Geneva: WTO Publications. Available at: https://www.wto.org/english/res_e/booksp_e/anrep_e/world_trade_report09_e.pdf. Accessed on 22-Mar-2025.
- WTO. (2015) *Trade and Tariffs*. Geneva: WTO Publications. Available at: https://www.wto.org/english/thewto_e/20y_e/wto_20_brochure_e.pdf. Accessed on 23-Mar-2025.
- Yotov, Y. V., Piermartini, R., Monteiro, J.-A. and Larch, M. (2016) *An advanced guide to trade policy analysis: the structural gravity model*. Geneva: World Trade Organization. Available at: https://www.wto.org/english/res_e/booksp_e/advancedwtounctad2016_e.pdf. Accessed on: 21-Aug-2025.
- Yu, H. (2024). *Riding on the BRI Train: Issues Relating to China’s Strengthening Ties with Cambodia*. In: *Understanding China’s Belt and Road Initiative*. Asia in

Transition, vol 26. Springer, Singapore. https://doi.org/10.1007/978-981-99-9633-9_6

- Zheng, J. et al. (2023) “Effects of Eliminating the US–China Trade Dispute Tariffs,” *World trade review*, 22(2), pp. 212–231. Available at: <https://doi.org/10.1017/S1474745622000271>.

11 Appendix

Additional information in the Appendix is organised by chapters.

11.1 Chapter 04

11.1.1 Domestic final demand

There are three types of final demand to be discussed in this section, namely private expenditures, public expenditures, and investment expenditures.

Abbreviation	Description
qpa	Quantity demanded by Private HH - composite - pc
qpd	Quantity demanded by Private HH - domestic - pc
qpm	Quantity demanded by Private HH - import - pc
qga	Quantity demanded by Government - composite - pc
qgd	Quantity demanded by Government - domestic - pc
qgm	Quantity demanded by Government - import - pc
qia	Quantity demanded for Investment - composite - pc
qinv	Quantity demanded for Investment aggregate - pc
qid	Quantity demanded for Investment - domestic - pc
qim	Quantity demanded for Investment - imported - pc
ppa	Price paid by Private HH – composite - pc
ppd	Price paid by Private HH – domestic – pc
ppm	Price paid by Private HH – import – pc
pga	Price paid by Government – composite - pc
pgd	Price paid by Government – domestic – pc
pgm	Price paid by Government – import – pc
pia	Price paid by Investor – composite - pc
pid	Price paid by Government – domestic - pc
pim	Price paid by Government – import - pc

ppriv	Price index Private HH expenditure - pc
pgov	Price index Government expenditure – pc
pinv	Price index Investment expenditure – pc
yr	Income – total regional - pc
yp	Income / Expenditure consumption Private - pc
yg	Income / Expenditure consumption Government - pc
pop	Population growth rate – pc
uepriv	Elasticity of private consumption expenditure (cost), with respect to utility from private consumption - pc
EP	Elasticity - own & cross-price
EY	Elasticity - income
INCPAR	Elasticity - income
SUBPAR	Elasticity - substitution
$APE_{c,k,r}$	Elasticity - Adjusted price for commodity c with respect to price index k in region r
$ALPHA_{k,r}$	Parameter reflecting the weight of price index k in the utility function for region r
$ALPHA_{c,r}$	Parameter reflecting the weight of commodity c in the utility function for region r ($1 - SUBPAR_{c,r}$)
$CONSHR_{k,r}$	Consumption share of price index k in region r
$CONSHR_{c',r}$	Consumption share of price index c' in region r
$\delta_{c,k}$	Cross-price elasticity parameter between commodity c and price index k (Kronecker with value [0,1] or [identical indices, otherwise])
$ESUBG_r$	Elasticity of substitution across commodities
ug_r	Utility from government consumption
$VGP_{c,r}$	Value of Government expenditure on commodity c in region r
GOVEXP	Total Government expenditure
PINV	Price of Investment
QINV	Quantity of Investment

QIA	Quantity demand for composite commodity by the capital goods
PIA	Price for composite commodity by the capital goods
VIP REGINV	/ Expenditure shares

Table 04.05: Summary of key variables

11.1.1.1 Private expenditures

The equation for private expenditures resembles the Marshallian demand equation, which normally represents the quantity of a particular good demanded by a private consumer as a function of its own price, the consumer's income, and other goods' prices.

$$(11) \text{ qpa}_{c,r} - \text{pop}_r = \sum_k \text{EP}_{c,k,r} \text{ ppak}_{k,r} + \text{EY}_{c,r} (\text{yr}_r - \text{pop}_r)$$

$\text{qpa}_{c,r}$ represents the percentage change in the quantity demanded by private consumers, and pop_r represents the population growth in region r . Hence, $\text{qpa}_{c,r} - \text{pop}_r$ shows the per capita growth rate in private consumption. Such a product is driven by the combined effect of price changes across all sectors, where the effect of each sector (k)'s price change is weighted by its own- and cross-price elasticities, $\text{EP}_{c,r}$. It is also determined by the effect of changes in per capita real GDP, $\text{yr}_r - \text{pop}_r$, where the effect is weighted by the income elasticity of demand for good 'c', $\text{EY}_{c,r}$.

The Constant Differences of Elasticity ("CDE") captures the private expenditure in the standard GTAP v7, and CDE is a non-homothetic functional form. Homotheticity means that an increase in income will result in the same proportional increase in the demand for all goods; for example, a 5% increase in income will lead to a 5% increase in demand for both apples and oranges. CDE is more realistic than other functional forms, such as Cobb-Douglas and CES (both are homothetic), in the sense that as income increases, a typical consumer would spend a larger share of their income towards luxurious goods and a smaller proportion towards necessities and inferior goods. Such changes in consumption behaviour are captured in the income elasticity of demand for each good.

The CDE demand system, under the Neoclassical approach, is described as follows:

$$\begin{aligned} \max U: \sum_c a_c U^{e_c b_c} \left(\frac{P_c}{Y} \right)^{b_c} &\equiv 1 \\ \text{subject to } Y &= \sum_c P_c X_c \end{aligned}$$

The above formulas refer to the utility (U) maximisation, subject to the budget constraint (Y). The term “e” refers to the income elasticity ($INCPAR_{c,r}$) while “b” refers to the substitution elasticity ($SUBPAR_{c,r}$).

By adopting Roy’s identity¹¹⁵ and the implicit function theorem¹¹⁶, we can derive the budget shares as follows:

$$s_c = \frac{Z_c}{\sum_k Z_k} \text{ where } Z_c = a_c b_c U^{e_c b_c} \left(\frac{P_c}{Y} \right)^{b_c}$$

$$(11) APE_{c,k,r} = ALPHA_{k,r} + ALPHA_{c,r} \left(1 - \frac{\delta_{c,k}}{CONSHR_{k,r}} \right) - \sum_{c'} CONSHR_{c',r} \cdot ALPHA_{c',r}$$

$$(11') ALPHA_c = 1 - SUBPAR_c$$

(12)

$$\begin{aligned} EY_{c,r} = [INCPAR_{c,r} (1 - ALPHA_{c,r}) + \sum_k CONSHR_{k,r} \cdot INCPAR_{k,r} \cdot ALPHA_{k,r}] \div \\ [\sum_k CONSHR_{k,r} \cdot INCPAR_{k,r}] + [ALPHA_{c,r} - \sum_k CONSHR_{k,r} \cdot INCPAR_{k,r}] \end{aligned}$$

$$(13) EP_{c,k,r} = CONSHR_{c,r} (APE_{c,k,r} - EY_{c,r})$$

¹¹⁵ Roy’s identity is a result of the consumer theory that provides a way to derive the demand for a good from the consumer’s indirect utility function. In simple terms, if an indirect utility function describes the highest possible utility (U) a consumer can achieve given their income (Y) and the prices of goods (P), Roy’s identity allows the recovery of the demand for a particular good (D) by taking the derivative of this function with respect to the good’s price, and normalising it by the derivative with respect to income $\{D = - [(dU/dP) / (dU/dY)]\}$. In the context of the GTAP model, this means that once the indirect utility function is defined, Roy’s identity is applied to generate the equations that model consumer demand for commodities, linking consumer preferences, prices, and income in the model.

¹¹⁶ The implicit function theorem is a mathematical concept from calculus that guarantees, under certain conditions, the existence of functions defined indirectly by equations. In economic modelling (as in GTAP v7), it allows researchers to examine how variables, such as utility, demand, or prices, change in response to shifts in parameters, even if explicit formulas are not available. When demand functions are defined via a utility maximisation problem, sometimes the resulting relationships are only described implicitly. The implicit function theorem then ensures that these relationships can be differentiated and manipulated mathematically, which is crucial for deriving the needed comparative statics and for constructing linearised (differential) equations for CGE models.

Formula (11), $AP_{c,k,r}$ refers to the Allen partial elasticity of substitution which quantifies the substitutability between two goods in response to relative price variations, maintaining a constant level of utility. Parameter δ (Kronecker) takes the value 1 for identical indices and 0 otherwise, while $CONSHR_c$ denotes the consumption share of good c in the total income.

Formula (12) calculates the income elasticity of demand for good c in region r , $EY_{c,r}$. Formula (13) takes into account the results of formulas (11) and (12) and measures the uncompensated price elasticities of good c with price index k and region r , $EP_{c,k,r}$. The uncompensated price elasticity, normally known as Marshallian demand, measures the change in quantity demanded of a good in response to a price change, without accounting for the resulting change in the consumer's real income. This contrasts with Hicksian demand or compensated price elasticity, which allows the consumer's income to change to keep the consumer on the same indifference curve when prices change. Given the invariance of the CDE function's parameters, fluctuations in the elasticity expressions are solely attributed to the dynamic budget shares ($CONSHR_{c,r}$).

The following formulas construct the private demand for domestic and imported commodities $qpd_{c,r}$ and $qpm_{c,r}$, respectively, as well as the price of the composite good paid by consumers, $ppa_{c,r}$.

$$(14) \quad qpd_{c,r} = qpa_{c,r} - ESUBD_{c,r} (ppd_{c,r} - ppa_{c,r})$$

$$(15) \quad qpm_{c,r} = qpa_{c,r} - ESUBD_{c,r} (ppm_{c,r} - ppa_{c,r})$$

$$(16) \quad PPA_{c,r} \cdot QPA_{c,r} = PPD_{c,r} \cdot QPD_{c,r} + PPM_{c,r} \cdot QPM_{c,r}$$

$$(16') \quad ppa_{c,r} = (1 - PMSHR_{c,r}) ppd_{c,r} + PMSHR_{c,r} \cdot ppm_{c,r}$$

The logic used to explain formulas (8), (9), (10), and (10') can also be applied to explain the four formulas above.

11.1.1.2 Public expenditure

Unlike private consumption, where CDE is utilised, the government's utility function is captured by Constant Elasticity of Substitution (CES).

$$(17) \text{ qga}_{c,r} = \text{ygr} - \text{pgov}_r - \text{ESUBGr} (\text{pga}_{c,r} - \text{pgov}_r)$$

$$(18) \text{ pgov}_r = \sum_c \frac{\text{VGP}_{c,r}}{\text{GOVEXP}_r} \text{pga}_{c,r}$$

Formula (17) shows that the percentage change in the government demand is positively influenced by the percentage change in government income, ygr , but negatively affected by the price level paid by the government, pgov_r . The percentage change in public expenditure is also negatively influenced by the relative price of the specific commodity c in relation to the aggregated price level, $\text{pga}_{c,r} - \text{pgov}_r$, weighted by the elasticity of substitution, ESUBGr . Equation (18) shows the government expenditure price index, with the budget shares ($\text{VGP}_{c,r} / \text{GOVEXP}_r$) represented by the ratio term.

$$(19) \text{ ygr} - \text{pop}_r = \text{pgov}_r + \text{ugr}$$

The above formula equates the percentage change in the public expenditure per capita to the percentage changes in the price of government consumption (pgov_r) plus changes in utility from government consumption (ugr).

$$(20) \text{ qgd}_{c,r} = \text{qga}_{c,r} - \text{ESUBD}_{c,r} (\text{pgd}_{c,r} - \text{pga}_{c,r})$$

$$(21) \text{ qgm}_{c,r} = \text{qga}_{c,r} - \text{ESUBD}_{c,r} (\text{pgm}_{c,r} - \text{pga}_{c,r})$$

$$(22) \text{ PGA}_{c,r} \cdot \text{QGA}_{c,r} = \text{PGD}_{c,r} \cdot \text{QGD}_{c,r} + \text{PGM}_{c,r} \cdot \text{QGM}_{c,r}$$

$$(22') \text{ pga}_{c,r} = (1 - \text{GMSHR}_{c,r}) \text{pgd}_{c,r} + \text{GMSHR}_{c,r} \cdot \text{pgm}_{c,r}$$

Equations (20), (21), (22) and (22') follow the logical explanations used for equations (8), (9), (10), and (10').

11.1.1.3 Investment expenditure

The Leontief utility function captures the investment expenditure function. A constraint is established between the aggregate amount of investment, qinv_r , and the total composite amount

of investment coming from domestic and overseas (net capital inflows), $qia_{c,r}$. Such a constraint is shown in equation (23).

$$(23) \ qinv_r = qia_{c,r}$$

$$(24) \ PINV_r \cdot QINV_r = \sum_c QIA_{c,r} \cdot PIA_{c,r}$$

$$(24') \ pinv_r = \sum_c \frac{VIP_{c,r}}{REGINV_r} pia_{c,r}$$

Formula (24) takes into account the price index to work out the total investment expenditure, and formula (24') simply expresses formula (24) in percentage change, with $(VIP_{c,r} / REGINV_r)$ expressing the investment expenditure share. The following formulas show the decomposed elements of the composite investment $qia_{c,r}$, in which qid and qim denote the quantity demanded for domestic investment and imported investment, respectively. $pia_{c,r}$ shows the percentage change in price of $qia_{c,r}$.

$$(25) \ qid_{c,r} = qia_{c,r} - ESUBD_{c,r} (pid_{c,r} - pia_{c,r})$$

$$(26) \ qim_{c,r} = qia_{c,r} - ESUBD_{c,r} (pim_{c,r} - pia_{c,r})$$

$$(27) \ PIA_{c,r} \cdot QIA_{c,r} = PID_{c,r} \cdot QID_{c,r} + PIM_{c,r} \cdot QIM_{c,r}$$

$$(27') \ pia_{c,r} = (1 - IMSHR_{c,r}) pid_{c,r} + IMSHR_{c,r} \cdot pim_{c,r}$$

The explanations for formulas (25), (26), (27), and (27') align with those provided for formulas (8), (9), (10), and (10'), respectively.

