

UNIVERSITI TEKNOLOGI MARA

**THE INFLUENCE OF GREEN
INNOVATION AND POLITICAL
STABILITY ON E-COMMERCE:
EVIDENCE FROM ASIAN
COUNTRIES**

**MOHAMAD HAZREN BIN
MANSUR**

MSc

August 2026

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MOHAMAD HAZREN BIN MANSUR

Thesis submitted in partial fulfilment
of the requirements for the degree of
Master in Science
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August 2026

CONFIRMATION BY PANEL OF EXAMINERS

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I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

In this new era of the digital revolution, the development of technology rapidly promotes the globalization of economic development, especially in the digital economy. E-commerce development has emerged as a critical component of any country's sustainable economic growth and development. In recent years, green technology innovation and political stability have gained increasing attention as key determinants of e-commerce development, particularly in Asian countries striving to achieve both digital transformation and sustainable economic progress. Although previous studies have examined the determinants of e-commerce growth, limited research has jointly explored the roles of green technology innovation and political stability in influencing e-commerce development. In addition, inconsistent findings on the impact of sustainability initiatives on E-commerce growth highlight an important research gap. This study contributes to the literature by shedding light on the intersection of green technology, governance, and E-commerce performance in Asian. These research studies empirically examine the effect of green technology innovation and political stability index factors that will impact e-commerce towards Asian countries. The data are collected based on 20 selected countries in Asian from secondary data for 2000 to 2020 and using panel data regression model methods to analyse the relationship between these variables. The results show that green technology innovation has a negative and insignificant relationship with e-commerce growth. In contrast, political stability has a positive and significant effect on e-commerce development. However, the relationship between green technology innovation and e-commerce becomes positive when the political stability index is included in the model. These findings suggest that while sustainability initiatives alone may have limited direct impact on digital economy expansion in Asian, strong political stability can enhance the effectiveness of green technology innovation. Overall, the results highlight the critical role of governance in shaping the digital economy, with political stability emerging as a stronger determinant of e-commerce success. Therefore, policy recommendations emphasize regional collaboration, sustainable innovation, and stronger governance policies to accelerate e-commerce growth.

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LIST OF SYMBOLS

Symbols

y	Independent Variables
i	Year
t	Time Period
β	Coefficient
ϕ	Parameter In Equation
δ	Parameter In Equation
p	Substitution Parameter
$\alpha \text{ \& } \beta$	Coefficient Value In Regression
$\ln$	Natural Log
Δ	Changes Value Between Two Points Of Time
Σ	Summation
ε	Error Term
v	Stochastic Error Term

LIST OF ABBREVIATIONS

Abbreviations

1MDB	1 Malaysia Development Berhad
ASEAN	Association Of Southeast Asian Nations
AR	Augments Reality
AI	Artificial Intelligence
BBC	British Broadcasting Corporation
BCG	Boston Consulting Group
B2B	Business to Business
B2C	Business to Consumer
B2G	Business to Government
CO ₂	Carbon Dioxide
COVID-19	Corona Virus 2019
DP	Digital Platform
DID	Difference-In-Difference
E-R&D	Engineering Research and Development
FE	Fixed Effects
GDP	Gross Domestic Product
GTI	Green Technology Innovation
GLS	Generalized Lease Squares

GTFP	Green Total Factor Productivity
IR	Industry Revolution
IMF	International Monetary Fund
ICT	Information and Communication Technology
IPS	Im Pesaran & Shin
LLC	Levin Liu Chin
LINGO	Language For Interactive General Optimization
LMT	Lagrange Multiplier Test
MINLP	Mixed-Integer Non-Linear Programming
NEDC	National E-commerce Demonstration Cities
NGT	New Growth Theory
OECD	Organization For Economic Cooperation and Development
PTPTN	Perbadanan Tabung Pendidikan Tinggi Nasional
PLS-SEM	Partial Least Square Structural Equation
PTAR	Perpustakaan Tun Abdul Razak
RCEP	Regional Comprehensive Economic Partnership
RFID	Radio Frequency Identification
R&D	Research and Development
SME	Small and Medium Enterprise
SSL	Secure Socket Layer
STATA	Syllabic Abbreviation of The Words Statistics and Data

SPSS	Statistical Package for The Social Sciences
TFP	Total Factor Productivity
TOT	Term Of Trade
UITM	Universiti Teknologi Mara
USD	United State Dollar
UNCTAD	United Nations Conference on Trade and Development
VAC	Value Appropriation Capabilities
VR	Virtual Reality
VIF	Variance Inflation Factor
WEF	World Economic Forum

CHAPTER 1

INTRODUCTION

1.1 Research Overview

The development of technology and communication has significantly promoted rapid globalisation, economic development, and innovation, which creates new business systems. According to Li (2020), information technology has rapidly advanced leading to the emergence of e-commerce as a new transaction model that is widely accepted by the public. E-commerce involves the buying and selling of goods and services over the internet which facilitates transactions between businesses and consumers or between businesses themselves. The extensive adoption of e-commerce platforms has not only driven contributed to substantial growth in the economy and confirmed but also to positively impact the macroeconomic indicators of the economy, such as increasing productivity in business and the economy (Heil & Prieger, 2009; Liu *et al.*, 2013; Park *et al.*, 2018). These studies reveal the increase by 1 per cent for e-commerce related capital such as in R&D capital will induce 0.002 per cent increase in value added. Scholars believed that the digitalization of the economy is a key engine of economic growth with important regional consequences for business, employment, and society as a whole (Bahl, 2016). This tendency is especially evident in developed countries, as mentioned by Dahlman *et al.*, (2016); Volkova *et al.*, (2021), highlight that digitisation boosts economic growth, enhances returns on capital, increases productivity, reduces transaction costs, and expands access to global markets.

E-commerce industries keep on developing even deeper to have a huge impact on the economic around the world. According to Tian & Stewart (2007), worldwide e-commerce would be worth \$6.8 trillion in early 2000s, with North America accounting for 50.9 per cent, the United States 47 per cent, Asia Pacific for 24.3 per cent, Europe for 22.6 per cent, and Latin America for 1.2 per cent. However, while the United States and North America presently dominate online transactions, Asia and Europe will become more active in e-commerce in the future years. In the post 2000s era, ecommerce underwent a substantial resurgence, rebounding emphatically from a prior downturn. This resurgence was further amplified by the burgeoning popularity of

online shopping platforms. Notably, the advent of the COVID-19 pandemic served as a catalyst, accelerating the already thriving e-commerce landscape.

Asian e-commerce had a huge growth that beginning with the recovery from the Asian economic crisis in the late 1990s and lasting into the early 2000s. Despite the establish of dot-coms penetration United States more active compare than Asia, the technology market crash of spring 2000 washed up on Asian shores as well, leaving a trail of dead or failing Internet enterprises. As a result, during the early stages of e-commerce, most of Asia was too preoccupied with keeping current economies together to devote the time and money required to launch whole new businesses and technology methods. Thus, the future of e-commerce in Asian countries has moved e-commerce to the next level of phase. In Asia Region perspective, Asia e-commerce business has grown rapidly since the mid of 2010s and the COVID-19 outbreak has catapulted it into a new age. From 2016 to 2021, the overall value of e-commerce sales increased by 40 per cent each year, and e-commerce is percentage of total retail sales increased from 5 per cent to 20 per cent (Sal Arora, 2022). Figure 1.1 represents the e-commerce market for global and Asian countries and it show the momentum of e-commerce in Asian countries.

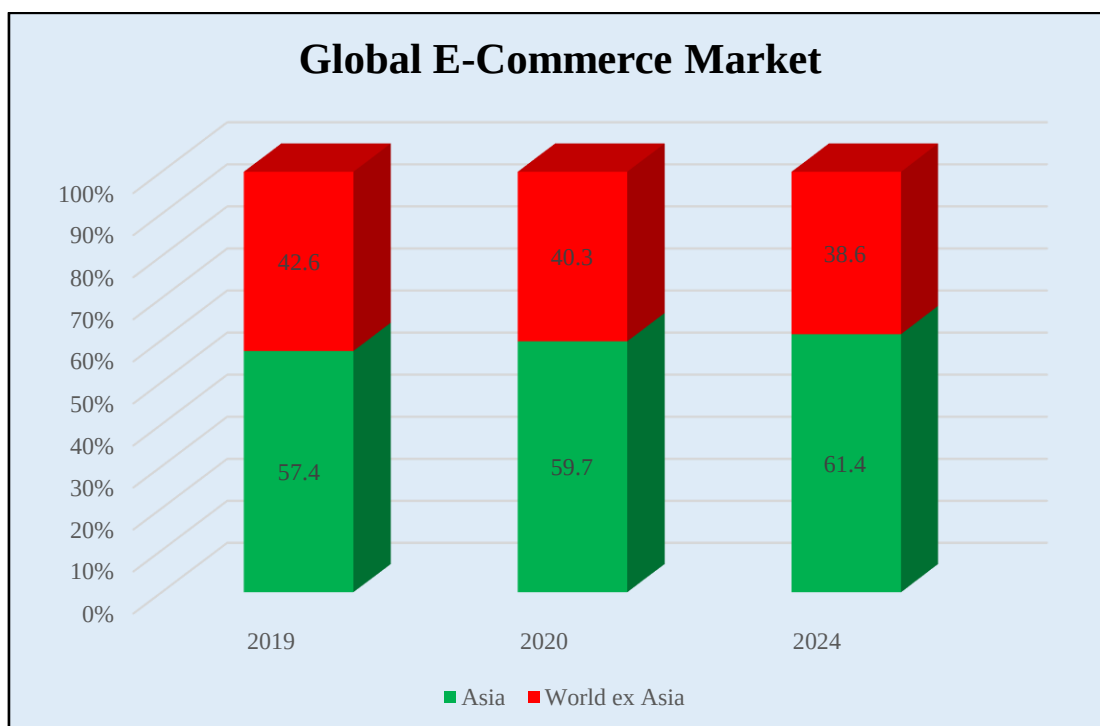


Figure 1.1 World's E-Commerce (B2C) Market

Sources : Statista and Eastspring Investments (2020)

According to Kinda (2019), the globe has experienced unprecedented increase in e-commerce transactions with its expanding middle class and rising internet penetration but interestingly Asia is at the forefront of global e-commerce growth. In 2019, Asia countries dominated the global e-commerce market, accounting for over 57.4 per cent of worldwide business-to-consumer e-commerce sales. Furthermore, Asian economies expected to take over 61.4 per cent for 2024 of the global e-commerce sectors. Their also mention that a robust logistical networks, a growing middle class, improved financial infrastructure, and quick innovation will generate Asia's e-commerce sales, driving GDP growth, productivity, and economic inclusion in a region. While, figure 1.2 shows the trends of e-commerce sales in Asia.