11.1.2 Trade, goods market equilibrium and prices

11.1.2.1 Sourcing on imports

As previously mentioned, there are four institutions in the standard GTAP model version 7, namely firms, private households, government and investors. However, while there are many firms and industries, there is only a single representative household, a single representative government and a single representative investor in each region. Each of these agents demands both domestic and imported goods, with the CES utility function being assumed for different import sources.

$$(28) \text{QMS}_{c,r} = \sum_a \text{QFM}_{c,a,r} + \text{QPM}_{c,r} + \text{QGM}_{c,r} + \text{QIM}_{c,r}$$

$$(29) \text{qxs}_{c,s,d} = \text{qms}_{c,d} - \text{ams}_{c,s,d} - \text{ESUBM}_{c,d} (\text{pmds}_{c,s,d} - \text{ams}_{c,s,d} - \text{pms}_{c,d})$$

$$(30) \text{PMS}_{c,d} \cdot \text{QMS}_{c,d} = \sum_s \text{PMDS}_{c,s,d} \cdot \text{QXS}_{c,s,d}$$

$$(30') \text{pms}_{c,d} = \sum_s \text{MSHRS}_{c,s,d} (\text{pmds}_{c,s,d} - \text{ams}_{c,s,d})$$

Formula (28) calculates the aggregate demand for the import composite commodity by all four institutions, while formula (29) measures the percentage change in the quantity demanded for disaggregated imported commodities by source ($\text{qxs}_{c,s,d}$) which inversely relates to both the substitution effect $\text{ESUBM}_{c,d}$ and by the relative price changes between $\text{pmds}_{c,s,d}$ and $\text{pms}_{c,d}$. Formula (30) calculates the total value of imports for commodity c, while formula (30') measures the percentage change of the price for aggregate imports.

Abbreviation	Description
QMS	Quantity of import demanded - aggregate
QFM	Quantity of import demanded - firms
QPM	Quantity of import demanded – private HH
QGM	Quantity of import demanded – government
QIM	Quantity of import demanded - investor
QXS	Quantity of export
QTM _m	Quantity of global demand for margin service m

$QTMFSD_{m,c,s,d}$	Quantity demanded for trade and transport service m, to deliver good c from region s to region d
QST_m	Quantity supply for global transportation service m
qxs	Quantity demanded for disaggregated imported commodities by source - pc
qms	Quantity of import demanded – aggregate - pc
qtmfsd	Quantity demanded for transport services - pc
qtm_m	Quantity demanded globally for margin - pc
qst	Quantity demand for regional supply of global transportation service
$qtmfsd_{m,c,s,d}$	Quantity demanded for trade and transport service m, to deliver good c from region s to region d - pc
$pmd_{c,s,d}$	Price basic of commodity c produced in region s augmented by a bilateral export tax
pms	Price of import demanded – aggregate - pc
ptrans	Price (modal average) of flow-specific of transport index
PT_m	Price of global transport (uniform)
$ESUBM_{c,d}$	Elasticity of substitution for imports by Destination region
$VTFSD_MSH$	
$MSHRS_{c,s,d}$	Share of import by source
ams	Technical efficiency change for import demand
atmfsd	Technical efficiency change for Transportation by Mode of Freight c from Source to Destination

Table 04.06: Summary of key variables

11.1.2.2 International trade and transport margins

The transport services, called m, are generated to deliver commodity c from the source region s to the destination region d.

$$(31) \text{ qtmfsc}_{m,c,s,d} = \text{qxs}_{c,s,d} - \text{atmfsc}_{m,c,s,d}$$

Formula (31) demonstrates that demand the transport services is directly proportional to delivery quantity qxs , subject to potential gains in transport efficiency as represented by the technical coefficient atmfsc , which denotes per-unit efficiency of Transportation by Mode of Freight c from Source to Destination.

$$(32) \text{ ptrans}_{c,s,d} = \sum_m \text{VTFSD_MSH}_{m,c,s,d} (\text{pt}_m - \text{atmfsc}_{m,c,s,d})$$

$$(33) \text{ QTM}_m = \sum_c \sum_s \sum_d \text{QTMFSD}_{m,c,s,d}$$

$$(34) \text{ qst}_{m,r} = \text{qtm}_m - \text{ESUBS}_m (\text{pds}_{m,r} - \text{ptm})$$

$$(35) \text{ PT}_m \cdot \text{QTM}_m = \sum_r \text{PDS}_{m,r} \cdot \text{QST}_{m,r}$$

Due to the absence of bilateral shipping service supplies, each transport mode, m , is offered at a uniform global price, PT_m . This global transport price is a composite derived from the price of national margin service exports, as defined by equation (35). To determine the composite Free On Board (FOB) to Cost, Insurance, and Freight (CIF) margin, it is required to aggregate the modal-specific transport prices across all applicable modes of transport for the given good. Taking into account atmfsc , formula (32) is then derived to calculate the price of transport to deliver good c from region s to region d, $\text{ptrans}_{c,s,d}$. Formula (33) calculates the global demand for margin service, QTM_m , by summing the demand of all bilateral traded commodities among all bilateral trade routes.

A frictional 'global' transport sector acquires transport services, m , from all regions, optimising the cost of these services across regions using a CES preference function. The optimal demand, determined by equation (34), yields $\text{QST}_{m,r}$, the regional supply of trade service m .

11.1.2.3 Trade prices

There are four different prices associated with the process of delivering one good from one region to another region. The first price is the domestic supply price, $\text{PDS}_{c,r}$. If the export tax

or subsidy, $TXS_{c,r,d}$, is added, the second price $PFOB_{c,s,d}$ is derived. To deliver commodity c overseas, transport costs $PTRANS_{c,s,d}$ is then added which leads to the third price called $PCIF_{c,s,d}$. And finally, to clear the destination country's custom, an import tax might be imposed which leads to the final price called $PMDS_{c,s,r}$. The second, third and fourth prices are calculated in the simple formulas shown below.

$$(36) PFOB_{c,s,d} = PDS_{c,s} \cdot TXS_{c,s,d}$$

$$(37) PCIF_{c,s,d} = PFOB_{c,s,d} + \zeta PTRANS_{c,s,d}$$

$$(38) PMDS_{c,s,d} = PCIF_{c,s,d} \cdot TMS_{c,s,d}$$

11.1.2.4 Goods market equilibrium

Consistent with neoclassical theory, market equilibrium for commodity c is established when total demand equals total supply. The total demand for commodity c is the combined demand from all four domestic institutions (firms, private household, government and investor), as calculated in Equation (39). The total supply of commodity c , measured by Equation (40), is then allocated to satisfy the sum of total domestic demand (QDS), foreign demand (QST), and the global demand for trade and transport services ($QXS_{c,r,d}$).

$$(39) QDS_{c,r} = \sum a QFD_{c,a,r} + QPD_{c,r} + QGD_{c,r} + QID_{c,r}$$

$$(40) QC_{c,r} = QDS_{c,r} + QST_{c,r} + \sum d QXS_{c,r,d}$$

11.1.2.5 Agents' prices for goods

As a reminder, the model incorporates four key institutions: firms, private households, the government, and investor. Each institution is subject to two distinct prices for commodities: the domestic supply price ($PDS_{c,r}$) and the CES aggregate import supply price at the domestic market ($PMS_{c,r}$). A core assumption of the model is that both of these prices are identical across all institutions.

The tax structure is defined by a series of variables representing taxes paid by each institution on its consumption and being unique to each institution. The notation for these taxes is based on the institution (F for Firms, P for Private Households, G for Government, I for Investors) and the origin of the commodity (D for Domestic, M for Imported). This yields a comprehensive set of tax variables, including TFD, TFM, TPD, TPM, TGD, TGM, TID, and TIM.

For firms:

$$(41) \text{PFD}_{c,a,r} = \text{PDS}_{c,r} \cdot \text{TFD}_c,$$

$$(42) \text{PFM}_{c,a,r} = \text{PMS}_{c,r} \cdot \text{TFM}_{c,a,r}$$

For private households:

$$(43) \text{PPD}_{c,r} = \text{PDS}_{c,r} \cdot \text{TPD}_{c,r}$$

$$(44) \text{PPM}_{c,r} = \text{PMS}_{c,r} \cdot \text{TPM}_{c,r}$$

For the government:

$$(45) \text{PGD}_{c,r} = \text{PDS}_{c,r} \cdot \text{TGD}_{c,r}$$

$$(46) \text{PGM}_{c,r} = \text{PMS}_{c,r} \cdot \text{TGM}_{c,r}$$

For investors:

$$(47) \text{PID}_{c,r} = \text{PDS}_{c,r} \cdot \text{TID}_{c,r}$$

$$(48) \text{PIM}_{c,r} = \text{PMS}_{c,r} \cdot \text{TIM}_{c,r}$$

11.1.3 Factor market equilibrium

Factors of production, also known as endowments, are categorised into three main groups. The first group is called perfect mobility, which contains labour and capital. The second group

contains partially mobile factors such as land, while natural resources belong to sector-specific group.

Abbreviation	Description
QE	Quantity supplied of fixed endowment / Economy-wide return to perfectly mobile factors
QFE	Quantity demand for FE
QES	Quantity supply for FE
PE	Price of factor endowment e in region r – aggregate
PES	Price (after tax) of remuneration
PFE	Price (activity) of endowment use (market equilibrium)
PEB	Price derived through economy-wide arbitration, equilibrium, pre-tax
$pe_{e,a,r}$	Price of e for use by a in r / Price (after tax) received by endowment e when used in activity a in region r .
$pe_{e,r}$	Price of factor endowment e in region r – aggregate - pc
peb	Price derived through economy-wide arbitration equilibrium, pre-tax - pc
qe	Quantity supplied of factor endowments - aggregate
qes	Quantity supplied of endowment - pc
TFE	Tax on endowment use
TINC	Tax on income derived from endowment use
ENDWM	Endowments
ETRAE $_{e,r}$	Elasticity of transformation

Table 04.07: Summary of key variables

11.1.3.1 Mobile endowments

Perfect mobility dictates price equalisation across all uses. Therefore, endowment returns display a uniform percentage change across activities, and market equilibrium is reached when aggregate demand matches the exogenous supply.

$$(49) \quad QE_{e,r} = \sum_e QFE_{e,a,r} \text{ for } e \in \{ENDWM\}$$

$$(50) \quad pes_{e,a,r} = pe_{e,r} \text{ for } e \in \{ENDWM\}$$

Formula (49) shows the equilibrium condition in the factor market where the total fixed or exogenous endowment supply, $QE_{e,r}$, equals the demand for each endowment, e , by activity, a , denoted as $QFE_{e,a,r}$. Formula (50) calculates the percentage change for the price of e for use by a in r , $pes_{e,a,r}$, which equals the price of mobile and sluggish endowment e in region r , $pe_{e,r}$. This equation enforces the "law of one price" for perfectly mobile factors across different sectors within a region. In other words, for any mobile endowment, such as labour or capital, the price received by that factor must be identical regardless of which activity (sector) employs it. For example, if labour is perfectly mobile between agricultural and manufacturing sectors, the wage rate must equalise across these two sectors.

11.1.3.2 Sluggish endowments

As these factors of production, mainly land in this case, are not perfectly mobile, the aggregate factor supply to individual activities exhibits imperfect elasticity, due to a transformation frontier that limits factor mobility across activities. Such a transformation frontier is captured by the Constant Elasticity of Transformation (CET).

$$(51) \quad qes_{e,a,r} = qe_{e,r} - ETRA_{e,r} (pes_{e,a,r} - pe_{e,r}) \text{ for } e \in \{ENDWM\}$$

$$(52) \quad PE_{e,r} \cdot QE_{e,r} = \sum_a PES_{e,a,r} \cdot QES_{e,a,r} \text{ for } e \in \{ENDWM\}$$

$$(53) \quad QES_{e,a,r} = QFE_{e,a,r} \text{ for } e \in \{ENDWM\}$$

Formula (51) models the allocation of sluggish factors, which is positively influenced by the aggregate demand for all endowments. Conversely, this allocation is negatively impacted by both the elasticity of transformation (ETRAE) and the relative price between the sluggish factor's price and the aggregate price of non-sector-specific endowments. Specifically, if the price level of a sluggish endowment in a particular sector ($pes_{e,a,r}$) rises relatively faster than the economy-wide average price level ($pe_{e,r}$), a smaller amount of that factor will be allocated to that sector. Additionally, a higher value for the elasticity of transformation (ETRAE) results in a lower demand for sluggish factors.

Formula (52) shows the resource constraint relationship in the economy for sluggish factors, where the total value of a sluggish endowment at the economy-wide level, $PE_{e,r} \cdot QE_{e,r}$, must equal the sum of its values across all activities where it is employed, $\sum_a PES_{e,a,r} \cdot QES_{e,a,r}$. Formula (53) represents a market-clearing condition for sluggish endowments where the supply equals demand across all activities.

11.1.3.3 Sector-specific endowments

The supply of natural resources, such as fossil fuel deposits, are assumed to be fixed or exogenous. Therefore, only one equation (54) is needed for this type of endowment and is identical to formula (53). However, equation (53) and (54) are consolidated and expressed within the single equation block, E_peb in the TABLO codes.

$$(54) \quad QES_{e,a,r} = QFE_{e,a,r} \text{ for } e \in \{ENDWM\}$$

The equilibrium market price for the use of factors of production, PEF equals to the equilibrium price-derived through economy-wide arbitration, PEB , times tax on endowment use, TFE , as shown in formula (55). PEB equals to the after-tax remuneration for the supply for factor endowments times the income tax derived from endowment use, $TINC$, as reflected in formula (56).

$$(55) \quad PFE_{e,a,r} = PEB_{e,a,r} \cdot TFE_{e,a,r}$$

$$(56) PEB_{e,a,r} = PES_{e,a,r} \cdot TINC_{e,a,r}$$

11.1.4 Numéraire and closure

Having discussed in Chapter 03, as economists pay attention to relative prices, one chosen market's price needs to be fixed and set equal to 1. Such a value is called numéraire. In the standard GTAP model version 7, a global price index (weighted-average return) of factor remuneration, **PFACTWLD**, is chosen to become a numéraire. $\varphi_{e,a,r}$ represents the weight of the remuneration share.

$$(57) PFACTWLD = \sum_e \sum_a \sum_r \varphi_{e,a,r} PEB_{e,a,r}$$

However, to construct the global price for factor remuneration, PFACTWLD, we need to calculate a similar price by regions and then sum everything up.

$$(58) pfactor_r = \frac{\sum_e \sum_a EVFB_{e,a,r}}{VENDWREG_r} peb_{e,a,r}$$

$$(58') VENDWREG_r \cdot pfactor_r = \sum_e \sum_a EVFB_{e,a,r} \cdot peb_{e,a,r}$$

Formula (58) shows that each factor's price change, $peb_{e,a,r}$, is weighted by its share in the region's total factor income, $\sum_e \sum_a EVFB_{e,a,r} / VENDWREG_r$. Formula (58') and its adapted version are used to linearise formula (58) and are used in the main model.

$$(59) pfactwld = \sum_r \frac{VENDWREG_r}{VENDWWLD} \cdot pfactor_r$$

$$(59') VENDWWLD \cdot pfactwld = \sum_r VENDWREG_r \cdot pfactor_r$$

Formula (59) shows a weighted average of regional price changes for factor endowment, $pfactor_r$, where weights are the regions' shares in global factor income, $VENDWREG_r \div$

ENDWWLD. Formula (59') is the linearised version of formula (59) and is used in the main model.¹¹⁷

The following three equations will cover Walras's Law, which was discussed in Chapter 03. Walras' Law posits that the aggregate of excess demands across all markets within a general equilibrium framework is zero. The global market for investment or capital goods is chosen as a model closure and is omitted for simulation by default. However, other markets can also be set as closures.

$$(60) \text{ walras_sup} = \text{pcgdswwld} + \text{globalecgs}$$

$$(61) \text{ GLOBINV} * \text{walras_dem} = \text{sum}\{r, \text{REG}, \text{SAVE}(r) * [\text{psave}(r) + \text{qsave}(r)]\}$$

$$(62) \text{ walras_sup} = \text{walras_dem} + \text{walrasslack}$$

Formula (60) aggregates changes in the value of global investment or capital goods (price $\times$ quantity) from the supply side, via the percentage change in the global price of investment or capital goods, *pcgdswwld*, and the percentage change in the real volume of global net investment, *globalecgs*. Formula (61) aggregates changes in global saving (i.e., demand for investment) across all regions. It is assumed that saving finances investment, so this represents demand-side consistency. Finally, formula (62) simply verifies that the total supply for global investment matches the total demand. A zero *walrasslack* means that the whole model is internally consistent and Walras's law holds. Otherwise, a non-zero *walrasslack* signals computational errors.

Abbreviation	Description
pfactor _r	Price of all primary factors in region r - pc
EVFB	Primary factor purchases, by firms, at basic prices
VENDWREG	Value (total) of factor Endowment payments in Region r
VENDWWLD	Value (total) of factor Endowment payments in the World
PFACTWLD	Price (global) of factor remuneration
GLOBINV	Global net investment
walras_dem	Quantity demand in the omitted market - pc

¹¹⁷ $\text{VENDWWLD} * \text{pfactwld} = \text{sum}\{r, \text{REG}, \text{VENDWREG}(r) * \text{pfactor}(r)\};$

walras_sup	Quantity supply in the omitted market - pc
walrasslack	Walras' Law diagnostic variable
pcgdswld	Price of capital goods/investment – global – pc
globalcgds	Quantity supply of capital goods/investment – global - pc
psave	Price of savings – pc
qsave	Quantity of savings - pc

Table 04.08: Summary of key variables

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Name	Code	2011	2012	2013	2014	2015	2016	2017
Brunei	BRN		0.91	-2.12	-2.51	-0.39	-2.48	1.33
Cambodia	KHM		7.65	7.86	8.00	7.21	7.91	8.08
Indonesia	IDN		6.03	5.56	5.01	4.88	5.03	5.07
Lao PDR	LAO		8.03	8.03	7.61	7.27	7.02	6.89
Malaysia	MYS		5.47	4.69	6.01	5.09	4.45	5.81
Myanmar	MMR		7.33	8.43	8.17	6.99	5.86	6.14
Philippines	PHL		6.90	6.75	6.35	6.35	7.15	6.93
Singapore	SGP		4.44	4.82	3.94	2.98	3.59	4.51
Thailand	THA		7.24	2.69	0.98	3.13	3.44	4.18
Timor-Leste	TLS		4.86	3.10	4.47	2.48	3.01	-3.18
Viet Nam	VNM		5.50	5.55	6.42	6.99	6.69	6.94
Southeast Asia	SEA		6.04	5.06	4.67	4.81	4.97	5.40

Name	Code	2018	2019	2020	2021	2022	2023	2024
Brunei	BRN	0.05	3.87	1.13	-1.59	-1.63	1.41	3.90
Cambodia	KHM	8.78	7.94	-3.56	3.09	5.10	4.96	6.00
Indonesia	IDN	5.17	5.02	-2.07	3.70	5.31	5.05	5.00
Lao PDR	LAO	6.25	5.46	0.50	2.53	2.71	3.75	4.30
Malaysia	MYS	4.84	4.41	-5.46	3.32	8.86	3.56	5.10
Myanmar	MMR	6.27	6.58	-9.05	-12.02	4.04	0.96	-1.10
Philippines	PHL	6.34	6.12	-9.52	5.71	7.58	5.55	5.70
Singapore	SGP	3.52	1.35	-3.87	9.69	3.84	1.08	4.40
Thailand	THA	4.22	2.11	-6.05	1.57	2.46	1.89	2.50
Timor-Leste	TLS	-0.47	24.21	31.73	5.36	-20.58	-18.12	4.10
Viet Nam	VNM	7.47	7.36	2.87	2.55	8.12	5.05	7.10
Southeast Asia	SEA	5.20	4.52	-3.86	3.74	5.63	3.91	4.81

Table 05.01: Southeast Asia's Real GDP Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Brunei	BRN		1.54	1.39	1.35	1.31	1.27	1.22
Cambodia	KHM		1.51	1.51	1.49	1.47	1.47	1.39
Indonesia	IDN		1.29	1.25	1.18	1.13	1.08	1.03
Lao PDR	LAO		1.44	1.42	1.39	1.47	1.58	1.58
Malaysia	MYS		1.72	1.72	1.73	1.75	1.78	1.78
Myanmar	MMR		0.85	0.85	0.83	0.80	0.80	0.78
Philippines	PHL		1.96	1.90	1.66	1.49	1.35	1.30
Singapore	SGP		2.48	1.63	1.31	1.19	1.31	0.09
Thailand	THA		0.62	0.59	0.53	0.46	0.45	0.42
Timor-Leste	TLS		2.22	2.10	2.00	1.97	1.92	1.90
Viet Nam	VNM		1.18	1.19	1.22	1.25	1.27	1.25
Southeast Asia	SEA		1.31	1.27	1.20	1.15	1.11	1.06

Name	Code	2018	2019	2020	2021	2022	2023	2024
Brunei	BRN	1.16	1.11	1.07	0.96	0.81	0.79	1.40
Cambodia	KHM	1.25	1.27	1.48	1.49	1.34	1.29	0.99
Indonesia	IDN	0.97	0.94	0.85	0.71	0.75	0.85	0.73
Lao PDR	LAO	1.57	1.54	1.50	1.45	1.42	1.40	1.26
Malaysia	MYS	1.72	1.61	1.34	1.16	1.20	1.24	0.99
Myanmar	MMR	0.73	0.70	0.71	0.70	0.69	0.70	0.71
Philippines	PHL	1.24	1.22	1.15	0.91	0.76	0.81	1.56
Singapore	SGP	0.47	1.15	-0.31	-4.08	3.36	4.98	0.87
Thailand	THA	0.30	0.20	0.17	0.12	0.01	-0.05	0.17
Timor-Leste	TLS	1.94	1.96	1.93	1.82	1.42	1.09	2.04
Viet Nam	VNM	1.11	0.97	0.93	0.87	0.75	0.67	0.89
Southeast Asia	SEA	0.99	0.95	0.87	0.71	0.74	0.78	0.86

Table 05.02: Southeast Asia's Population Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Brunei	BRN		1.79	1.63	1.57	1.51	1.45	1.41
Cambodia	KHM		-0.89	-1.56	1.82	0.78	4.35	1.17
Indonesia	IDN		2.32	0.53	1.25	1.32	0.94	1.90
Lao PDR	LAO		2.21	2.10	2.05	1.98	1.92	1.87
Malaysia	MYS		4.00	3.94	3.87	2.59	2.07	2.36
Myanmar	MMR		1.14	1.08	1.04	1.01	-0.88	-0.98
Philippines	PHL		1.75	2.05	3.47	1.02	2.59	-1.87
Singapore	SGP		3.76	1.72	2.76	2.86	1.08	-0.24
Thailand	THA		0.64	-2.86	0.72	0.13	-0.48	-0.26
Timor-Leste	TLS		2.61	2.80	2.75	2.89	2.90	3.38
Viet Nam	VNM		1.40	2.49	1.27	1.38	0.48	1.18
Southeast Asia	SEA		1.77	0.77	1.62	1.18	0.92	0.76

Name	Code	2018	2019	2020	2021	2022	2023	2024
Brunei	BRN	3.62	-0.90	0.33	1.08	1.31	0.83	0.69
Cambodia	KHM	2.14	2.21	1.61	-1.46	2.47	1.75	1.68
Indonesia	IDN	2.74	2.15	-0.04	-1.24	2.92	1.23	1.27
Lao PDR	LAO	4.04	3.98	3.10	4.34	4.62	1.89	2.08
Malaysia	MYS	2.75	2.62	1.45	2.18	1.97	1.93	1.90
Myanmar	MMR	1.66	-1.97	0.44	-7.35	0.90	1.12	0.78
Philippines	PHL	1.79	2.79	-6.04	5.09	10.70	1.76	1.24
Singapore	SGP	0.05	1.88	-0.66	-1.32	2.16	4.69	1.41
Thailand	THA	1.19	-0.60	0.75	0.46	0.78	-0.06	-0.26
Timor-Leste	TLS	3.18	1.65	1.99	2.27	3.99	1.42	2.20
Viet Nam	VNM	1.26	-0.10	-1.83	0.22	2.18	0.58	0.59
Southeast Asia	SEA	2.06	1.25	-0.87	-0.19	3.40	1.13	1.00

Table 05.03: Southeast Asia's Labour Force Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Brunei	BRN		5.39	6.74	2.07	4.08	3.27	3.15
Cambodia	KHM		5.95	7.22	8.67	8.71	8.64	8.61
Indonesia	IDN		7.79	7.19	7.14	6.98	6.65	6.31
Lao PDR	LAO		10.43	9.16	8.52	9.20	7.72	8.59
Malaysia	MYS		5.34	5.77	5.57	5.47	5.20	5.06
Myanmar	MMR		13.85	14.38	13.37	14.07	11.29	10.36
Philippines	PHL		3.74	4.59	4.77	5.60	7.15	7.29
Singapore	SGP		5.45	5.87	5.89	5.18	4.56	4.45
Thailand	THA		4.43	3.64	3.13	3.08	2.82	2.70
Timor-Leste	TLS		4.92	3.97	5.61	3.46	3.63	-3.15
Viet Nam	VNM		3.99	3.89	4.17	4.78	4.49	4.77
Southeast Asia	SEA		6.10	5.94	5.81	5.81	5.59	5.43

Name	Code	2018	2019	2020	2021	2022	2023	2024
Brunei	BRN	-0.10	0.06	-0.03	-0.03	0.03	0.01	0.03
Cambodia	KHM	6.79	6.98	7.10	7.10	7.16	7.13	7.09
Indonesia	IDN	4.98	5.20	5.24	5.18	5.18	5.12	5.06
Lao PDR	LAO	6.82	7.13	7.27	7.36	7.41	7.44	7.45
Malaysia	MYS	4.07	4.25	4.26	4.24	4.27	4.23	4.20
Myanmar	MMR	7.86	7.65	7.45	7.26	7.15	7.01	6.87
Philippines	PHL	4.60	4.78	5.03	5.14	5.30	5.38	5.43
Singapore	SGP	4.56	4.47	4.37	4.20	4.08	3.93	3.79
Thailand	THA	3.48	3.70	3.79	3.78	3.81	3.79	3.77
Timor-Leste	TLS	-0.87	24.72	43.85	6.59	-21.08	-17.32	4.15
Viet Nam	VNM	8.12	8.33	8.17	8.01	7.90	7.71	7.52
Southeast Asia	SEA	4.77	4.96	5.01	4.95	4.94	4.90	4.86

Table 05.04: Southeast Asia's Physical Capital Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Brunei	BRN		0.00	0.00	0.00	0.00	0.00	0.00
Cambodia	KHM		1.49	0.77	0.77	0.76	0.75	0.75
Indonesia	IDN		0.00	0.00	0.00	0.00	0.00	0.00
Lao PDR	LAO		2.45	2.40	0.29	0.29	0.29	-4.75
Malaysia	MYS		0.32	-7.57	1.41	1.39	0.00	0.00
Myanmar	MMR		-0.32	0.20	0.41	1.08	0.14	1.04
Philippines	PHL		2.39	0.18	0.00	0.00	0.00	0.00
Singapore	SGP		0.00	-9.52	-1.75	0.00	0.00	0.00
Thailand	THA		-0.55	-0.55	-1.70	-0.77	-0.26	-0.71
Timor-Leste	TLS		-0.35	-0.35	-0.35	-0.35	-0.35	-0.35
Viet Nam	VNM		-0.56	0.34	-0.21	9.26	-0.07	-0.14
Southeast Asia	SEA		0.09	-0.07	-0.34	0.97	0.00	-0.09