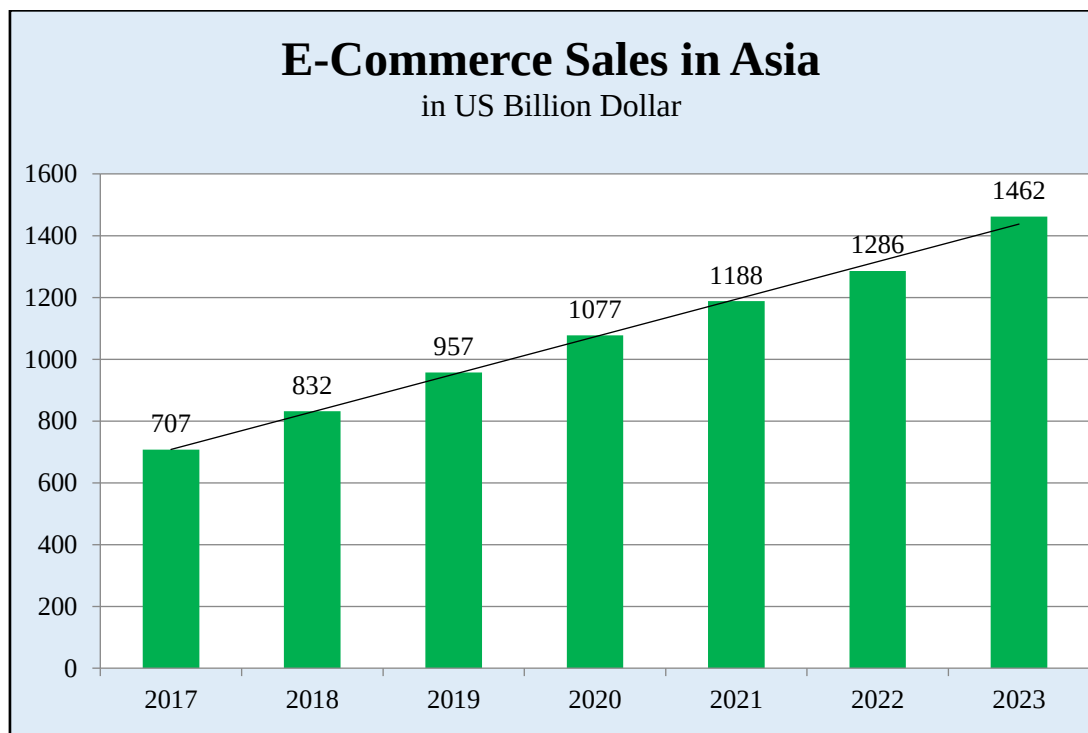


Figure 1.2 E-Commerce Sales in Asia in US Billion Dollars

Sources : Asia Ecommerce marketing and Statista (2023)

Based on report by Buii (2023) as in figure 1.2, it shows that data for e-commerce sales in Asia from 2017 to 2023. For instance, in 2017 e-commerce sales has reach over 707 billion US dollar while in 2023 has reach 1,462 trillion US dollar which. The data show the trend for e-commerce significant growth from year to year. However, Asia e-commerce revenues will increase by 22.4 per cent to 1 trillion USD in 2020. As mention above in figure 1 and figure 2, the data for e-commerce sales in Asia expected to reach 1.92 trillion USD by 2024. In recent year, the data for e-

commerce sales in Asia increase from year to year and show significant growth trend. Hence, figure 1.3 shows the e-commerce sales for worldwide by region.

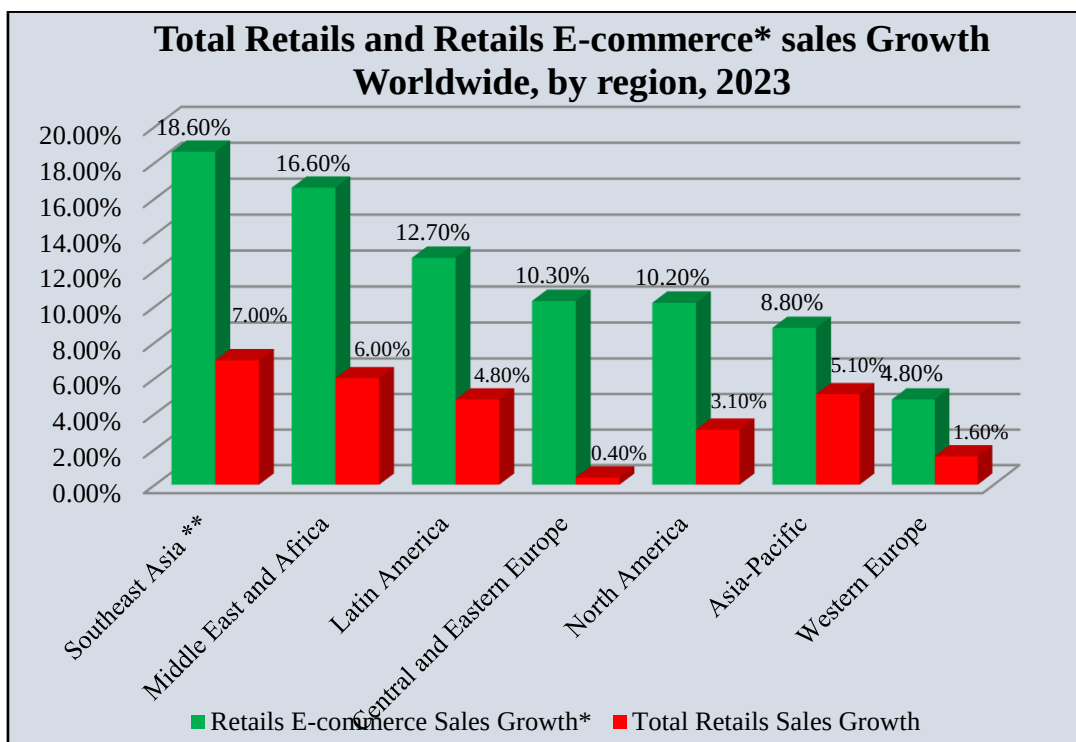


Figure 1.3 Total Retails and Retails E-commerce Sales Growth Worldwide by Region

Sources : Emarketer (2022)

Note: excludes travel and event tickets, payments such as bill pay, taxes, or money transfers, restaurant sales, foods services and drinking place sales, gambling and other vice goods sales; * includes products or services ordered using the internet regardless of the method of payment or fulfilment: excludes travel and event tickets, payments such as bill pay, taxes, or money transfers, restaurant sales, foods services and drinking place sales, gambling and other vice goods sales; ** is a subset of Asia-Pacific and the southeast Asia figure area also included in the Asia-Pacific Totals.

In general, Asia as the largest e-commerce growth over the global e-commerce growth and has achieve 18 per cent for e-commerce sales in 2023 for Southeast Asia compare than another region. Central and Eastern show the different result compare to the retails e-commerce and total sales which is for e-commerce sales 10.3 per cent and the total only 0.4 per cent in 2023, while for Western Europe 4.8 per cent the lowest e-commerce sales in 2023.

The total retail sales show that Asia countries also the highest ranking which 7.6 per cent follow by Middle East and Africa for 6.6 per cent, Latin America and Asia Pacific 4.8 per cent, for North America 3.1 per cent, and Western Europe 1.8 per cent in 2023. The figure shows that the global e-commerce and Southeast Asia are the

fastest highest rate of e-commerce in the region. According to Kinda (2019), Southeast Asia continues to have immense development potential, and it has traditionally demonstrated spectacular expansion in spurts throughout Asia.

1.2 E-Commerce, Green Technology and Political Stability in Asian Countries

In this new era of the digital revolution, e-commerce development has emerged as a critical component of any country's sustainable economic growth and development (John, 2017). However, there are two mains concerned by recent studies which are the environmental issues Yu *et al.*, (2023) and political stability Volkova *et al.*, (2021). According to Yu *et al.*, (2023), resource depletion and environmental concerns have recently gained interest, becoming a serious danger to the well-being of humans. It has become a global priority for maintaining a sustained growth of mankind within natural boundaries. Thus, as mention by Palladan & Adamu (2019) that the risk in the political factor may exist in the political stability due to the unpredictable change in the political factor in the country that may have some effect to the e-commerce.

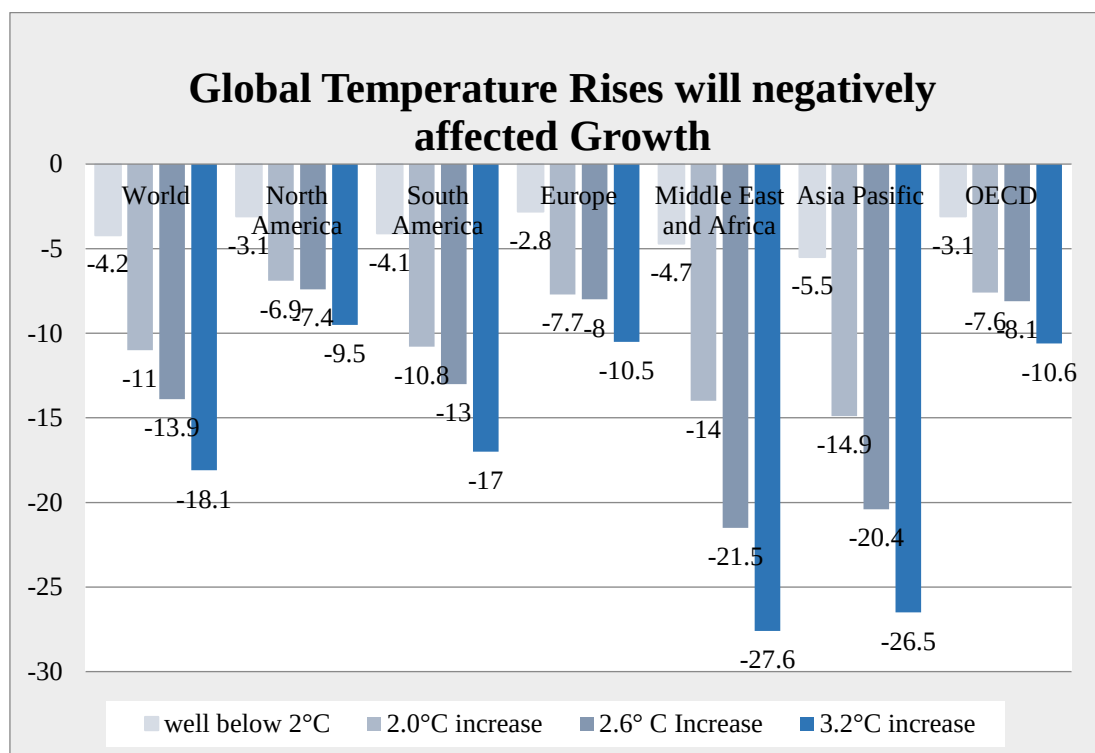


Figure 1.4 Global Temperature Rises Will Negatively Affected Growth

Sources : The economics of climate change (2021) and Consultancy Asia

World Economic Forum (WEF) and Boston Consulting Group (BCG) have released a comprehensive report indicating that Asia is expected to experience the most significant and immediate adverse effects due to climate change. It is imperative for businesses throughout Asia to take a leading role in advancing efforts to combat climate change. Therefore, the data above show the simulation that the impact of economic losses in GDP percent that represent in region including Asia countries. The temperature level at a safe zone which is below that 2 Celsius not less than zero Celsius are referring to the Paris Target as indicator for climate change. According to the forecast Europe will be that lowest losses if the temperature increases due to the global warming following by North and South America, Middle East and Africa and the highest losses in economic would be Asian. The figure 1.5 shows the CO₂ Emissions global per cent. Even a slight increase in global temperatures, below 3 degrees Celsius, would have severe repercussions on the GDP of Asian countries. For instance, if global temperatures were to rise by 3.2 degrees Celsius above pre-industrial levels, Singapore and Malaysia could face a staggering 46% drop in GDP, while Thailand could see a 43% decline, and Indonesia could experience a 39 per cent reduction (Asia, 2023).

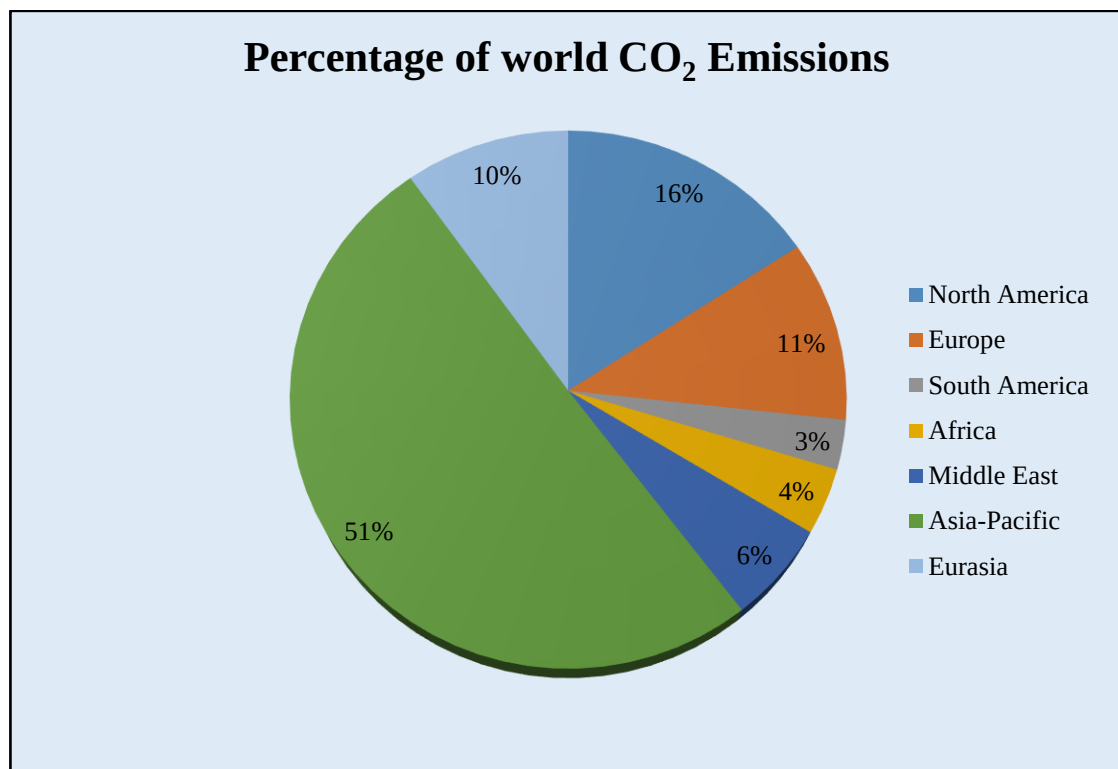


Figure 1.5 Percentages of World CO₂ Emissions

Sources : Climate watch, BBC Analysis and Consultancy Asia.

According to Asia (2023), given the substantial risks involved, it is imperative for Asia to intensify its efforts to address climate change. Asia currently accounts for 51 per cent of global CO₂ emissions, with a significant portion of this emission distributed unevenly among countries. China, India, Indonesia, and South Korea emerge as the largest contributors to pollution by a considerable margin. Essentially, Asia must accelerate the decarbonisation process in the region promptly. The report highlights that the pace of decarbonisation in Asia lags significantly behind the global average and is not anticipated to improve in the foreseeable future. Figure 1.5 explain that Asia region shows the worst environmental issue. Hence, it is importance to investigate the environmental issue.

The development of technology and the innovation show an unexpected pace in improving the e-commerce environment. Technology innovations also become the main bone of e-commerce as business strategy (Eurostat, 2018; Ortiz *et al.*, 2020). E-commerce is one of the Industry Revolutions (IR), the change of traditional business methods to modern business and encourages more innovation, and vice versa. However, in the dynamic landscape of global commerce, the nexus between environmental sustainability and e-commerce has become a focal point of discourse and innovation. The rise of e-commerce, facilitated by technological advancements it has also raised critical questions about the environmental footprint of digital transactions that might has negative effect. In the last decade, modern society has focused extensively on the potential benefits of the digital economy but has largely overlooked its adverse environmental impact (Alorse, 2019). An example in Iran country, an inventive e-commerce technology solution has been introduced, offering a deeply localized and customer-centric shopping experience to expand their operations nationwide. According to Corredera (2020), this service achieved an impressive 5.4 million transactions recorded in 2014.

E-commerce enablers, such as Digital Networks, enhance supply chain efficiency and intelligence through the internet, facilitating swift connections to customers. This not only reduces pollution but also promotes environmentally friendly businesses (Yassin *et al.*, 2021). From a sustainability point of view, several authors such as Mangiaracina *et al.*, (2015) and Gevaers *et al.*, (2014) say that technology and innovation are the most significant factors in mitigating e-commerce's environmental effects. Green innovation, which encompasses a wide range of environmentally friendly technology and sustainable practices, has gained importance as a response to

the growing need for environmental protection (Wang *et al.*, 2021). However, many industries remain unwilling to embrace green innovation. One clear factor inhibiting individuals from participating in green projects is the uncertainty of the advantages of such initiatives (Yan *et al.*, 2022). Interestingly, a recent study found that by Guo *et al.*, (2023) there is a significant positive moderating effect of green innovation in the financing process of SMEs embedded in e-commerce. As e-commerce platforms persist in transforming market dynamics, there is a heightened focus on scrutinizing the environmental impact of these operations (Jones, 2022).

Strong evidence of green innovation was found by Yin *et al.*, (2018), that green innovations have a significant positive impact on the sustainability of development in the form of the efficiency of resources and friendly environment for society. Innovations may carry out something new or change in e-commerce that would have has significant impact on the e-commerce on growth, market expansion and sales (Hardilawati *et al.*, 2019). According to Kinda, (2019), many Asian economies are still unable to fully realise the potential advantages due to existing digital inequalities, shortcomings in crucial infrastructure, and unfavourable e-commerce laws. Despite its rapid development, e-commerce, especially cross-border e-commerce, might grow more quickly if certain obstacles were eliminated. Besides that, green innovation in e-commerce may spread awareness among society that green innovations are important to the sustainability of countries. The modernization of the environment idea would maintain advanced economic systems that may enhance resource efficiency through green tech innovation (Yassin *et al.*, 2021). According to Yu *et al.*, (2023), e-commerce's impact on Green Technology Innovation is rarely investigated by the researcher. Since the relationship between e-commerce and green innovation is less conducted among researchers, especially in Asian countries, perhaps this study may find a knowledge gap to fulfil the objective of these studies and the importance of studying the variable. Investigating the factors that will affect e-commerce it is importance because Asia is the largest e-commerce conquer in the world where Asian countries in the top ten rank of e-commerce such as Japan, China and Korea. As we know technology is the main factor that contributed to the e-commerce as main bones. As mention by Feng & Jin (2022), advances in technology have hastened the growth of e-commerce and e-commerce sector had an exceptional surge of expansion, particularly during the Covid-19 crisis.

On the other hand, political stability plays important roles in the development of a country such as the growth of the economy, the increase of investors or FDI, two ways business which is trade and e-commerce. Additionally, while e-commerce primarily relies on online operations, the stability of political conditions continues to wield a significant influence on the e-commerce landscape. Several studies have revealed that the slow progress of e-commerce in developing countries can be attributed, in part, to the absence of a comprehensive policy framework of e-commerce sector on four essential factors encompassing technological, political, social, and economic as highlighted by (Stahl, 2007; Lawal & Abdulkadir, 2012; Alyoubi *et al.*, 2020). Political factors such as ideology are one of the factors that have an effect on the e-commerce market. A crucial problem in political leadership investigations is how to regulate the interaction between political participants and the situation in which they identify themselves to be managed (Korosenyi *et al.*, 2016). Therefore, it would be different in every country depending on the rules and regulations of countries. Political and regulatory challenges ahead of e-businesses have steadily increased (Coppel, 2000; Gibbs, *et al.*, 2003; Rahayu & Day, 2015; Kabakova & Plaksenkov, 2018; Thanh, 2021). Hence, to focus on political stability it is important to study the stability of the country and the development of the country; this is because it would have consequences due to the stability of politics.

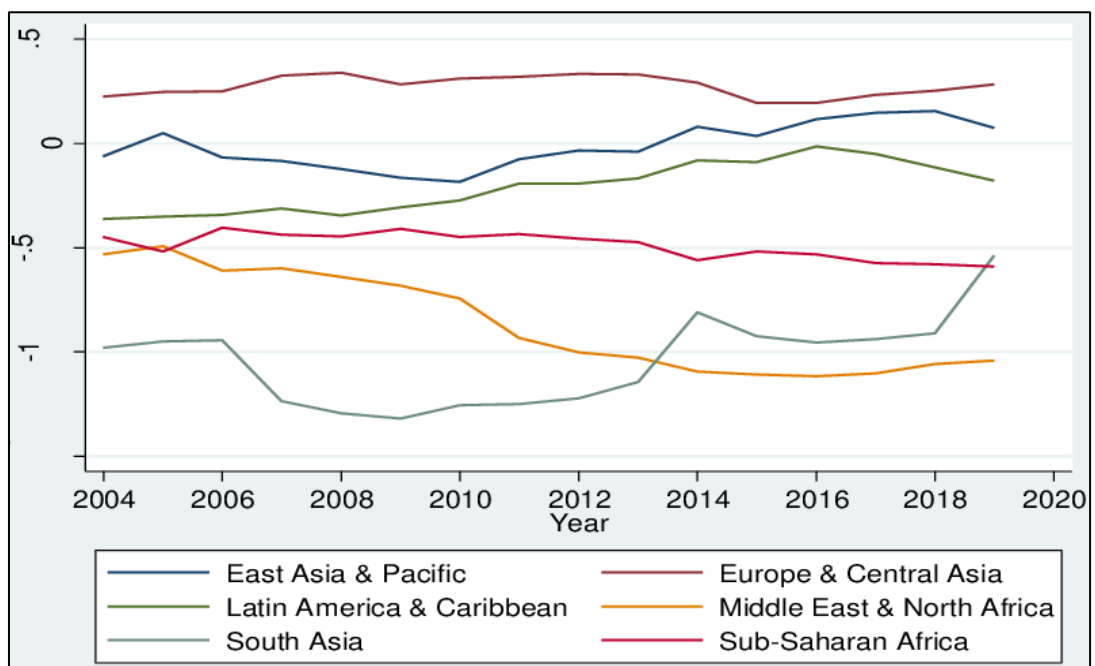


Figure 1.6 Comparison of Political Stability by Regions

Sources : Worldwide Government Indicator (2021)

The figure 1.6 represents the comparison of political stability by regions over the world. According to Muriu (2021), the Europe and Central Asia region has maintained relative stability. However, since 2010, the Middle East and North Africa have experienced political instability stemming from events such as the Arab Spring revolution and ongoing conflicts in Syria and Yemen. Sub-Saharan Africa has also seen a decline since 2012, possibly due to ongoing conflicts, particularly in fragile states. Political upheavals, conflicts, and labour unrest in South Africa indicate persistent political instability related to elections. Additionally, security risks include insurgencies and terrorist threats, as evidenced by incidents in countries like Kenya.