Name	Code	2018	2019	2020	2021	2022	2023	2024
Brunei	BRN	0.00	0.00	0.00	0.00	0.00		
Cambodia	KHM	0.74	0.74	0.73	0.73	0.00		
Indonesia	IDN	0.00	0.00	0.00	0.00	0.00		
Lao PDR	LAO	-4.99	-5.25	-5.53	0.00	0.00		
Malaysia	MYS	0.00	0.00	0.00	0.00	0.00		
Myanmar	MMR	0.17	-0.81	0.00	0.00	0.00		
Philippines	PHL	0.00	0.00	0.00	0.00	0.00		
Singapore	SGP	0.00	0.00	0.00	0.00	0.00		
Thailand	THA	-0.01	0.32	1.02	1.05	0.00		
Timor-Leste	TLS	-0.35	-1.15	0.00	0.00	0.00		
Viet Nam	VNM	-0.52	-2.42	0.04	-0.28	-0.21		
Southeast Asia	SEA	-0.09	-0.38	0.21	0.29	-0.02		

Table 05.05: Southeast Asia's Arable Land Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Southeast Asia	SEA		6.04	5.06	4.67	4.81	4.97	5.40
United States	USA		2.29	2.12	2.52	2.95	1.82	2.46
China & HK	CHN_HK		7.66	7.62	7.29	6.91	6.72	6.87
Japan	JPN		1.37	2.01	0.30	1.56	0.75	1.68
Korea, Republic of	KOR		2.40	3.16	3.20	2.81	2.95	3.16
India	IND		5.46	6.39	7.41	8.00	8.26	6.80
Taiwan	TWN		2.20	2.50	4.70	1.50	2.20	3.70
Australia	AUS		3.92	2.60	2.60	2.19	2.76	2.28
EU_27	EU27		-0.76	-0.04	1.63	2.37	1.94	2.80
Rest of the world	RoW		2.87	2.89	2.60	1.53	1.70	2.62
World	WLD		2.69	2.87	3.13	3.13	2.81	3.45

Name	Code	2018	2019	2020	2021	2022	2023	2024
Southeast Asia	SEA	5.20	4.52	-3.86	3.74	5.63	3.91	4.81
United States	USA	2.97	2.58	-2.16	6.06	2.51	2.89	2.80
China & HK	CHN_HK	6.65	5.76	2.04	8.41	2.82	5.21	4.95
Japan	JPN	0.64	-0.40	-4.15	2.56	0.95	1.68	0.10
Korea, Republic of	KOR	2.91	2.24	-0.71	4.30	2.61	1.36	2.00
India	IND	6.45	3.87	-5.78	9.69	6.99	8.15	6.50
Taiwan	TWN	2.90	3.10	3.40	6.70	2.70	1.10	4.30
Australia	AUS	2.88	2.17	-0.12	2.11	4.24	3.44	1.00
EU_27	EU27	2.05	1.88	-5.58	6.36	3.50	0.43	1.10
Rest of the world	RoW	2.32	1.61	-4.80	6.36	3.72	2.17	4.21
World	WLD	3.28	2.68	-2.88	6.35	3.24	2.83	3.30

Table 05.06: All regions' Real GDP Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Southeast Asia	SEA		1.31	1.27	1.20	1.15	1.11	1.06
United States	USA		0.74	0.70	0.74	0.74	0.73	0.63
China & HK	CHN_HK		0.68	0.67	0.63	0.58	0.57	0.61
Japan	JPN		-0.16	-0.14	-0.13	-0.11	-0.05	-0.08
Korea, Republic of	KOR		0.53	0.46	0.63	0.53	0.40	0.28
India	IND		1.38	1.34	1.27	1.20	1.20	1.17
Taiwan	TWN		0.39	0.25	0.26	0.25	0.20	0.13
Australia	AUS		1.76	1.74	1.50	1.45	1.57	1.66
EU_27	EU27		0.15	0.24	0.25	0.22	0.21	0.16
Rest of the world	RoW		1.78	1.76	1.74	1.73	1.69	1.63
World	WLD		1.26	1.25	1.22	1.19	1.17	1.14

Name	Code	2018	2019	2020	2021	2022	2023	2024
Southeast Asia	SEA	0.99	0.95	0.87	0.71	0.74	0.78	0.86
United States	USA	0.53	0.46	0.97	0.16	0.37	0.49	0.67
China & HK	CHN_HK	0.47	0.36	0.24	0.08	-0.02	-0.09	0.23
Japan	JPN	-0.13	-0.14	-0.29	-0.46	-0.44	-0.49	-0.43
Korea, Republic of	KOR	0.43	0.35	0.14	-0.13	-0.19	0.08	0.21
India	IND	1.10	1.05	0.98	0.83	0.79	0.89	0.72
Taiwan	TWN	0.08	0.06	-0.18	-0.79	-0.47	0.67	-0.09
Australia	AUS	1.51	1.49	1.24	0.14	1.28	2.48	1.13
EU_27	EU27	0.17	0.08	0.08	-0.24	0.29	0.21	0.21
Rest of the world	RoW	1.61	1.62	1.61	1.46	1.49	1.52	1.21
World	WLD	1.08	1.04	1.02	0.83	0.87	0.90	0.81

Table 05.07: All regions' Population Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Southeast Asia	SEA		1.77	0.77	1.62	1.18	0.92	0.76
United States	USA		0.66	0.22	0.40	0.59	1.15	0.98
China & HK	CHN_HK		0.11	0.04	0.15	0.10	-0.02	-0.22
Japan	JPN		-0.45	0.37	0.34	0.13	0.91	0.81
Korea, Republic of	KOR		1.74	1.52	2.97	1.53	0.95	1.13
India	IND		0.89	1.77	1.70	1.62	1.60	1.58
Taiwan	TWN		1.26	0.92	0.79	0.89	0.76	0.58
Australia	AUS		1.39	1.41	1.15	1.92	1.40	2.18
EU_27	EU27		0.66	0.33	0.31	0.27	0.39	0.52
Rest of the world	RoW		1.98	1.76	1.40	1.91	1.78	1.68
World	WLD		1.14	1.05	1.04	1.16	1.11	1.01

Name	Code	2018	2019	2020	2021	2022	2023	2024
Southeast Asia	SEA	2.06	1.25	-0.87	-0.19	3.40	1.13	1.00
United States	USA	0.79	1.09	-0.84	0.37	1.17	1.31	0.64
China & HK	CHN_HK	-0.29	-0.12	-1.56	2.26	-1.42	0.59	-0.20
Japan	JPN	1.66	0.92	-0.23	0.02	0.38	0.39	0.10
Korea, Republic of	KOR	0.54	1.08	-0.67	0.67	2.24	1.32	0.20
India	IND	1.46	1.34	0.22	3.35	3.37	3.53	3.18
Taiwan	TWN	0.67	0.61	0.15	-0.38	-0.55	0.76	0.49
Australia	AUS	2.33	2.07	-0.03	1.64	2.65	2.86	1.08
EU_27	EU27	0.36	0.31	-1.09	0.81	1.36	0.72	-0.34
Rest of the world	RoW	1.61	1.77	-0.88	3.20	1.04	1.22	1.28
World	WLD	1.07	1.08	-0.85	2.30	1.10	1.41	1.08

Table 05.08: All regions' Labour Force Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Southeast Asia	SEA		6.10	5.94	5.81	5.81	5.59	5.43
United States	USA		1.58	1.68	1.95	2.04	1.95	2.07
China & HK	CHN_HK		11.80	11.23	10.44	9.45	8.72	8.31
Japan	JPN		0.25	0.61	0.78	0.76	0.61	0.85
Korea, Republic of	KOR		4.04	3.83	3.75	3.71	3.76	4.16
India	IND		7.26	6.31	5.95	5.64	5.70	6.04
Taiwan	TWN		5.71	4.78	6.85	3.21	3.52	4.13
Australia	AUS		3.56	3.62	3.19	2.87	2.56	2.08
EU_27	EU27		0.88	0.62	0.69	0.94	1.09	1.31
Rest of the world	RoW		2.66	2.78	2.79	2.76	2.40	2.21
World	WLD		2.99	3.03	3.11	3.10	2.97	3.02

Name	Code	2018	2019	2020	2021	2022	2023	2024
Southeast Asia	SEA	4.77	4.96	5.01	4.95	4.94	4.90	4.86
United States	USA	2.59	2.65	2.65	2.55	2.50	2.41	2.33
China & HK	CHN_HK	8.03	8.06	7.99	7.79	7.67	7.47	7.28
Japan	JPN	1.13	1.22	1.39	1.35	1.31	1.27	1.25
Korea, Republic of	KOR	4.34	4.24	4.12	3.91	3.77	3.58	3.40
India	IND	8.27	8.47	8.62	8.61	8.64	8.59	8.52
Taiwan	TWN	3.69	4.04	4.39	7.76	3.74	2.09	5.28
Australia	AUS	3.16	3.20	3.19	3.03	2.94	2.83	2.74
EU_27	EU27	2.12	2.19	2.16	2.05	1.96	1.86	1.76
Rest of the world	RoW	2.92	3.02	3.06	2.89	3.00	2.99	2.84
World	WLD	3.57	3.69	3.76	3.70	3.69	3.64	3.60

Table 05.09: All regions' Physical Capital Growth 2011-2024 (Author's own calculations)

Name	Code	2011	2012	2013	2014	2015	2016	2017
Southeast Asia	SEA		0.09	-0.07	-0.34	0.97	0.00	-0.09
United States	USA		-4.21	0.33	0.35	0.32	0.30	0.33
China & HK	CHN_HK		-1.14	-0.81	-0.66	-0.63	-1.24	-1.60
Japan	JPN		-0.19	-0.19	-0.38	-0.40	-0.50	-0.55
Korea, Republic of	KOR		2.30	-1.73	-1.32	-0.78	-2.97	-1.71
India	IND		-0.28	-0.07	0.01	-0.03	-0.06	-0.27
Taiwan	TWN		0.00	0.33	-0.07	-0.50	-0.44	-0.17
Australia	AUS		-0.18	-1.32	2.37	-2.72	-3.32	2.31
EU_27	EU27		0.19	-0.74	-0.11	-0.28	-0.38	-0.02
Rest of the world	RoW		1.13	0.56	0.19	0.56	0.50	0.32
World	WLD		-0.01	0.17	0.11	0.24	0.09	0.09

Name	Code	2018	2019	2020	2021	2022	2023	2024
Southeast Asia	SEA	-0.09	-0.38	0.21	0.29	-0.02		
United States	USA	-0.71	-0.77	-0.77	-0.76	-0.75		
China & HK	CHN_HK	-1.03	-1.39	-0.19	-0.42	-0.40		
Japan	JPN	-0.46	-0.43	-0.48	-0.44	-0.49		
Korea, Republic of	KOR	-1.63	-0.73	-0.88	-0.67	-1.71		
India	IND	-0.27	-0.07	-0.59	0.00	0.00		
Taiwan	TWN	0.46	-0.08	0.82	-0.52	-1.17		
Australia	AUS	0.72	-1.29	0.23	2.03	0.00		
EU_27	EU27	-0.54	0.40	-0.06	0.05	-0.39		
Rest of the world	RoW	0.37	-0.15	0.51	0.21	0.11		
World	WLD	-0.02	-0.31	0.12	0.06	-0.09		

Table 05.10: All regions' Arable Land Growth 2011-2022 (Author's own calculations)

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See the next seven pages

			Reporter										
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		Australia	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	0.000	0.000	0.000	0.000	0.000	0.193	0.000	0.001	0.000	1.055	1.249
2	MeatLstk	Livestock and Meat Products	0.000	0.069	0.011	0.000	0.000	1.802	0.000	1.953	0.000	2.263	6.098
3	Extraction	Mining and Extraction	0.000	0.000	0.000	0.000	0.000	1.499	0.000	0.066	0.000	0.000	1.565
4	ProcFood	Processed Food	0.000	0.471	0.043	0.000	0.000	0.877	0.001	0.704	0.000	3.379	5.474
5	TextWapp	Textiles and Clothing	0.000	4.735	0.464	0.808	0.159	4.386	1.376	6.581	0.000	8.221	26.731
6	MotorVehicl_Parts	Motor vehicles and parts	0.000	8.050	0.040	16.035	0.008	7.250	0.008	33.425	0.000	22.186	87.003
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.000	1.242	0.168	0.040	0.080	4.135	0.042	3.108	0.000	3.145	11.960
8	Iron_Steel	Iron and Steel	0.000	1.726	0.054	1.278	0.294	2.660	0.103	3.608	0.000	2.009	11.731
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.000	0.825	0.054	0.073	0.050	1.812	0.006	2.043	0.000	2.747	7.612
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			0.000	17.119	0.835	18.234	0.591	24.614	1.535	51.490	0.000	45.005	159.422

Table 07.01.a: Tariff Structure in 2017 – Australia (Author’s own calculations)

			Reporter										
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Australia	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.000	0.000	0.000	0.000	0.000	0.193	0.000	0.001	0.000	1.055	1.249
2	MeatLstk	Livestock and Meat Products	0.000	0.056	0.011	0.000	0.000	1.802	0.000	1.953	0.000	2.263	6.086
3	Extraction	Mining and Extraction	0.000	0.000	0.000	0.000	0.000	1.499	0.000	0.066	0.000	0.000	1.565
4	ProcFood	Processed Food	0.000	0.365	0.043	0.000	0.000	0.877	0.000	0.704	0.000	3.379	5.368
5	TextWapp	Textiles and Clothing	0.000	4.508	0.142	0.000	0.000	4.386	0.000	6.581	0.000	8.221	23.839
6	MotorVehicl_Parts	Motor vehicles and parts	0.000	6.380	0.040	13.893	0.000	7.250	0.000	33.425	0.000	22.186	83.175
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.000	0.569	0.148	0.000	0.000	4.135	0.000	3.108	0.000	3.145	11.105
8	Iron_Steel	Iron and Steel	0.000	1.340	0.012	0.000	0.000	2.660	0.000	3.608	0.000	2.009	9.629
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.000	0.467	0.042	0.000	0.000	1.812	0.000	2.043	0.000	2.747	7.110
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			0.000	13.686	0.438	13.893	0.000	24.614	0.000	51.490	0.000	45.005	149.125

Table 07.01.b: Tariff Structure in 2024 – Australia (Author’s own calculations)

				Reporter									
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		Rest of the world	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	3.248	10.705	21.421	0.574	3.500	7.144	10.196	12.042	10.083	16.080	94.993
2	MeatLstk	Livestock and Meat Products	9.278	10.875	4.728	1.485	0.708	4.641	5.851	3.078	17.549	36.895	95.086
3	Extraction	Mining and Extraction	0.013	0.207	1.402	0.154	0.178	0.892	0.023	0.561	0.016	0.256	3.702
4	ProcFood	Processed Food	8.298	4.112	9.128	1.759	8.074	7.199	8.221	5.164	8.112	13.895	73.963
5	TextWapp	Textiles and Clothing	0.702	2.882	5.387	1.112	2.530	2.169	4.727	8.139	0.400	1.483	29.532
6	MotorVehicl_Parts	Motor vehicles and parts	0.586	0.535	3.691	4.300	7.681	4.125	1.177	8.135	0.075	1.496	31.802
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.168	0.686	3.144	0.652	2.221	4.058	0.929	1.313	0.166	0.900	14.236
8	Iron_Steel	Iron and Steel	0.161	0.814	1.371	0.908	2.055	2.463	0.225	1.759	0.054	0.055	9.865
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.249	0.410	0.925	0.284	1.581	1.302	0.323	1.737	0.144	0.405	7.361
10	Util_Cons	Utilities and Construction	0.000	0.002	0.000	0.000	0.071	0.000	0.607	0.000	0.000	0.000	0.680
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			22.702	31.228	51.197	11.227	28.601	33.993	32.281	41.928	36.599	71.464	361.220

Table 07.02.a: Tariff Structure in 2017 – Rest of the World (Author's own calculations)

				Reporter									
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Rest of the world	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	0.000	3.232	6.178	0.250	1.297	27.281	3.512	3.644	0.451	14.283	60.127
2	MeatLstk	Livestock and Meat Products	0.231	13.784	7.817	8.538	0.055	0.000	80.406	1.028	14.936	37.556	164.350
3	Extraction	Mining and Extraction	0.000	0.073	1.953	0.022	0.155	18.835	0.196	4.733	0.000	0.179	26.147
4	ProcFood	Processed Food	0.413	4.481	7.834	2.843	12.759	1.555	7.680	7.281	7.610	14.083	66.538
5	TextWapp	Textiles and Clothing	0.060	2.662	7.846	0.027	2.358	3.354	4.675	10.258	0.051	0.404	31.696
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.122	1.333	4.148	0.253	14.334	0.770	7.540	10.370	0.023	0.647	39.541
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.013	1.297	4.695	0.026	2.451	0.596	2.875	7.431	0.018	0.065	19.466
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.000	1.337	3.040	0.001	1.279	0.073	2.257	3.048	0.004	0.011	11.050
9	HeavyMnfc_ex_IS	Iron and Steel	0.019	0.463	1.729	0.003	1.696	0.197	1.190	4.079	0.025	0.175	9.577
10	Util_Cons	Utilities and Construction	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			0.857	28.664	45.240	11.963	36.385	52.662	110.331	51.871	23.118	67.404	428.495

Table 07.02.b: Tariff Structure in 2024 – Rest of the World (Author's own calculations)

						Reporter	GTAP v09	GTAP v09					
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		Japan	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	10.124	7.180	11.299	0.000	3.805	5.064	9.139	1.447	13.876	4.915	66.848
2	MeatLstk	Livestock and Meat Products	24.419	27.218	9.075	0.000	7.495	3.226	7.951	0.112	34.727	46.280	160.503
3	Extraction	Mining and Extraction	0.004	0.030	1.550	0.000	4.808	1.878	0.031	0.096	0.099	0.218	8.715
4	ProcFood	Processed Food	20.440	8.164	10.846	0.000	18.582	5.962	9.483	2.227	11.460	10.144	97.310
5	TextWapp	Textiles and Clothing	0.953	4.155	7.966	0.000	6.410	4.803	0.008	0.125	6.445	8.839	39.704
6	MotorVehicl_Parts	Motor vehicles and parts	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.046	2.532	6.170	0.000	1.182	1.250	1.137	2.094	0.666	6.128	21.205
8	Iron_Steel	Iron and Steel	2.257	0.568	0.087	0.000	0.160	0.006	0.000	0.517	0.017	0.177	3.790
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.135	0.340	0.048	0.000	0.840	0.392	0.024	0.319	0.628	0.718	3.445
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			58.379	50.188	47.041	0.000	43.282	22.581	27.773	6.938	67.918	77.419	401.520

Table 07.04.a: Tariff Structure in 2017 – Japan (Author’s own calculations)

						Reporter	GTAP v09	GTAP v09					
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Japan	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	9.202	5.690	11.299	0.000	3.805	5.064	9.082	1.404	13.876	3.729	63.151
2	MeatLstk	Livestock and Meat Products	19.152	24.667	9.075	0.000	7.495	3.226	7.913	0.111	34.727	44.194	150.559
3	Extraction	Mining and Extraction	0.000	0.018	1.550	0.000	4.808	1.878	0.026	0.095	0.099	0.039	8.513
4	ProcFood	Processed Food	7.407	5.207	10.846	0.000	18.582	5.962	7.265	1.771	11.460	4.149	72.651
5	TextWapp	Textiles and Clothing	0.006	3.075	7.966	0.000	6.410	4.803	0.006	0.048	6.445	0.499	29.259
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.003	1.750	6.170	0.000	1.182	1.250	0.984	1.662	0.666	1.047	14.715
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.000	0.546	0.087	0.000	0.160	0.006	0.000	0.000	0.017	0.000	0.817
9	HeavyMnfc_ex_IS	Iron and Steel	0.042	0.179	0.048	0.000	0.840	0.392	0.024	0.172	0.628	0.016	2.341
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			35.812	41.132	47.041	0.000	43.282	22.581	25.300	5.264	67.918	53.674	342.005

Table 07.04.b: Tariff Structure in 2024 – Japan (Author’s own calculations)

						GTAP v09	Reporter	GTAP v09					
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		Republic of Korea	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	19.347	258.562	145.593	11.890	0.000	13.928	144.197	146.233	61.349	90.531	891.630
2	MeatLstk	Livestock and Meat Products	25.671	16.035	3.692	4.323	0.000	11.508	22.531	0.004	10.112	4.991	98.868
3	Extraction	Mining and Extraction	0.075	1.620	3.704	8.781	0.000	3.124	0.030	0.039	0.049	0.003	17.425
4	ProcFood	Processed Food	33.242	12.581	28.094	37.061	0.000	20.408	6.783	6.419	12.640	22.699	179.927
5	TextWapp	Textiles and Clothing	0.061	4.078	7.859	9.178	0.000	7.617	0.122	2.479	0.000	0.074	31.468
6	MotorVehicl_Parts	Motor vehicles and parts	0.000	2.616	4.954	7.934	0.000	5.135	0.044	0.000	0.027	0.000	20.710
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.273	1.033	2.356	4.726	0.000	4.788	0.817	0.012	0.051	0.033	14.089
8	Iron_Steel	Iron and Steel	0.076	0.631	0.213	0.122	0.000	0.052	0.000	0.000	0.000	0.000	1.094
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.370	1.398	2.190	5.254	0.000	1.624	0.590	0.238	0.170	0.175	12.009
10	Util_Cons	Utilities and Construction	0.000	1.438	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.438
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			79.115	299.991	200.654	89.269	0.000	68.184	175.115	155.424	84.399	118.506	1270.659

Table 07.05.a: Tariff Structure in 2017 – Republic of Korea (Author's own calculations)

						GTAP v09	Reporter	GTAP v09					
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Republic of Korea	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	11.696	257.557	144.406	11.890	0.000	13.928	144.168	146.233	45.169	11.343	786.390
2	MeatLstk	Livestock and Meat Products	9.480	10.328	2.413	4.323	0.000	11.508	22.391	0.004	2.406	0.223	63.076
3	Extraction	Mining and Extraction	0.000	1.613	2.241	8.781	0.000	3.124	0.029	0.039	0.000	0.000	15.828
4	ProcFood	Processed Food	17.745	9.265	24.944	37.061	0.000	20.408	6.693	6.419	2.538	7.942	133.014
5	TextWapp	Textiles and Clothing	0.000	4.063	3.811	9.178	0.000	7.617	0.122	2.479	0.000	0.000	27.270
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	0.000	2.612	1.677	7.934	0.000	5.135	0.044	0.000	0.000	0.000	17.402
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.012	0.971	0.716	4.726	0.000	4.788	0.790	0.012	0.000	0.000	12.015
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.000	0.521	0.054	0.122	0.000	0.052	0.000	0.000	0.000	0.000	0.749
9	HeavyMnfc_ex_IS	Iron and Steel	0.134	1.369	0.616	5.254	0.000	1.624	0.590	0.238	0.000	0.000	9.826
10	Util_Cons	Utilities and Construction	0.000	1.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.438
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			39.067	289.737	180.878	89.269	0.000	68.184	174.828	155.424	50.112	19.508	1067.008

Table 07.05.b: Tariff Structure in 2024 – Republic of Korea (Author's own calculations)

			GTAP v09			GTAP v09	GTAP v09	Reporter		GTAP v09	GTAP v09	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		Taiwan	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	6.700	0.748	8.199	18.861	20.449	0.000	9.573	4.138	2.326	7.475	78.469
2	MeatLstk	Livestock and Meat Products	5.898	0.100	0.512	0.939	0.735	0.000	0.858	4.840	7.335	4.198	25.415
3	Extraction	Mining and Extraction	0.076	0.034	1.224	0.800	11.884	0.000	0.037	1.878	1.040	3.383	20.356
4	ProcFood	Processed Food	8.885	2.715	15.553	21.257	15.856	0.000	6.815	4.513	9.348	10.689	95.631
5	TextWapp	Textiles and Clothing	1.768	10.136	8.818	7.223	5.225	0.000	6.644	4.701	5.701	8.360	58.577
6	MotorVehicl_Parts	Motor vehicles and parts	11.862	4.611	10.293	11.538	9.814	0.000	2.738	13.735	15.357	15.495	95.443
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.271	0.094	2.835	2.430	1.427	0.000	0.248	4.178	0.725	1.509	13.717
8	Iron_Steel	Iron and Steel	0.001	0.000	0.228	0.050	0.091	0.000	0.006	0.005	0.042	0.085	0.508
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.359	0.794	1.077	1.813	0.889	0.000	0.046	1.764	1.240	1.784	9.765
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			35.820	19.232	48.738	64.911	66.370	0.000	26.966	39.752	43.114	52.978	397.881

Table 07.06.a: Tariff Structure in 2017 – Republic of China (Taiwan) (Author's own calculations)

			GTAP v09			GTAP v09	GTAP v09	Reporter		GTAP v09	GTAP v09	GTAP v09	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		Taiwan	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	6.700	0.529	8.199	18.861	20.449	0.000	9.570	4.139	2.326	7.475	78.248
2	MeatLstk	Livestock and Meat Products	5.898	0.095	0.512	0.939	0.735	0.000	0.573	4.840	7.335	4.198	25.125
3	Extraction	Mining and Extraction	0.076	0.032	1.224	0.800	11.884	0.000	0.034	1.878	1.040	3.383	20.351
4	ProcFood	Processed Food	8.885	2.130	15.553	21.257	15.856	0.000	3.906	4.513	9.348	10.689	92.137
5	TextWapp	Textiles and Clothing	1.768	10.132	8.818	7.223	5.225	0.000	6.578	4.701	5.701	8.360	58.507
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	11.862	4.610	10.293	11.538	9.814	0.000	0.000	13.735	15.357	15.495	92.704
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.271	0.094	2.835	2.430	1.427	0.000	0.210	4.178	0.725	1.509	13.679
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.001	0.000	0.228	0.050	0.091	0.000	0.000	0.005	0.042	0.085	0.502
9	HeavyMnfc_ex_IS	Iron and Steel	0.359	0.794	1.077	1.814	0.889	0.000	0.003	1.764	1.240	1.784	9.724
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			35.820	18.415	48.738	64.912	66.370	0.000	20.875	39.753	43.114	52.978	390.976

Table 07.06.b: Tariff Structure in 2017 – Republic of China (Taiwan) (Author's own calculations)

			GTAP v09					GTAP v09		Reporter	GTAP v09		
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		India	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code	Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27		
1	GrainsCrops	Grains and Crops	29.903	6.411	27.437	12.469	13.096	21.253	11.542	0.000	24.404	27.752	174.267
2	MeatLstk	Livestock and Meat Products	5.258	2.854	13.368	5.346	6.121	13.408	0.128	0.000	15.146	5.621	67.251
3	Extraction	Mining and Extraction	2.968	0.581	2.772	3.651	0.017	5.223	0.028	0.000	3.649	8.267	27.156
4	ProcFood	Processed Food	53.773	14.890	38.379	31.884	43.083	42.691	40.090	0.000	31.460	52.326	348.575
5	TextWapp	Textiles and Clothing	6.354	3.050	12.217	0.657	9.596	12.687	2.471	0.000	12.474	15.853	75.360
6	MotorVehicl_Parts	Motor vehicles and parts	17.888	9.449	11.180	9.300	7.007	14.337	5.473	0.000	27.050	9.829	111.513
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	9.056	4.387	9.571	3.707	0.771	10.038	0.416	0.000	8.832	9.731	56.509
8	Iron_Steel	Iron and Steel	5.302	2.585	7.028	0.439	0.448	5.243	0.018	0.000	5.498	6.894	33.455
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	8.991	4.945	5.285	3.161	2.720	6.248	1.979	0.000	7.015	6.649	46.991
10	Util_Cons	Utilities and Construction	0.000	18.562	50.382	0.000	0.000	0.000	0.000	0.000	0.000	50.382	119.326
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			139.493	67.714	177.618	70.614	82.859	131.128	62.146	0.000	135.528	193.304	1060.404

Table 07.08.a: Tariff Structure in 2017 – India (Author’s own calculations)