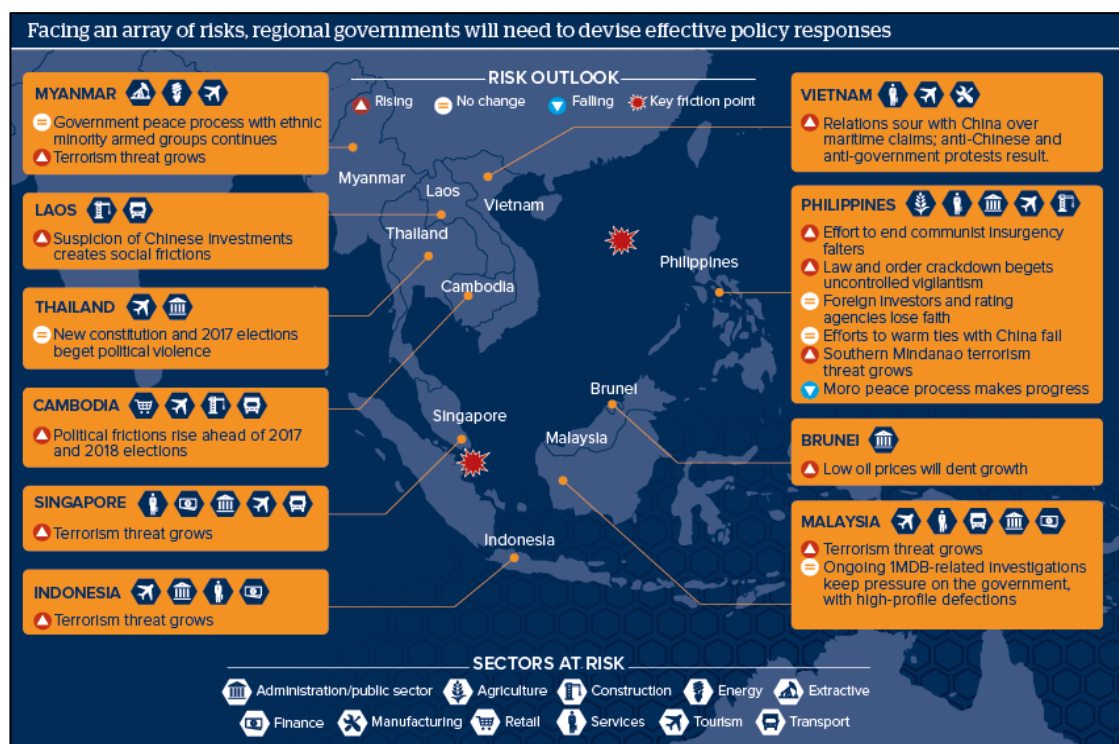


Figure 1.7 South-east Asian Instability Flashpoints May Multiply

Sources : Oxford Analytica (Analytica, 2016)

Figure 1.7 shows that effect by the unstable of countries that may led to negative effect toward economic performance. An example for the figure above such as Malaysia that the rising threat of terrorism and the 1MDB investigation on pressure for government influence high profile level will affect the tourism, services, transportation, administration or public sector, and currency. However, the effect of instability of countries also effects the GDP, purchasing power and many that has direct and indirect relationship with the stability. Therefore, for the figure above it will show how the effect of political will affect the e-commerce sector either direct or not.

Political stability concerns can have significant consequences on the expansion of e-commerce (Phan, 2021). During the Russia-Ukraine war, e-commerce in Ukraine in Pre-Invasion and Post-Invasion e-commerce had a 65 per cent drop in e-commerce, a 73 per cent drop in transactions, and an 87 per cent drop in revenue produced from digital sales across all categories (Jones, 2022). Instead, Political stability is the driver for the e-commerce either it develops or vice versa. One of example in Asian region is the agreement among Asian countries under the countries ASEAN E-commerce agreement, become one of the reasons that political stability contributes to the growth of e-commerce. As an Asian expected to experience the biggest growth in e-commerce over the next decade, now is the high time to look closely Asian countries (Shanmugalinga et al., 2023).

1.3 Problem Statement

In every e-commerce business, technological innovations may be a powerful tool. E-commerce that exists today is in a growth cycle in the business and digital worlds, but there are still systems or management systems that need innovation to become better. Liu (2002) found that there is a complementary relationship between e-commerce and technological innovations for productivity improvement. In a more recent study, Ortiz *et al.*, (2020) stated that the more money invested in technological innovations, the faster e-commerce will grow. Nonetheless, the dramatic acceleration in the rate and power of technological innovations can be related to environmental problems (Karmaker *et al.*, 2021). While reaching huge amounts in economic growth, rapid expansion for e-commerce in modernisation and manufacturing has several environmental and ecological issues.

From an environmental impact standpoint, Asia is the most vulnerable region compared to others, as climate change poses greater risks to its supply chains, logistics, and infrastructure, potentially resulting in substantial GDP losses (Asian, 2023). Cleaner and more energy-efficient technology innovation has been advocated for in the fight against climate change and global warming in Asian countries. According to United Nations Conference on Trade and Development (2024), there is a urgent need to promote more sustainable e-commerce practices through the adoption and use of green products.

Despite Mu et al. (2021) highlighting that green technological innovation and e-commerce are emerging as important and current research topics, relatively few studies have empirically examined how green technology innovation influences e-commerce development. According to Babenko *et al.*, (2019), lack of understanding may lead to negative effects on an entire system of e-commerce. Moreover, the green technology innovation strategy is considered the most crucial strategy in the era of digitalization to create awareness among peoples (Barforoush et al., 2021). According to Yu *et al.*, (2023), green technology innovation aims to improve resource efficiency and reduce pollutant emissions on manufacturing. It is the fundamental approach for reducing global environmental contamination and attaining sustainable development over time. However, the impact of green technology innovation on e-commerce remains underexplored, particularly in the context of Asian countries.

In relation to green technology innovation, political stability plays an important enabling role. Kwilinski et al. (2019) emphasize that effective e-commerce functioning requires a stable political system with strong regulatory support at both national and international levels. Drezner (2021) further demonstrates that political stability significantly affects e-commerce performance, as political decisions and governance structures directly influence national economic conditions and market confidence. Similarly, Phan (2021) notes that geopolitical instability can disrupt e-commerce operations and business decision-making, that potentially leading to financial losses and reduced investor confidence. In the context of Asian countries, Haqqi and Murdani (2023) highlight that the complexity of the digital economy continues to create political tensions and power struggles, which in turn affect the development of e-commerce. To date, many Asian countries continue to experience varying levels of political instability, policy uncertainty, and governance challenges, which may disrupt market efficiency and hinder the expansion of e-commerce (Haqqi & Murdani, 2023).

Existing literature provides mixed and insufficient evidence on how green technology innovation and political stability individually and jointly affect e-commerce development in Asian countries. This lack of clear empirical consensus creates a significant research gap, particularly in understanding whether sustainable technological advancement can effectively promote e-commerce growth under different governance conditions. Therefore, this study seeks to address these gaps by

examining the impact of green technology innovation and political stability on e-commerce development in selected Asian countries.

1.4 Research Questions

From the above issues, there are two (2) research questions will be derived as follows:

- i. Does green technology innovation on the development of e-commerce in Asian countries?
- ii. What is the impact of political stability index on the development of e-commerce in Asian countries?

1.5 Research Objective

From the above issues, there are two (2) research objectives will be derived as follows:

- i. To examine the impact of green technology innovation on the development of e-commerce in Asian countries.
- ii. To analyse the influence of political stability index on the development of e-commerce in Asian countries.

1.6 Significance of Study

1.6.1 Policy Maker

For policy makers, this study provides important empirical evidence on the roles of green technology innovation and political stability in shaping the performance of the e-commerce sector. The findings can assist governments in designing more effective policies that promote sustainable digital transformation. In particular, it highlights the importance of maintaining political stability to ensure policy consistency, regulatory efficiency, and investor confidence, all of which are crucial for the growth of e-commerce. At the same time, it emphasizes the need to encourage green technology innovation through supportive policies, incentives, and infrastructure development to ensure that digital economic growth does not come at the expense of environmental sustainability.

1.6.2 Body of Knowledge

This study contributes to the body of knowledge by bridging the gap between environmental economics and digital commerce. It applies the New Growth Theory (NGT) to a contemporary issue, thereby enriching theoretical discussions and providing new directions for interdisciplinary research. By integrating green technology innovation and the political stability index into the analysis of e-commerce development, the study introduces a more holistic framework that can be extended and applied by future researchers, particularly in emerging economy contexts.

This study is grounded in the NGT, which emphasizes innovation, knowledge, and technological progress as key drivers of long-term economic growth. In this framework, green technology innovation in the e-commerce sector represents an endogenous growth mechanism that supports productivity improvement and sustainable development. The study examines green technology innovation as a potential driver of e-commerce development, particularly in Asian countries that are experiencing rapid digital transformation alongside increasing environmental concerns.

In addition, the political stability index is incorporated as an important institutional factor that supports the effectiveness of innovation. A stable political environment provides the necessary foundation for innovation to be effectively implemented, sustained, and translated into economic performance. In this sense, political stability index enhances the ability of green technology innovation to contribute meaningfully to e-commerce growth across Asian countries.

1.7 Limitation

This study has several limitations that should be considered when interpreting the findings. First, the research is limited to 20 selected Asian countries due to the unavailability or incompleteness of data on e-commerce and green technology innovation for some countries in the region. As a result, the findings may not be fully generalizable to all Asian countries or other regions with different economic and institutional contexts. Second, there is a limited body of existing literature that directly examines the relationship between green technology innovation, political stability, and e-commerce development. This constraint reduces the depth of available theoretical and empirical references, particularly in strengthening certain aspects of the

conceptual and analytical framework (Kadir et al., 2020). Third, the study is constrained by time limitations, as it was conducted within a specific timeframe. This restricts the extent of data exploration, robustness checks, and deeper empirical analysis that could further strengthen the findings.

1.8 Summary

As mentioned, previously e-commerce has currently evolved into a prominent global business platform. However, recent studies, notably those by Yu *et al.*, (2023) on environmental concerns and Volkova *et al.*, (2021) on political stability index, highlight two key considerations. Green technology innovations, beyond their profitability focus, extend to safeguarding the environment globally. This ensures that the product outcomes do not adversely impact the ecological balance. Simultaneously, the emphasis on political stability index is crucial, contributing not only to individual knowledge but also to economic growth. Nevertheless, due to the limited number of studies conducted thus far, the present study aims to explore the impact of green technology innovation and political stability index on e-commerce.