			GTAP v09					GTAP v09		Reporter	GTAP v09		
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		India	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU27	
1	GrainsCrops	Grains and Crops	29.903	6.411	27.437	5.834	12.170	21.253	9.741	0.000	24.404	27.752	164.905
2	MeatLstk	Livestock and Meat Products	5.258	2.854	13.368	0.205	6.121	13.408	0.084	0.000	15.146	5.621	62.065
3	Extraction	Mining and Extraction	2.968	0.581	2.772	1.348	0.017	5.223	0.027	0.000	3.649	8.267	24.852
4	ProcFood	Processed Food	53.773	14.890	38.379	29.278	42.711	42.691	32.633	0.000	31.460	52.326	338.140
5	TextWapp	Textiles and Clothing	6.354	3.050	12.217	0.005	9.588	12.687	2.454	0.000	12.474	15.853	74.682
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	17.888	9.449	11.180	8.933	6.867	14.337	5.374	0.000	27.050	9.829	110.908
7	LightMnfc_ex_MVH	Motor vehicles and parts	9.056	4.387	9.571	0.948	0.767	10.038	0.403	0.000	8.832	9.731	53.732
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	5.302	2.585	7.028	0.000	0.444	5.243	0.000	0.000	5.498	6.894	32.993
9	HeavyMnfc_ex_IS	Iron and Steel	8.991	4.945	5.285	0.956	2.603	6.248	1.963	0.000	7.015	6.649	44.654
10	Util_Cons	Utilities and Construction	0.000	18.562	50.382	0.000	0.000	0.000	0.000	0.000	0.000	50.382	119.326
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			139.493	67.714	177.618	47.508	81.287	131.128	52.679	0.000	135.528	193.304	1026.258

Table 07.08.b: Tariff Structure in 2024 – India (Author’s own calculations)

			GTAP v09					GTAP v09			GTAP v09	Reporter	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2017		EU_27	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU_27	
1	GrainsCrops	Grains and Crops	1.924	0.616	4.473	5.889	0.591	4.162	2.556	4.473	3.439	0.000	28.123
2	MeatLstk	Livestock and Meat Products	20.147	1.769	12.042	12.386	0.000	0.362	6.881	12.042	26.163	0.000	91.793
3	Extraction	Mining and Extraction	0.044	0.202	2.118	3.865	0.000	0.687	1.210	2.118	0.320	0.000	10.563
4	ProcFood	Processed Food	13.317	1.474	12.125	15.582	0.028	11.363	6.869	12.125	11.540	0.000	84.423
5	TextWapp	Textiles and Clothing	4.129	0.000	6.415	8.101	0.000	6.563	3.666	6.415	6.938	0.000	42.228
6	MotorVehicl_Parts	Motor vehicles and parts	3.787	0.081	2.176	5.823	0.000	4.673	1.243	2.176	7.716	0.000	27.675
7	LightMnfc_ex_MVH	Light Manufacturing excluding MVH	0.701	0.024	0.509	2.308	0.000	4.036	0.312	0.509	1.144	0.000	9.544
8	Iron_Steel	Iron and Steel	0.076	0.001	0.057	0.407	0.000	0.140	0.033	0.057	0.394	0.000	1.166
9	HeavyMnfc_ex_IS	Heavy Manufacturing excluding Iron & Steel	0.771	0.019	0.588	3.338	0.000	1.691	0.336	0.588	1.528	0.000	8.860
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			44.896	4.186	40.504	57.700	0.619	33.677	23.106	40.504	59.182	0.000	304.375

Table 07.09.a: Tariff Structure in 2017 – European Union (Author’s own calculations)

			GTAP v09					GTAP v09			GTAP v09	Reporter	
Base Year:		Report region:	1	2	3	4	5	6	7	8	9	10	
2024		EU_27	Australia	Rest of the world	China & HK	Japan	Republic of Korea	Taiwan	Southeast Asia	India	United States	EU_27	Total
Code		Description	AUS	RoW	CHN_HK	JPN	KOR	TWN	SEA	IND	USA	EU_27	
1	GrainsCrops	Grains and Crops	1.924	0.610	4.473	0.765	0.513	4.162	2.556	4.473	3.439	0.000	22.914
2	MeatLstk	Livestock and Meat Products	20.147	1.739	12.042	0.049	0.000	0.362	6.881	12.042	26.163	0.000	79.426
3	Extraction	Mining and Extraction	0.044	0.196	2.118	0.519	0.000	0.687	1.210	2.118	0.320	0.000	7.212
4	ProcFood	Processed Food	13.317	1.425	12.125	0.623	0.028	11.363	6.869	12.125	11.540	0.000	69.416
5	TextWapp	Textiles and Clothing	4.129	0.000	6.415	0.000	0.000	6.563	3.666	6.415	6.938	0.000	34.127
6	MotorVehicl_Parts	Light Manufacturing excluding MVH	3.787	0.000	2.176	0.621	0.000	4.673	1.243	2.176	7.716	0.000	22.392
7	LightMnfc_ex_MVH	Motor vehicles and parts	0.701	0.017	0.509	0.051	0.000	4.036	0.312	0.509	1.144	0.000	7.280
8	Iron_Steel	Heavy Manufacturing excluding Iron & Steel	0.076	0.000	0.057	0.000	0.000	0.140	0.033	0.057	0.394	0.000	0.757
9	HeavyMnfc_ex_IS	Iron and Steel	0.771	0.012	0.588	0.012	0.000	1.691	0.336	0.588	1.528	0.000	5.527
10	Util_Cons	Utilities and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	TransComm	Transport and Communication	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	OthServices	Other Services	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total			44.896	4.000	40.504	2.641	0.540	33.677	23.106	40.504	59.182	0.000	249.052

Table 07.09.b: Tariff Structure in 2024 – European Union (Author’s own calculations)

11.4 Chapter 08

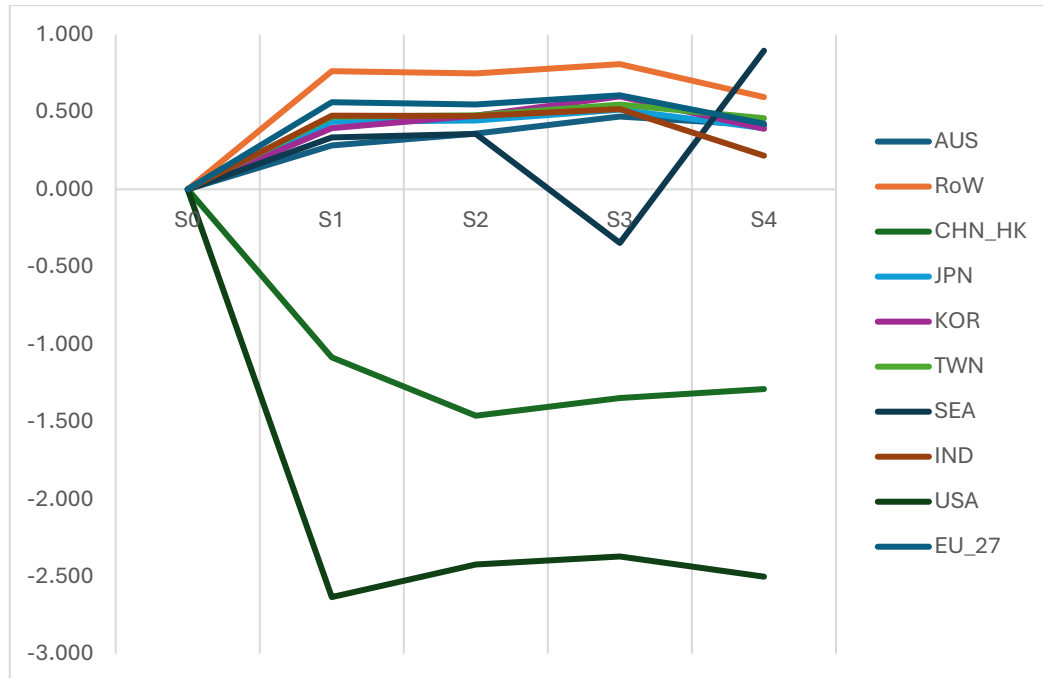


Figure 08.02: All regions' normalised real GDP growth (qgdp) (Author's own calculations)

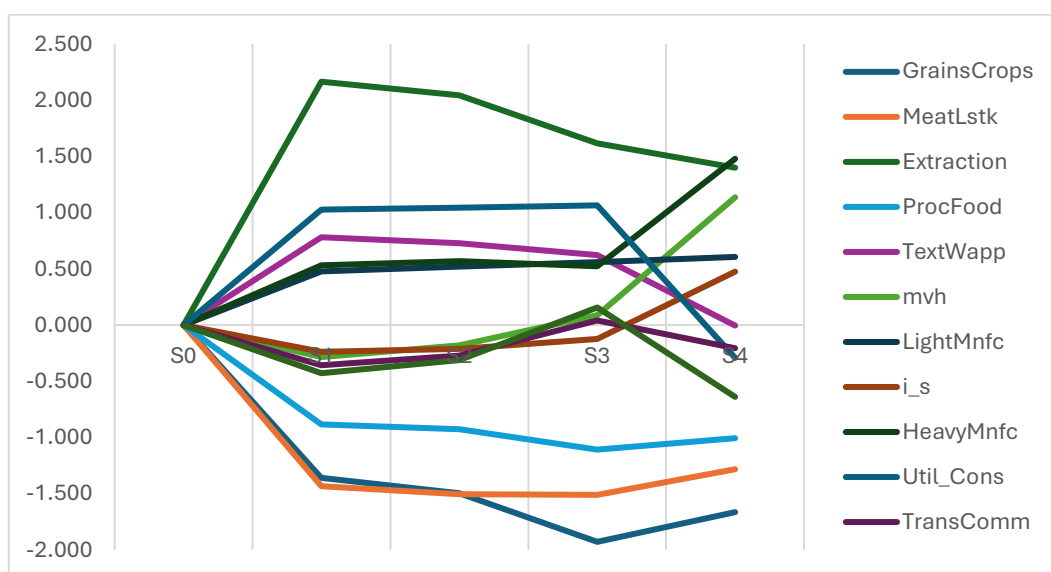


Figure 08.03.a: SEA's normalised real private consumption growth by sector (qpa) (Author's own calculations)

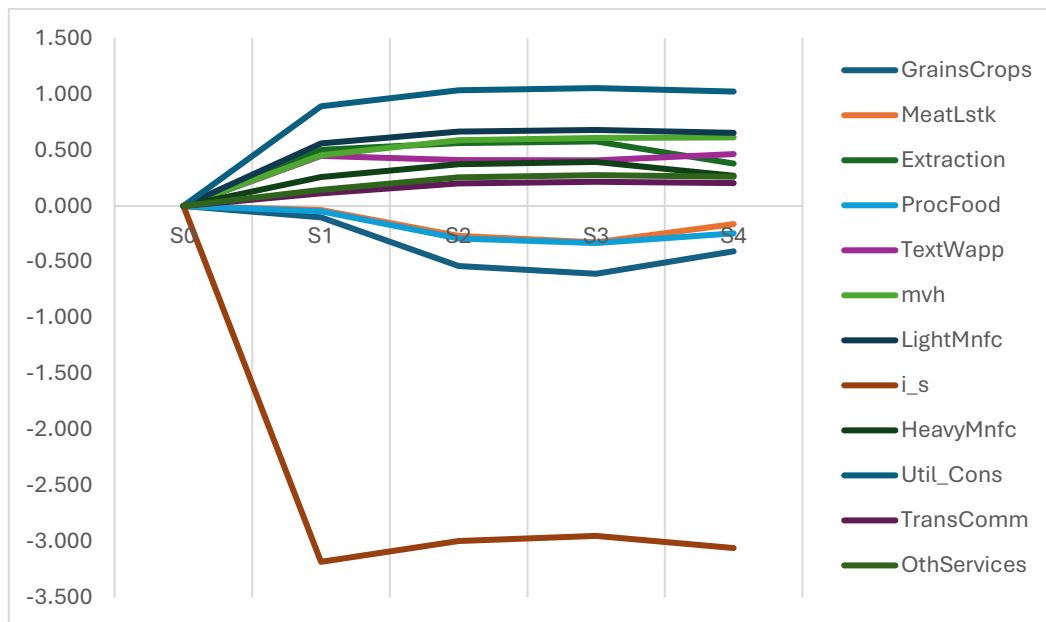


Figure 08.03.b: CHN_HK's normalised real private consumption growth by sector (qpa) (Author's own calculations)

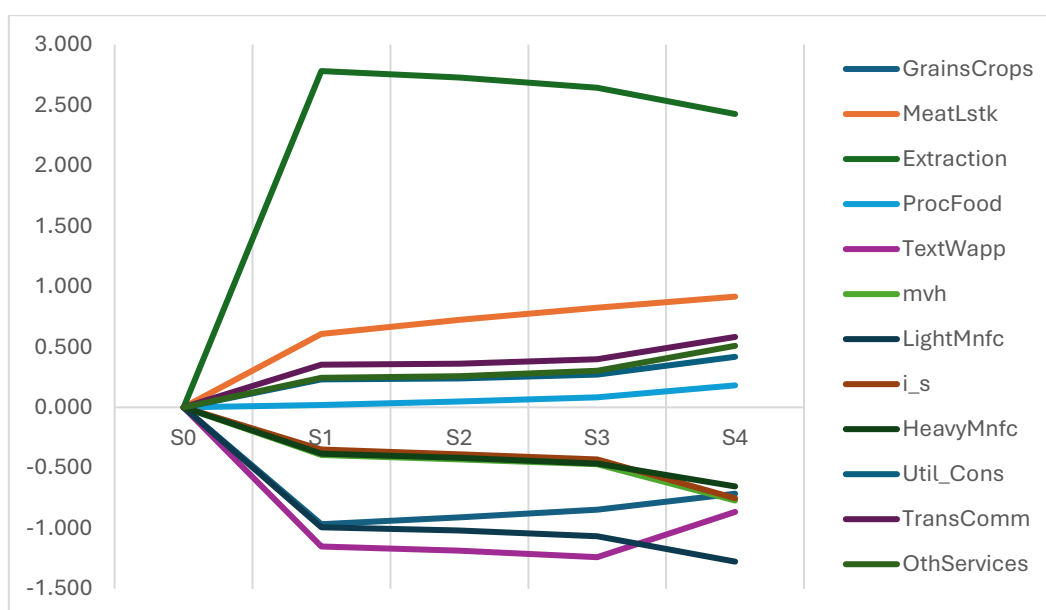


Figure 08.03.c: USA’s normalised real private consumption growth by sector (qpa) (Author’s own calculations)