The remainder of the study is organized as follows: Chapter 2 provides a review of the related literature on the relationship between the independent variables and e-commerce development. This chapter also highlights relevant theories and empirical evidence aligned with the focus of the study. Chapter 3 presents the research methodology, including the theoretical and empirical framework, hypothesis development, data description, and econometric specification used in the study. Chapter 4 presents the empirical results and discussion, where the findings from the econometric analysis are reported, interpreted, and compared with previous studies. This chapter explains the relationship between green technology innovation, political stability, and e-commerce development based on the regression results. Finally, Chapter 5 provides the conclusion and policy recommendations of the study. It summarizes the key findings, discusses their implications, and offers suggestions for policymakers, industry stakeholders, and future research directions.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Literature Review

This chapter reviews previous studies that influences the effect of e-commerce specifically the green technology innovation and political stability index. Firstly, the chapter started with providing overview of e-commerce and its definition. Then, chapter also reviews some of the most prominent theories related to this study, empirical evidence and their critics and empirical shortcomings. Within this process, relevant articles were sought from search engines and databases such as Google Scholar, Science Direct, Taylor and Francis, Sage Publication, and other relevant websites and sources. In order to find relevant literatures, keywords, such “e-commerce”, “green technology innovation” “political stability index” Asian Countries “panel data” was used in this process.

2.2 E-commerce

E-commerce, as defined by the Organisation for Economic Co-operation and Development (OECD) in 2001 and revised in 2009, refers to the process of conducting business transactions or services through computer networks, facilitating commercial exchanges (OECD, 2019). The scope of e-commerce has expanded exponentially with advancements in internet technology, leading to significant transformations in business and consumer interactions. As highlighted by Kusuma & Marhaeni (2019), businesses that adopt e-commerce platforms tend to outperform those that do not, with factors such as pricing strategies, product demand, and macroeconomic conditions playing crucial roles in driving success.

Furthermore, Lucero Ortiz *et al.*, (2020) emphasize that five key factors for e-commerce which is macroeconomics, market dynamics, sociocultural influences, technological advancements, and government involvement significantly impact national e-commerce competitiveness. As stated by Corredera (2020), e-commerce has emerged as a driving force of economic growth, innovation, and competitiveness. Additionally, Corredera (2020) highlights that e-commerce is essential for businesses aiming to innovate and remain competitive in a globalized economy. Moreover, its

ability to connect consumers and businesses across borders has diminished geographical barriers, fostered international trade and stimulated overall economic activity. Therefore, as suggested by various researchers, understanding the internal and external factors influencing e-commerce growth is vital for both policymakers and business leaders.

As stated by John (2017), the evolution of the digital landscape has made e-commerce an integral component of the global economy, influencing consumer behaviour, business operations, and international trade. John (2017) further asserts that e-commerce not only enhances business competitiveness but also grants global access to products and services, leading to improved market efficiency. This development has been particularly advantageous for businesses seeking expansion beyond geographical limitations. As noted by Ho et al., (2011), Myovella et al., (2020), and Kang *et al.*, (2021), the internet has facilitated the reduction of trade barriers and promoted cross-border transactions, making it easier for businesses to thrive in the global marketplace.

The relationship between e-commerce and macroeconomic factors is crucial in understanding its broader economic impact. As mentioned by (Heil & Prieger, 2009), e-commerce enhances productivity, streamlines business processes, and improves efficiency across industries. Furthermore, Terzi (2011) supports this perspective by stating that e-commerce reduces transaction costs and enhances customer service, ultimately contributing to economic growth. Similarly, according to Anvari and Norouzi (2016), long-term studies indicate that the development of e-commerce platforms has a lasting impact on macroeconomic conditions, positively influencing business operations and national economic growth.

Macroeconomic variables such as Gross Domestic Product (GDP), inflation, and market dynamics significantly influence e-commerce development. According to Ozekenci et al. (2019), there is a positive correlation between e-commerce growth and GDP, suggesting that as national economies expand, e-commerce adoption and expansion become more pronounced. This phenomenon has been accelerated by internet-driven globalization, particularly in the realm of internet-based exports (Deng *et al.*, (2022). Additionally, reinforce this idea, emphasizing that the internet plays a pivotal role in driving e-commerce growth at an international level

Beyond technological advancements, e-commerce reflects broader societal shifts. As argued by the OECD (1999) and John, (2017), e-commerce is reshaping

modern society by driving technological innovation and economic efficiency. According to Khan *et al.* (2010) and Palladan & Adamu, (2019), e-commerce enhances resource utilization and economic security, benefiting consumers, businesses, and governments alike. Additionally, as pointed out by Ortiz *et al.*, (2020), e-commerce platforms significantly contribute to national economic growth by stimulating local businesses and creating new opportunities in the global marketplace.

In addition to its economic impact, e-commerce also plays a pivotal role in cross-border trade. As emphasized by Ho et al. (2011) and Myovella et al. (2020), e-commerce enables businesses to overcome geographical barriers, fostering specialization in industries where nations hold a comparative advantage. This process, as noted by various researchers, promotes knowledge diffusion, technology transfer, and global economic efficiency, allowing businesses to access international markets with minimal investment in physical infrastructure.

Finally, as suggested by many scholars, e-commerce continues to expand, making it essential for countries to leverage it as a tool for economic development. According to various studies, businesses can enhance productivity, streamline operations, and enter new markets more efficiently by adopting e-commerce platforms. Furthermore, as stated by several economic analysts, policymakers play a critical role in shaping the future of e-commerce by fostering innovation, reducing trade barriers, and supporting the digital transformation of industries.

2.3 Review of Concepts

2.3.1 Review of E-Commerce Trends in Asian Countries

E-commerce rapidly growth all over the world due to the development of internet access, mobile device and technology sector create massive changing in e-commerce market. Asian countries led the international market and sales in e-commerce based on the growth rate. In Asia, almost all firms or businesses introduce new goods and services or product all over the year and e-commerce in Asia has international quality certification over 60 percent (Kinda, 2019). In the line of global digitalization, it bring e-commerce trend in Asian countries such as VR and AR (Kimura & Chen, 2017), the development of technology (Machine Learning, Internet of things (IoT), 5G (Fifth Generations), Block-chain Technology (C.-Y. Park et al., 2018), and Social commerce (Abecassis *et al.*, 2022). For instance, e-commerce

technologies are not only offered for better goods and services but it will help to focus on increase customer satisfaction and experience. The development e-commerce services and technology allow customer to shopping in online platforms.

E-commerce sector in Asia also consistently focusing in sustainability e-commerce product and services. As mentioned by Kimura and Chen (2017), e-commerce required a favourable environment in which to flourish as well as government help in creating and optimizing to assure the safety and stability of e-commerce to growths. In order to reduce the environment pollution in ecological systems, green technology innovation is needed to improve the efficiency of product in e-commerce (Wang et. al., 2014; Ye & Cheng, 2019). Last not least, e-commerce is Asia also focusing how the SME or firm may reach global market. According to Kinda, (2019), e-commerce in Asia has international quality certificate and almost all of e-commerce create more product and services in years. The achievement of e-commerce sector by accepted the quality certificate it allows e-commerce to expand the market the market thru global.

During the early stages of e-commerce, most of Asia was too preoccupied with keeping current economies together to devote the time and money required to launch whole new businesses and technology methods. However, the future of e-commerce in Asian countries has moved e-commerce to the next level of prosperity. Asian countries lead the international market and sales in e-commerce. The transaction of e-commerce in China estimated bigger than Germany, France, United Kingdom, and the United States combined (Woetzal *et al.*, 2017). According to IMF (2018), Asia leading are roles in every aspect in digitalization technology include e-commerce and accelerated of e-commerce user. Aside from China, several Asian nations, including Japan, India, Indonesia, South Korea, and Vietnam, have a strong and attractive e-commerce sector (Kinda, 2019). This is support by Qi *et al.*, (2020), China is the large economic country and leader in the e-commerce market. According to the report by Statista (2023), e-commerce in Asia is expected gain 2.05 trillion USD in 2023.

According to Uddin (2019), the development of Mobile Commerce in 2005 in global e-commerce to introduce mobile commerce for consumer to make purchase and conduct transactions using their smartphones, paving the way for a new era of convenience. E-commerce has increasing trends as an extra trading channel of transactions among the industries (Kusuma & Marhaeni, 2019). The used of social commerce or social media becomes useful method to publish the product and to

discover more to exchange information thru internet (Jain *et al.*, 2021). According to Abecassis *et al.*, (2022), Social commerce advancements are bringing innovation to consumers product discovery experiences that reflected in e-commerce platforms and social commerce are introducing unique features to discover product thru livestreaming and become intermediate point in communication between customer and merchant. However, by understand the trends and focus e-commerce will develop the knowledge of availability toward e-commerce in Asian. The rising popularity of online content and social media platforms such as Facebook, Instagram, and TikTok, new business models defined as social commerce have emerged in to e-commerce (Abecassis *et al.*, 2022). According to SoftBank (2023), the establish of new social e-commerce platform in SEA will increase the online shopping to allow the customer discover, make research for product and services, and make purchase in social media to gain sales and new customer.

As technology advances, we may expect further innovations to define the future of e-commerce, such as augmented reality shopping experiences, voice commerce, and block-chain-based transactions. E-commerce continues to grow with each milestone, enabling companies and customers globally and revolutionising the way we purchase and sell products and services (Gold M., 2023). Moreover, population also one of important factor that contribute to e-commerce growth. According to Ozekenci *et al.*, (2019), they point out that population are essentials that determine for online purchasing in the e-commerce market. Population are important in the country that will be represent as potential consumers to the e-commerce (He & Wang, 2019). For instance, is the emerging leader in the e-commerce market due it high population which represents the significant opportunities to the firm and foreign country to gain benefit in the cross border e-commerce (Qi et al., 2020).

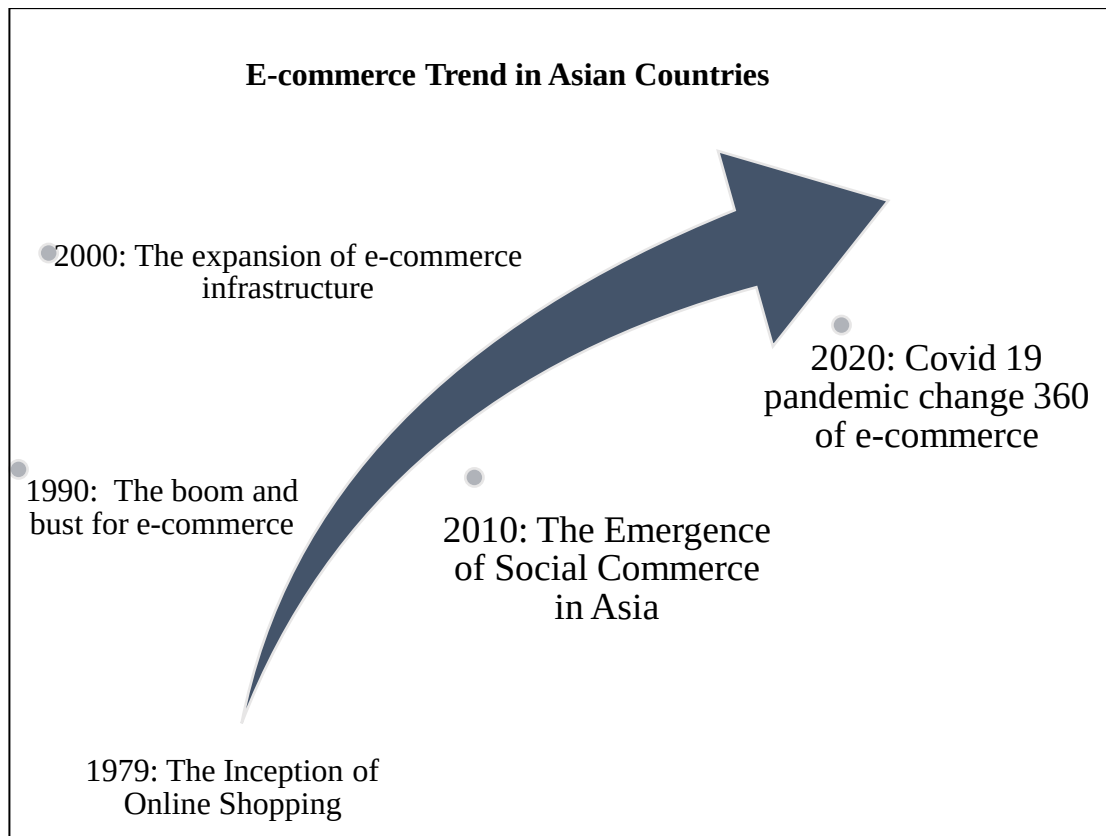


Figure 2.1 E-commerce Trend in Asian Countries

Sources : Gold (2023)

This figure 2.1 refer to the historical trend for e-commerce, according to Gold, (2023), the origins of e-commerce trace back to the 1970s when Michael Aldrich pioneered the concept by linking a television to a computer via telephone lines, laying the foundation for modern online shopping. This concept gained further traction with the introduction of Electronic Data Interchange (EDI), which, as noted by Uddin (2019), enabled businesses to exchange transactional data electronically. Additionally, Uddin (2019) points out that PizzaNet, a pioneering service introduced by a pizza company, allowed customers to place food orders online via television, marking an early milestone in e-commerce history.

Looking into the e-commerce development in Asian, e-commerce was developed and becomes universal standard to business to share information such as document. During 90s, the government report “Emerging Digital Economy” was released by United States department for first time, the concept is digital economy, and the term was recognized worldwide (Zhang *et al.*, 2021). Many changes took place in the early 1990s era of e-commerce which was the launch of “Worldwide Web” and PayPal for the first secure online transaction made called as secure socket

layer (SSL), the start of online Auction web and the market boom for online business which is e-commerce (Tian & Stewart, 2007).

In early 2000s, the expansion of e-commerce infrastructure such as the uses of internet broadband that become widely in e-commerce to facilitate faster and smoother online shopping experiences for customer and over 69 million people have internet access in Asia countries during 2000 (Uddin, 2019). Infrastructure development generates improvements in logistics and fulfilment, resulting in improved shipping alternatives and shorter delivery times.

According to Uddin (2019), the development of Mobile Commerce in 2005 in global e-commerce to introduce mobile commerce for consumer to make purchase and conduct transactions using their smartphones, paving the way for a new era of convenience. Therefore, the Emergence of Social Commerce in 2010 in Asian such as Social media or social commerce (Abecassis *et al.*, 2022) platforms in examples Facebook, Instagram, and Pinterest integrate shopping functionalities, allowing users to purchase products directly within the app.

In 2015, the global digitalization it bring e-commerce trend In Asian countries such as VR and AR (Kimura & Chen, 2017), the development of technology (Machine Learning, Internet of things (IoT), 5G (Fifth Generations), Block-chain Technology (Park *et al.*, 2018). In examples, such as Alibaba and T-Mall platform collaborated with logistics operator to implement block-chain technology in its cross-border supply chain to improve monitoring and give fully transparent data on the items purchased by online customers (Zhao 2018). Technologies such as machine learning, voice assistants and artificial intelligence are playing important roles in offering great experiences and satisfaction to the customers (Feng & Jin, 2022). According to SoftBank (2023), the adoption of technology such as VR (Virtual Reality) and AR (Augments Reality) allows the customer to enjoy the online shopping in channel and multiple platforms like in physical store. Therefore, by focusing to increase the interested of customer in e-commerce it allows the e-commerce sector to develop the services to increase the customer experience, satisfaction and may help e-commerce to develop more than expected.

According to Gold M. (2023), the COVID-19 epidemic stimulates the transformation to ecommerce by prompting physical businesses to close temporarily and consumers to prioritise purchasing goods over the internet. Online marketplaces, supermarket delivery services, and digital payment systems are seeing significant

interest and record-breaking sales in 2020. According to Abecassis *et al.*, (2022), this is owing to increased internet penetration and the Covid-19 epidemic, which is speeding purchases from online platforms 80 per cent of internet users have made some type of online transaction. However, 85 per cent of consumers prefer shopping in physical stores, according to (TimeTrade 2015: Park *et al.*, 2018), because many characteristics of brick-and-mortar businesses cannot be replicated online. The chronology of important advances in ecommerce depicts the extraordinary journey from its conception to its incorporation into our daily life.

2.3.2 Review of Green Technology Innovation Trends in Asian Countries

Green technology innovation in Asian nations has evolved significantly over the last five decades, led by growing industrialisation, rising environmental concerns, and government policies aiming at ensuring economic sustainability. As the world biggest and most populated continent, Asia has experienced significant environmental concerns such as air pollution, water scarcity, and carbon emissions, guiding authorities and corporations to invest in green technology solutions.

According to Nepal *et al.* (2021), in past centuries of the growth and adoption of green technology in Asia has been impacted by fast industrialisation, population increase, and rising environmental awareness. The Green Revolution of the 1960s and 1970s resulted in technical advances in agriculture, increasing crop yields while simultaneously raising environmental worries about excessive chemical usage and soil deterioration (Parayil, 2003). Realising the detrimental effects of industrialisation, Asian nations began incorporating sustainability into their long-term economic objectives in the 1990s and early 2000s, resulting in an increase in green legislation, renewable energy investments, and low-carbon technology.

During the beginning stages of green innovation, from the 1960s to the 1990s, most environmental regulations in Asia were reactive rather than proactive, with an emphasis on pollution and industrial waste management. Countries like Japan and South Korea were early adopters of pollution control measures, with Japan pioneering energy-efficient industrial processes in response to the 1970s oil crisis (Albino *et al.*, 2014). Considering the long-term repercussions of environmental deterioration, China implemented environmental restrictions in the late 1980s, with an emphasis on reducing pollution in heavy sectors (Zhu *et al.*, 2021). However, green technology

adoption remained limited at this time due to high prices, a lack of incentives, and low regulatory enforcement.

A significant change happened during the 2000s and 2010s, when governments around Asia began to implement enhanced green policies to promote environmental sustainability. Several notable actions were necessary in facilitating this transformation. China Renewable Energy Law (2005) established incentives and financial incentives for solar and wind energy projects, promoting China as the world's largest manufacturer of renewable energy technologies (Yan et al., 2024). At that time, Japan implemented Circular Economy Policies (2000) to promote waste reuse and resource conservation, as well as promoting a closed-loop production framework that minimised environment impact (Ardito et al., 2014). India pursued an analogous trajectory by announcing the National Action Plan on Climate Change (2008), which assigned, green buildings, solar energy and sustainable urban development (Crespi et al., 2015). In Southeast Asia, governments such as Thailand, Malaysia, and Vietnam have implemented strategies for sustainable development into their national legislation, committing to clean energy projects and eco-industrial parks to assure future environmental sustainability (Lai 2020).

According to Huang et al. (2024), during the last decade, top Asian nations have seen an exponential increase in green technology innovation, notably in environmental sustainability and renewable energy. In the 2020s and beyond, Asia has become a worldwide leader in green technology innovation, due to digital revolution, larger environmental legislation, and committed carbon neutrality plans. The most recent trends show a shift towards technology-driven green innovation, with nations such as Japan and South Korea investing heavily in green hydrogen technology, which has the potential to revolutionise energy storage and low-carbon transportation (Angelakis & Manioudis, 2024).

Furthermore, building AI powered smart grids to improve energy efficiency and lower carbon emissions (Afreltra et al., 2023). Blockchain technology is also being used in green supply chain management to ensure compliance and transparency along with environmental rules (Albino et al., 2014). Furthermore, some Asian economies, like China have set ambitious objectives to become carbon neutral by 2021 to 2025, respectively, driving large investments in climate resilience projects, renewable finance and eco-entrepreneurship (Yan et al., 2024). As a result, growing environmental concerns, government legislation, and advances in clean technology

have made green innovation a crucial component of Asia's long-term economic success. Regulatory frameworks, investment in research and development (R&D), and corporate sustainability programs have all played a role in shaping the Asian green innovation movement.

Several Asian economies, including China, Japan, South Korea, and India, have boosted their investments in green technologies to enhance reduce carbon footprints and energy efficiency. According to Jo et al. (2015), South Korea and Japan have made significant investments in hydrogen energy, viewing it as a long-term solution for the sustainable energy transition. According to Tolliver et al. (2021), the acceleration of green financing and targeted legislative incentives has considerably helped to the spread of electric vehicles (EV) and renewable energy in Asia. Tolliver further emphasises that China is commitment to green finance has played a critical role in promoting technology developments in the wind, solar, and electric car industries, resulting in widespread acceptance.

Asian countries have enacted stringent environmental rules and sustainability requirements to encourage enterprises to embrace green technologies. Ahmed et al. (2022) emphasise that nations such as Singapore and Malaysia have built structured sustainability policies, focussing on eco-industrial parks and carbon neutrality initiatives to foster green transformation in manufacturing industries. In South Asia, Chien et al. (2021) state that Bangladesh and India are prioritising green supply chain management and eco-friendly infrastructure development to improve sustainability, notably in e-commerce and logistics.

Green trade has also had a huge impact on green innovation in Asia. According to Ahmed et al. (2022), the export of green technology such as solar panels and energy-efficient machinery has become a key economic engine for nations such as China and South Korea, allowing them to lead the global clean energy industry. Their study also reveals that green innovation policies, when combined with trade initiatives, have contributed positively to economic growth in various South Asian nations.

Despite substantial advances, some barriers impede Asia is quick adoption of green innovations. However, Jo et al. (2015) predict that with rising global attention on carbon neutrality and sustainable industrialisation, green innovation in Asia is projected to accelerate further, notably through public-private partnerships and cross-border collaborations. High initial investment prices, an inadequately qualified

workforce, and discrepancies in legislative frameworks continue to be impediments to widespread green technology adoption particularly in developing countries (Wen et al., 2021).

Hence, Asia still faces significant difficulties in increasing green technology adoption. According to Lei et al. (2023), despite previous gains, Asia continues to suffer major gaps in clean energy adoption and green technology dissemination, owing to budgetary restrictions and a lack of policy coordination. Many emerging Asian nations continue to face budget challenges, weak infrastructure, and restricted access to innovative green technology. To address these difficulties, governments must expand regional partnerships, increase incentives for private-sector investment, and incorporate digital technology into sustainability programs.

The history of green technology innovation in Asia has progressed from pollution control measures in the late twentieth century to policy-driven green initiatives in the 2000s, and lastly to digital transformation and technology-driven sustainability in the 2020s. While early efforts aimed to remedy environmental harm, the current strategy prioritises proactive investments in renewable energy, green finance, and AI-driven eco-innovation. As Asia expands its leadership in green technology, the success of its sustainability projects will be heavily reliant on improved policy coordination, more investment, and international cooperation.