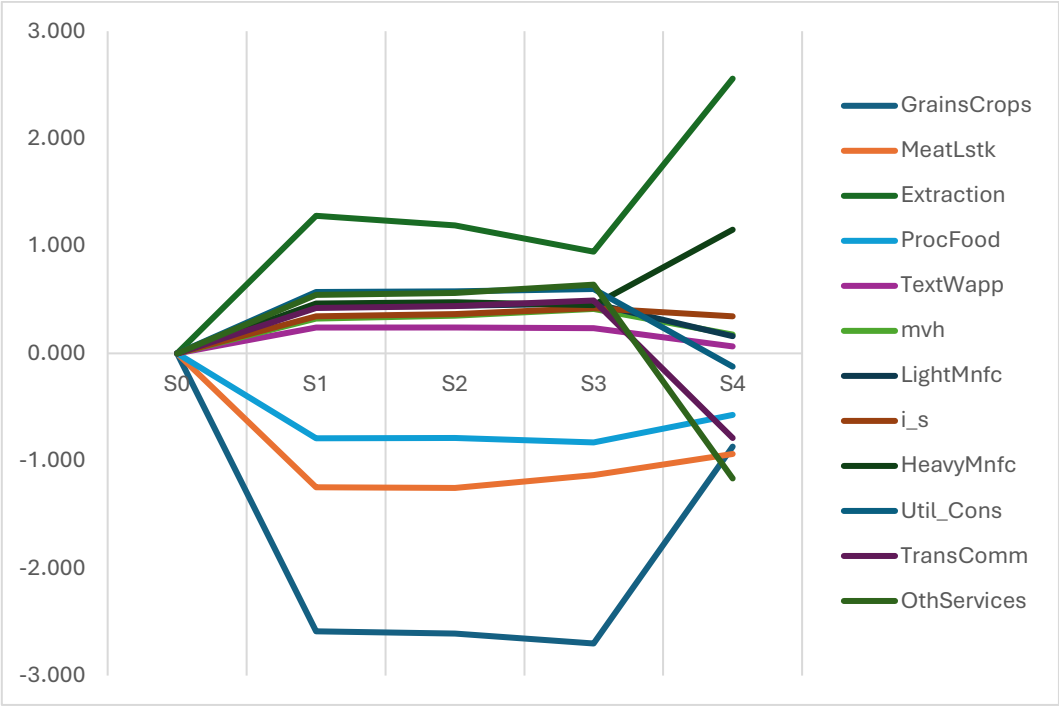


Figure 08.06.a: SEA’s normalised real government consumption growth by sector (qga) (Author’s own calculations)

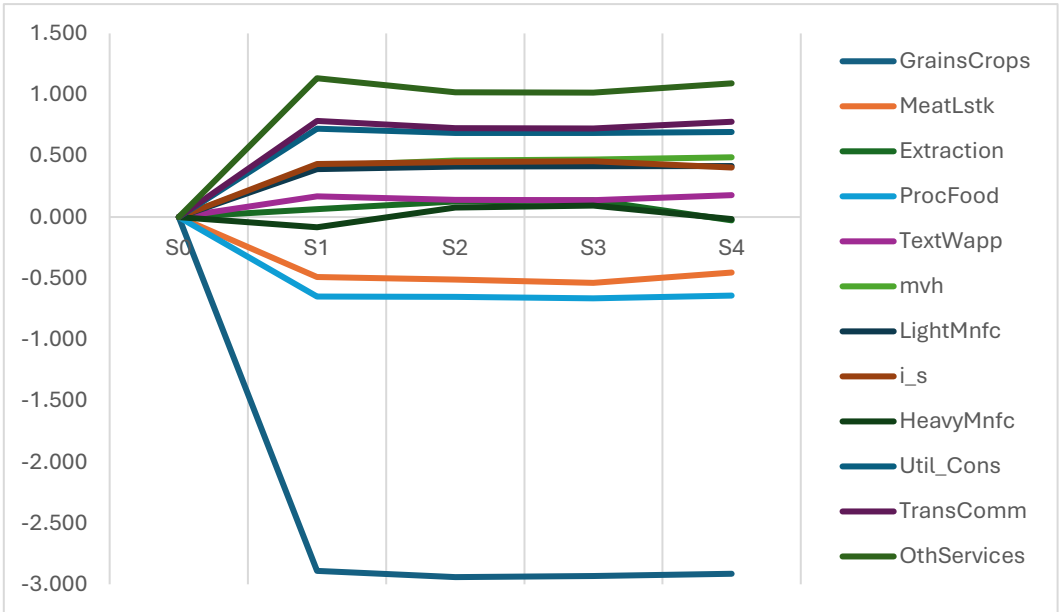


Figure 08.06.b: CHN_HK's normalised real government consumption growth by sector
(qga) (Author's own calculations)

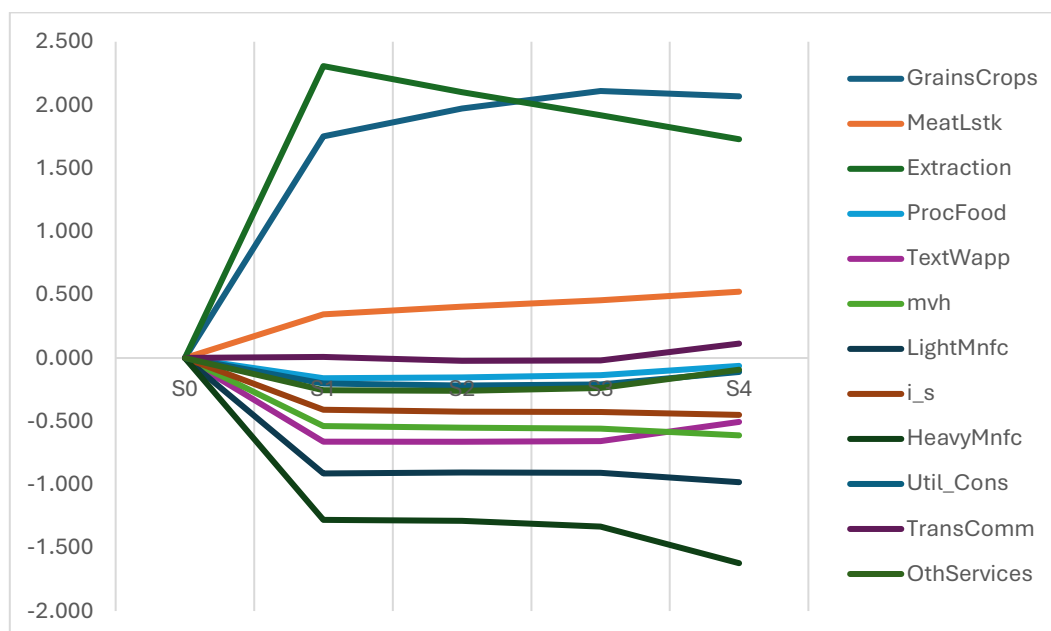


Figure 08.06.c: USA's normalised real government consumption growth by sector (qga)
(Author's own calculations)

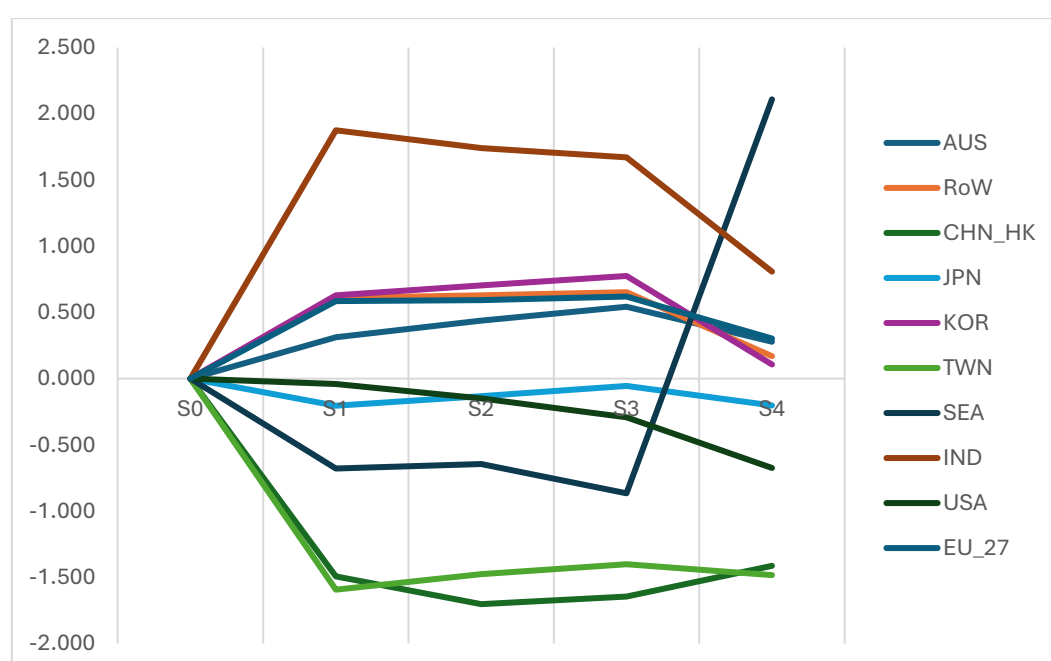


Figure 08.09: All regions' normalised real investment consumption growth (qinv) (Author's own calculations)

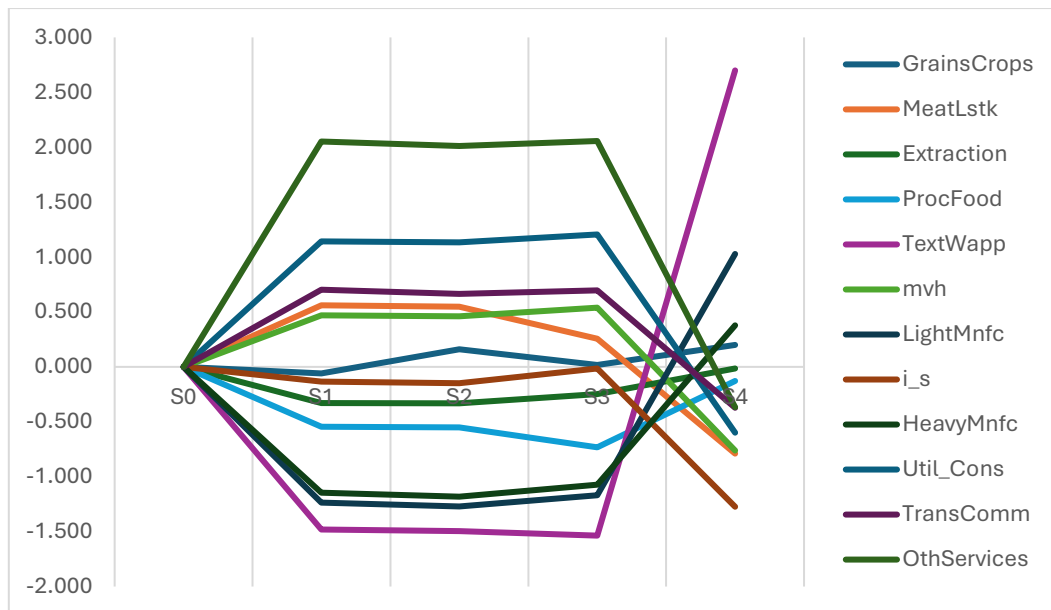


Figure 08.12.a: SEA's normalised real export growth by sector (qxw) (Author's own calculations)

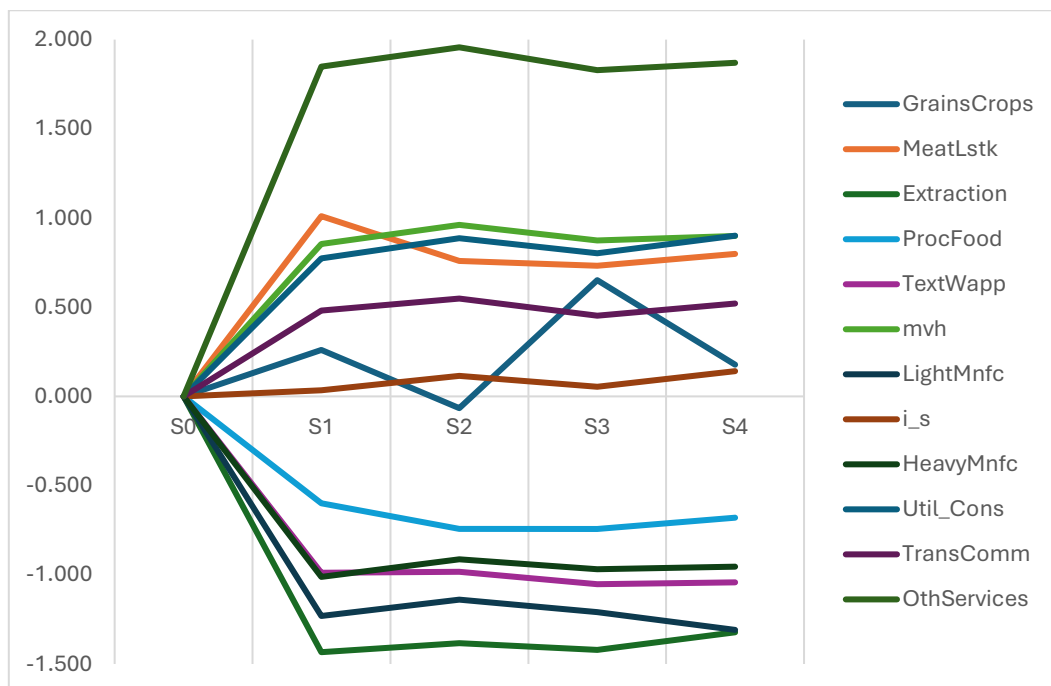


Figure 08.12.b: CHN_HK's normalised real export growth by sector (qxw) (Author's own calculations)