2.3.3 Review of Political Stability in Asian Countries

Political stability in Asia has changed drastically in recent years, influenced by historical wars, economic shifts, governance arrangements, and foreign factors. While some countries, such as Japan and Singapore, have maintained constant political stability, others, such as Myanmar and Afghanistan, have faced lengthy instability as a result of internal wars and outsider interventions. According to Younis et al., (2008), the fast economic rise of newly industrialised nations like Singapore, Taiwan, South Korea, and Hong Kong, as well as Malaysia and, more recently, China, has sparked worldwide interest. However, Myanmar's military authorities have stifled economic progress via civil conflicts and mismanagement, ensuring that the advantages of development are concentrated among the military and its close supporters rather than the general public (Perkins, 2021).

The post-colonial transitions and political stability for 1945s to 1970s following World War II, many Asian nations transitioned from colonial rule to independence, resulting in both political stability and turmoil. Right after World War II, much of emerging Asia eliminated colonial control, which was frequently a cause of domestic turmoil, and gradually restored political stability (Mccawley, 2021). According to Weerachai (2024), Southeast Asia is a major area that can be explored the impact of political stability on economic growth because of its diverse government regimes and development levels. Since the post-colonial era began in 1945, the region has experienced both stable periods and political upheavals, which have shaped its economic and governance landscape. Meanwhile, in South Asia, political instability was prevalent due to partition conflicts, territorial disputes, and military interventions.

At the time of cold war era and regional political dynamics in 1970s to 2000s the political stability is a key driver of economic growth and development. During the Cold War, political stability in Asia was influenced by ideological conflicts, superpower interventions, and economic modernization efforts. According to Younis et al., (2008), China has experienced rapid economic expansion as a result of the establishment of the new communist party, which introduced economic reforms and highlighted factors such as human capital, physical investment, technology, and foreign trade as contributors to growth. While all of these factors made a positive contribution to economic growth, they were all directly and indirectly dependent on the political stability that those economies had during their development period. The Cold War had an impact on Asia, but the area remained relatively calm, with just a few nations experiencing combat. Political stability increased significantly after the Vietnam War ended in 1975, with the fall of Saigon. Cambodia formally recovered peace with the Paris Peace Agreements in 1991, whereas Sri Lanka has a long-standing civil strife, and Afghanistan continues to confront continuous security issues and remains reliant on foreign support (Mccawley, 2021).

The 20 centuries brought a wave of economic liberalization and technological advancements, which in turn influenced political stability across Asia. Yap (2018) provides similar findings in Asia, emphasising the importance of institution-building in maintaining political stability and development in the region, where governments frequently prioritise short-term growth strategies over longer-term institutional reforms in order to avoid poor economic performance that could undermine their support. Once the region's countries had overcome wars and revolutions, it was up to

policymakers to determine that economic growth was necessary and to construct policy frameworks that would encourage high levels of investment (Perkins, 2021). In recent years, digital governance and international trade agreements have played important roles in ensuring stability. According to Mccawley (2021), Asian countries should continue to encourage free trade and investment by lowering tariff and nontariff barriers, encouraging services trade, particularly e-commerce and digital trade, and assisting small and medium-sized firms in accessing international markets.

Colonial legacies, economic policies, governance systems, and regional security dynamics have all played a role in shaping Asia's historical political stability. While some countries have attained long-term stability via excellent governance and economic progress, others continue to grapple with political instability. Unresolved wars continue to cause political instability in Afghanistan, Myanmar, and other countries of South Asia. The future of Asia's political stability will be determined by economic resilience, regional collaboration, and governance adaptation.

2.4 Theoretical Framework

The theory that used in this theoretical framework as a guide to understand more in methodology in chapter three. The Assumption between variables will explain in the theoretical framework and how the theory will have connection between equations. This section presents an overview of theoretical framework as a baseline of this study to address the research questions.

2.4.1 New Growth Theory

The New Growth Theory (NGT) argues that technological innovation and knowledge accumulation are key drivers of productivity and long-term economic growth (Liberto, 2021). As we know the NGT is develop by Paul Romer to develop new theory that will improve the neoclassical theory in the economic. The focuses of NGT are to create new roles of new knowledge creation, and way to driving the economic growth, mechanics, geography, and the critical roles of culture and also for institutions.

According to Ifinedo *et al.*, (2021), New Growth Theory was developed by Romer in 1986 and Lucas in 1988 to enhance classical theories in explaining economic development. This theory emphasizes the critical role of innovation,

technology, and human capital in fostering economic growth. New Growth Theory can assist businesses, firms, and countries in advancing their economic sectors by leveraging these key drivers. As highlighted by Liberto (2021), the theory underscores the significance of entrepreneurship, technology, knowledge creation, and innovation in addressing external forces that are often uncontrollable in neoclassical economics. NGT rejects the view that economic progress is determined by external forces that cannot be controlled and determined but places emphasis on innovation, technology, and entrepreneurs (Corporate finance, 2022).

Innovations are the most important process in a country where it can help the country develop the economy, business, standard of living and so on. According to Cortright, (2001), the process of innovation in the economy is very important and can help the formation of a country, firm and also includes SMEs and e-commerce. NGT emphasizes that the process of innovation is important in the economy that can help develop the economy as well as the country. Creating new knowledge is key for business and to growth the economy. The new knowledge that related to the e-commerce is to create new products and services. According to Team (2022), the innovation and new technologies do not happen by mere coincidence but it depends on how people find the new innovation or technology for the purpose of improvement.

The theory posits that innovation and technological advancements do not occur simply by random chance; rather, they depend on the number of people seeking out new innovations or technologies and the intensity of their efforts. Few decade ago since the NGT was publish thousands of journals and studies have been publishing by using this Growth Theory. According to Ho et al., (2008), the New Growth Theory has been develop into two type which is Exogenous and Endogenous Growth Theory. Hence, economic growth theories primarily exogenous and endogenous growth theories are explored, along with their implications for comprehending economic performance at the country level. Exogenous growth theory attributes economic growth to external factors like sustained technological advances, assuming that technological change is led externally and available uniformly across closed economy systems.

On the other hand, endogenous growth theory posits that economic growth stems from internal factors within an economic system, emphasizing the role of technology adoption and positive externalities from knowledge economy development. Both theories offer contrasting perspectives on studying e-commerce

growth across countries. The statement was supported by other studies based on endogenous growth theory that mentions by (W. Zhang et al., 2021), internal research and development (R&D) efforts and innovation are identified as the primary drivers of economic growth and technological advancement. The progression of digital technology is seen not only as an expansion of the production possibility boundary but also an extension of the innovation possibility boundary.

Since early 2000s numerous studies have been published and show the contrary of the previous study and the evidence shows the consistence of many predictors for the new theory (Capolupo, 2009). According to Romer, 1994; Srivastava & Teo, 2007; Lakka et al., 2013; Ifinedo et al., 2021 NGT will show an advance result that country that have high capability and endowment. The previous studies mention that NGT shows that impact to the technology progress. The New Growth Theory is suitable for the innovation in the country that either it for individual or nationally. This is because it may give much benefit not only for e-commerce but all level of improvement.

In summary, the New Growth Theory provides a robust framework for understanding how innovation, technology, and knowledge creation drive economic progress. Its relevance extends beyond individual businesses to national and global scales, offering insights into strategies for achieving sustainable growth in a rapidly evolving economic landscape.

2.4.2 Schumpeter Theory

According to (Muftiadi, 2022), innovation is defined as the development of new or significantly improved products or processes that differ from those previously produced or owned by a company, either through market introduction or internal implementation. This emphasizes that innovation is not just about generating new ideas but about transforming them into commercially viable products or services that meet consumer demand. In the contemporary era of technological change, innovation may be looked on as the intellectual process behind the development of businesses, as well as particularly when the focus is on optimising profits in the middle of tough competition (Arque-Castells and Spulber, 2019). According to Jackson (2021), innovation creates a scenario in which old or existent methods of production are

nearly forced to become obsolete because of originality in human intellect, which is driven by entrepreneur is constant improvement in research and development (R&D).

Therefore, this study also focuses on explaining the Schumpeter theory of Innovation emphasizes the role of entrepreneurs in driving economic change through creative destruction, where old industries and business models are replaced by new, innovative ones (Schumpeter, 1942). This concept is particularly relevant to the e-commerce sector in Asia, where digital transformation, technological innovation, and policy changes are reshaping economic structures. Barua et al., (2000) argue that Schumpeter's theory of creative destruction, which was initially controversial, remains highly relevant today as a foundational framework for explaining economic growth in the emerging digital economy. This theory aligns which how green technology innovation fosters a new wave of digital commerce models that prioritize sustainability for e-commerce across Asia. The Schumpeterian economic system is inherently adaptable and dynamic, as entrepreneurs and their innovations drive continuous reconfiguration and change through the process of creative destruction (Croitoru, 2008).

According to Barua et al., (2000), the principles of Schumpeter theory in 1909 for Constructive Destruction in adaptation for the era of the digital economy that Schumpeter (1909) emphasized economic development is driven by the continuous process of creative destruction, where new innovations replace old economic structures. In the digital economy, this concept has been adapted to reflect the emergence of e-commerce, fintech, AI driven business models, and digital entrepreneurship. According to Croitoru, (2008), the theory of Schumpeter (1939) emphasized that technological innovation is a key driver of business and economic cycles. This is evident in the rapid expansion of e-commerce ecosystems in Asia. Schumpeter is theory identifies innovation, entrepreneurship, and technical advancement as major drivers of economic evolution, emphasising the importance of entrepreneurial spirit and creative disruption in the capitalist system (Dewi & Lusikooy, 2023).

E-commerce success aligns with Schumpeter is Theory of Innovation, as it represents a creative destruction process where traditional commerce models are replaced by a more efficient digital economy. Barua et al., (2000) highlight those e-commerce leverages the internet as a new economic infrastructure, optimizing the production, distribution, and consumption of information goods and knowledge-based

products. This transformation mirrors Schumpeter's view that technological advancements drive economic evolution by replacing outdated systems with more productive and innovative alternatives.

Schumpeter economic thought emphasizes that while political, historical, and social factors influence economic systems, innovation and entrepreneurship are the primary drivers of development (Croitoru, 2008). Political stability fosters a favourable environment for innovation, providing regulatory consistency, institutional support, and investor confidence necessary for e-commerce growth. Conversely, instability disrupts market expansion and technological progress. This aligns with Schumpeter view that while external factors like wars and political upheavals affect economies, the true engine of transformation lies in creative destruction, where stable institutions allow innovation to flourish.

2.4.3 Institutional Theory

Institutional theory explains why organisations display similar tendencies through three essential features (DiMaggio & Powell, 1983). This theory may also be used to better explain the dynamics driving the expansion of e-commerce in Asia. According to Scott (2001), institutions define as laws, rules, cultural norms, and professional standards that offer stability and purpose to social conduct. Regulatory institutions are formal laws, rules, and enforcement procedures that affect e-commerce marketplaces. Institutional forces help to homogenise organisational structures within institutional contexts (Magnano et al., 2024).

Institutional Theory discusses how official and informal institutions, such as government legislation, cultural norms, and industry standards, affect corporate behaviour and economic progress. According to Scott (1995), institutions are cognitive, moral, and regulatory frameworks that offer stability and purpose to social behaviour. This approach is extremely useful for analysing how political, economic and technological institutions influence e-commerce growth in Asia.