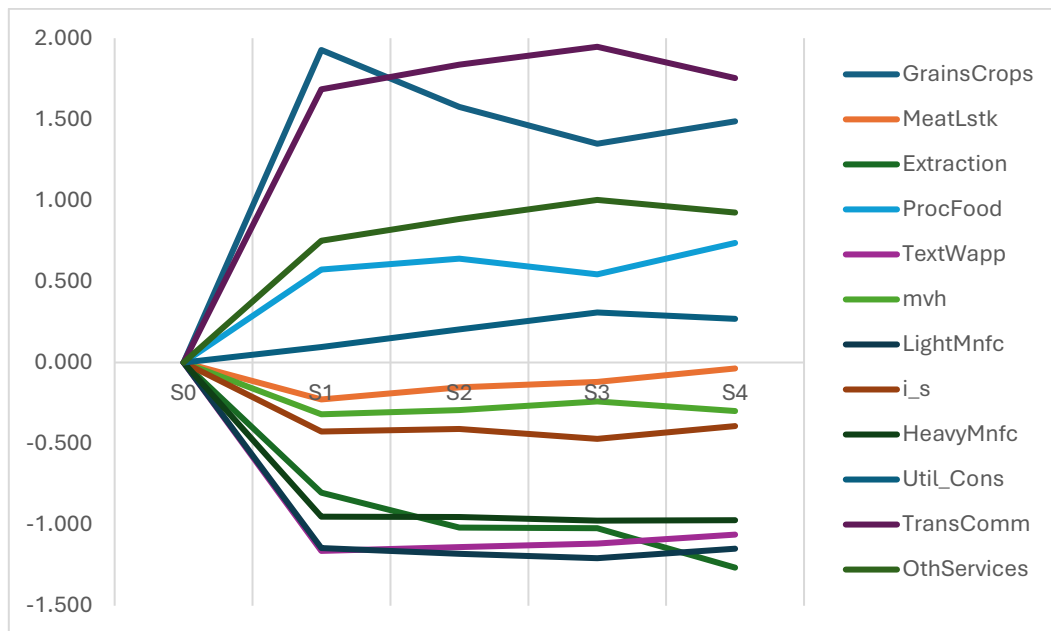


Figure 08.12.c: USA's normalised real export growth by sector (qxw) (Author's own calculations)

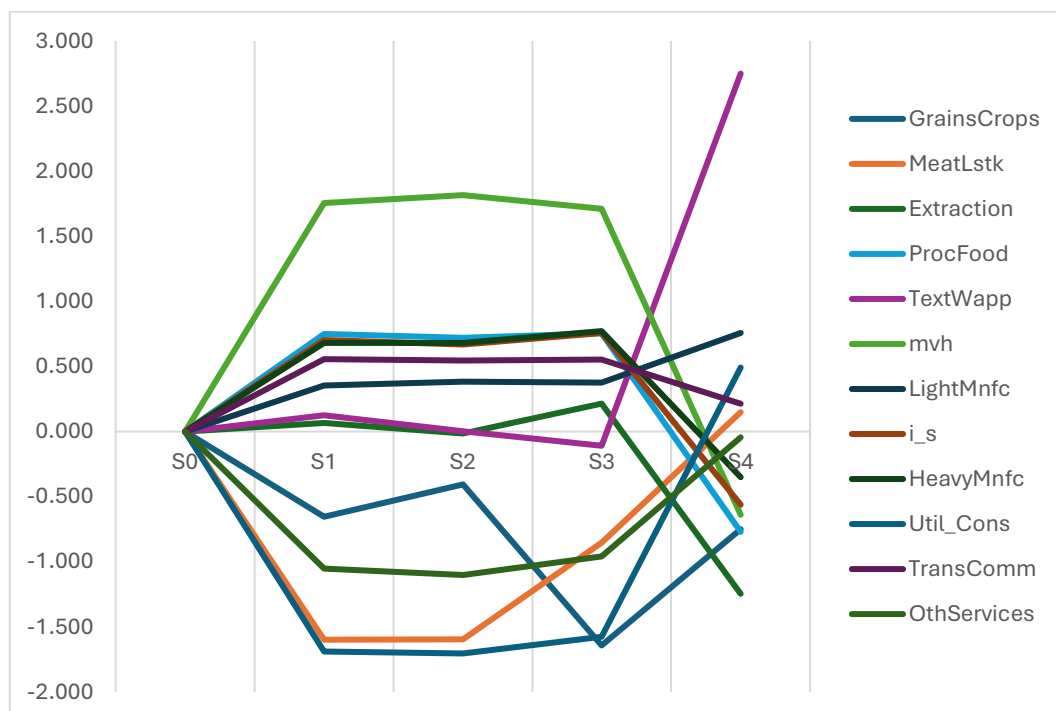


Figure 08.14.a: SEA's normalised real import growth by sector (qmw) (Author's own calculations)

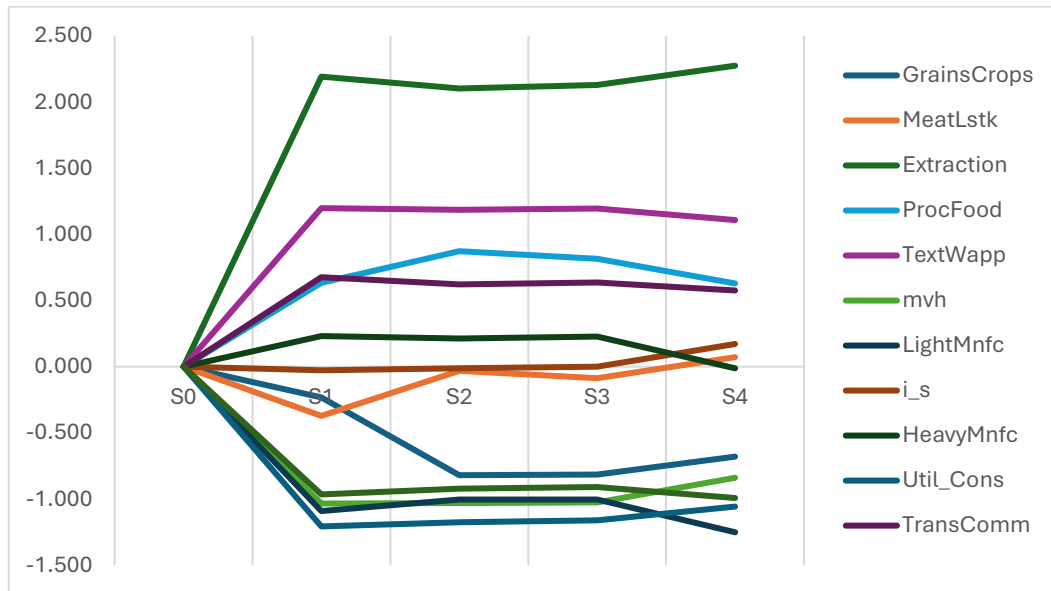


Figure 08.14.b: CHN_HK's normalised real import growth by sector (qmw) (Author's own calculations)

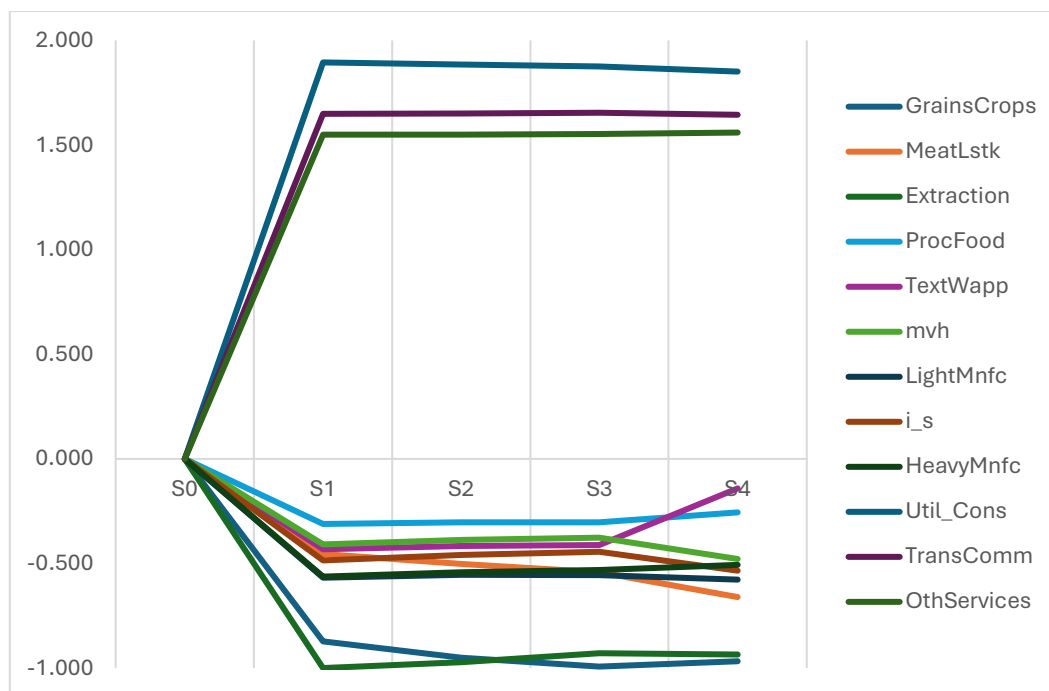


Figure 08.14.c: USA's normalised real import growth by sector (qmw) (Author's own calculations)

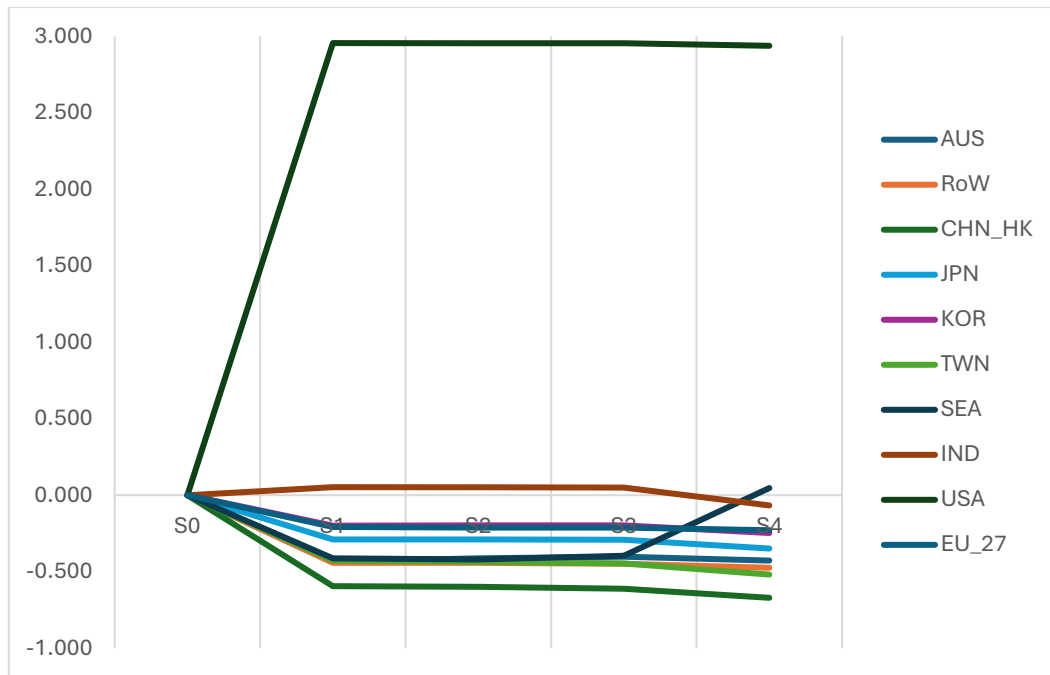


Figure 08.17.a: All regions' normalised Terms of Trade changes (tot) (Author's own calculations)

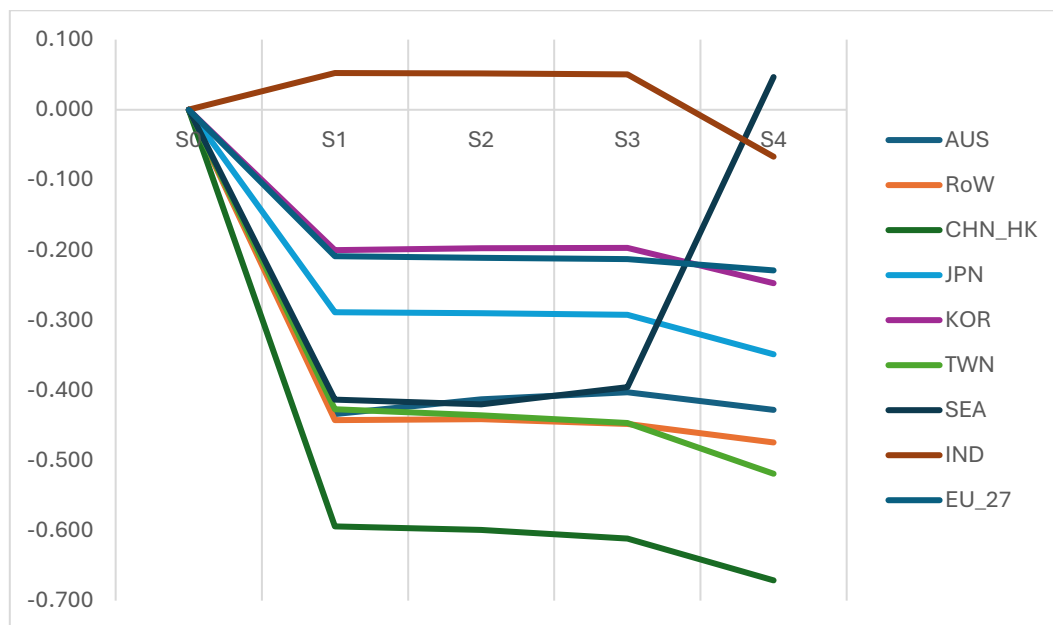


Figure 08.17.b: All regions' (without the USA) normalised Terms of Trade changes (tot) (Author's own calculations)