As highlighted by Deegan (2009), emphasises the institutional theory is critical in explaining how corporations reconcile sustainability responsibilities with commercial performance. Businesses that engage in create diverse organisational structures to match with customers demand, resulting in increased efficiency in businesses. Political stability is an important institutional factor influencing the

growth of e-commerce in Asia. Political stability promotes a solid regulatory framework, resulting in consistent regulations and dependable infrastructure for digital e-commerce. This idea is critical in understanding how external surroundings influence organisational behaviour. Organisations operate in a constantly changing social context shaped by new laws, developing conventions, regulatory changes, altering behavioural patterns, and emergent industry players. Institutional Theory gives insights into how aspects such as structures, procedures, and professional standards are developed and distributed within and among organisations (Roszkowska, 2023).

On the other hand, political instability may lead to regulatory uncertainty, shifting market confidence, and investment obstacles, limiting e-commerce enterprises capacity to grow successfully. Furthermore, Marrucci et al. (2023) use institutional theory to explain how external and internal pressures impact an organization's performance and the adoption of green human resource management techniques. Political stability has a considerable impact on e-commerce growth via institutional theory processes. Coercive isomorphism ensures that rules are explicit, requiring enterprises to follow requirement or guidelines standards. Mimetic isomorphism encourages organisations to reproduce successful business models in stable markets, which reduces uncertainty. Normative isomorphism encourages professionalism through industry norms and certifications.

High political stability promotes regulatory uniformity, innovation, and market trust, whereas instability poses dangers that impede e-commerce growth. According to North (1990), institutions help to minimise uncertainty by providing a solid structure for human interaction. In Asia, government policies on data protection, taxes, cybersecurity, and trade laws have a direct influence on ecommerce. However, in certain nations, regulatory ambiguity stifles e-commerce expansion. According to Huang et al. (2021), weak enforcement of e-commerce legislation in Southeast Asia raises risks for enterprises and consumers while impeding digital market development. Bag et al. (2022) found that coercive, normative, and mimetic pressures are positively correlated with green innovation products. According to Magnano et al., (2024), institutional theory sheds light on how firms face external pressure in the form of coercive such as enforcement of regulation by authorities, normative the value, beliefs, or norms, and mimetic pressure for imitation of practices by firms to respond

to competitors, as well as how these pressures facilitate economic processes and promote sustainable products.

E-commerce companies in Asia must navigate institutional pressures using three important strategies (DiMaggio & Powell, 1983). Coercive pressure occurs when governments require compliance with cybersecurity, taxes, and consumer rights legislation, such as China E-Commerce Law 2019 which places harsher rules on internet firms. Mimetic pressure leads businesses to emulate successful business models, as evidenced when Shopee replicated Alibaba's marketplace strategy to gain a competitive advantage. Meanwhile, normative pressure comes from industry groups that establish best practices and certification requirements, such as Singapore Fintech rules, which promote a stable and safe digital commerce ecosystem.

2.5 Empirical Framework

2.5.1 E-commerce and Green Technology Innovation

According to Leal Millan et al. (2017), the term "green innovation" refers to any invention that facilitates the development of crucial goods, services, or processes aimed at reducing pollution and environmental degradation while optimizing resource utilization. In the modern era, this type of innovation plays a fundamental role in improving human well-being by ensuring the efficient use of natural resources. Furthermore, innovation and the adoption of new technologies in manufacturing processes are crucial for supporting sustainable development.

In the context of e-commerce, innovation serves as a key indicator of success, as it enables businesses to develop new platforms that enhance operational efficiency and market competitiveness (Giaoutzi et al., 2016; Azyabi, 2018). The concept of innovation in the e-commerce sector involves integrating new knowledge and ideas to improve services, thereby better fulfilling customer needs (Lusch et al., 2015; Witell et al., 2016; Xin et al., 2021). These technological advancements are not only essential for business performance but also for ensuring that e-commerce contributes positively to environmental sustainability.

E-commerce has emerged as a key driver of digital transformation, reshaping global business landscapes. The rapid evolution of digital infrastructure, artificial intelligence (AI), and cloud computing has further accelerated green innovation in the e-commerce sector, optimizing logistics, inventory management, and energy

consumption (Hamid M. et al., 2019). Additionally, IoT enabled supply chain management has significantly improved energy efficiency and waste reduction, reinforcing sustainability in e-commerce operations (Prajapati et al., 2022).

As stated by Anvari & Norouzi (2016), innovation whether traditional or technological is a key economic process that drives growth. In developing nations, the expansion of e-commerce must align with economic progress to contribute to long-term economic stability. Hellsmark et al., (2016) and Wang et al., (2021) argue that industrial technological innovation can significantly boost productivity, leading to rapid industrial expansion. However, as pointed out by Yassin et al., (2021), innovation should also focus on reducing environmental degradation to ensure sustainable economic growth. Despite its advantages, green technology innovation may increase production costs for firms, requiring them to develop a deeper understanding of environmental impacts to maintain energy efficiency (Wang et al., 2021). This cost challenge often discourages manufacturers from investing in green technology, as noted by Mu et al., (2021).

The role of green technology innovation in improving energy total factor productivity (TFP) is particularly crucial in the current era of carbon peaking and carbon neutrality (Wang et al., 2021). Green technology innovation focuses on enhancing resource efficiency and minimising environmental emissions during production, making it a fundamental approach to mitigating global environmental damage and achieving sustainable development (Yu et al. 2023).

Furthermore, Mu et al., (2021) emphasized that e-commerce supply chains play a vital role in promoting sustainable business practices, as companies integrate green innovation into logistics, packaging, and energy consumption strategies. Chin et al., (2022) also highlighted that blockchain technology could enhance value appropriation capabilities (VAC) in green innovation, helping firms manage environmental impacts more efficiently. Additionally, Pan et al., (2023) emphasized that environmental taxation and privacy regulations should be balanced to ensure that green technology innovation continues to thrive within e-commerce ecosystems.

Several factors contribute to the growing adoption of green innovation in e-commerce, including regulatory frameworks, consumer preferences, and technological advancements. According to Heussaff et al., (2024), governments worldwide have introduced policies that promote sustainable business practices through financial incentives, tax reductions, and stricter environmental regulations. For instance, the

European Union 2040 Carbon Neutrality Strategy mandates e-commerce firms to integrate greener technologies to comply with rigorous environmental standards. However, high transition costs and global market competitiveness remain substantial challenges in achieving these sustainability goals.

Despite the growing importance of green technology in e-commerce, research on how green innovation directly influences e-commerce development remains relatively limited (Yu et al., 2023). While there is evidence that e-commerce serves as a driver of sustainability through supply chain optimization, digitalization, and green business models, further empirical studies are needed to explore the long-term implications of green innovation on e-commerce performance, profitability, and regulatory compliance.

2.5.1.1 Empirical Study on Green Innovation

This study employs a systematic review of academic research to examine the relationship between Green Technology Innovation and e-commerce development. The methodology integrates findings from panel data analysis, econometric modelling, and case studies, providing a structured analysis of how Green Technology Innovation influences e-commerce sustainability at different economic levels. The selection of studies follows a rigorous process, focusing on empirical research that provides quantitative and qualitative evidence on Green Technology Innovation impact on digital commerce.

Therefore, Mu et al., (2021) conducted research on cooperative green technology innovation of an e-commerce sales channel in a two-stage supply chain. This research investigates a two-stage supply chain of e-commerce sales channels using various cooperative models. The potential large market for green consumption has inspired a growing number of businesses to engage in green technology innovation. Green tech innovation and green promotional services may be expanded by the producer and retailer to increase product market demand in both online and offline channels. However, consumer e-commerce appears, and online free-riding behaviours, on the other hand, influence the manufacturer's sales decisions regarding channels. The findings indicate that the greater the amount of collaboration among all individuals, the greater the economic, ecological, and social advantages.

Meanwhile, Wang et al., (2021) validates the impact of green technology innovation on energy TFP in a complete sample and subsamples by region by developing a panel threshold model and analysing its influence mechanism using annual provincial data from mainland China within 2005 to 2018. The result of the study reveals as following: There is a threshold effect in the influence of green technology innovation on the energy TFP when the degree of economic development is used as the threshold variable. Second, Green technology innovation influences energy TFP through industrial structure upgrading; that is, industrial structure acts as a moderator in the influence mechanism. Lastly, the influence of green technology innovation on energy TFP varies by area in China, and the threshold effect occurs solely in the western region, since the central and eastern regions have passed a specific growth level. Based on this study, the green technology innovation provides a growth in economic development which might indirectly influence e-commerce.

On the other hand, Badran (2021) examines the role of digital platforms in Africa, using Jumia Egypt as a case study. Africa's e-commerce sector has lagged other regions, with the continents share of e-commerce in GDP being less than 1 per cent in 2018, compared to 2.4 per cent in Latin America, 10 per cent in the United States, and 20 per cent in China. This disparity presents a significant opportunity for the development of e-commerce platforms like Jumia Group. The paper highlights the rise of digital platforms in Africa, driven by the growing apps economy, while also addressing a knowledge gap in how policymakers can effectively govern these disruptive technologies. The study applies the analytical framework from Rossotto et al. (2018), which focuses on four key pillars: definition, business models, platform enablers, and platform dynamics. While the study underscores the crucial role of innovation in driving e-commerce, it lacks specificity regarding the type of innovation involved, such as whether it pertains to technological, environmental or policy-driven innovation,

However, Zhang et al. (2021) analysed the impact of the digital economy on high-quality economic development in China by constructing a Digital Economic Development Index comprising digital infrastructure, digital industry, and digital integration. Using panel data from 30 cities between 2015 and 2019, the study applied an econometric model to assess the relationship between digital economic development and economic growth, while also examining the mediating role of technological progress. The findings reveal steady growth in China's digital economy,

with significant advancement in digital infrastructure, though progress in the digital industry remains relatively slower. In relation to the current study, Zhang et al.'s work reinforces the importance of innovation, particularly digital and technological innovation, as a driver of economic transformation.

However, Yuan et al. (2023) investigated the relationship between digital finance and ecological performance in 2,128 Chinese counties from 2014 to 2020. Using fixed effects and panel threshold models, the study examined the direct effects, heterogeneity, and transmission channels through which digital finance influences environmental quality. The findings highlight that the digitalisation of commerce, while beneficial for financial inclusion and growth, should not overlook its environmental consequences."

While the study above offers valuable insights into the role of the digital economy and technological advancement, it does not address the environmental dimension of innovation. Cao et al., (2021) offers strong empirical evidence linking e-commerce expansion with green development outcomes, particularly in urban contexts. This study explored how the National E-commerce Demonstration Cities (NEDC) pilot policy contributes to Green Total Factor Productivity (GTFP) in China. Using data from 230 cities between 2003 and 2017 and employing a Multi-period Difference-in-Differences (DID) method, the study found that urban GTFP increased by approximately 1.24% on average after cities became NEDC pilots. Robustness tests confirmed the reliability of these results. The study further revealed that the NEDC policy had a more pronounced impact on mid-western and resource-based cities. The key mechanisms driving this improvement include industrial structure upgrading, reduction of unproductive costs, and stimulation of green innovation. These findings provide empirical evidence on the link between e-commerce and green development, offering valuable policy insights for other countries seeking sustainable, energy-efficient economic growth.

Similarly, Li et al. (2022) who conducted a study on the impact of national e-commerce demonstration city policies on urban green innovation capacity highlight the important of policy drives green innovation on e-commerce development. Using a difference-in-differences approach and robustness tests on panel data from 297 Chinese prefecture-level cities 2005 to 2018, the study found that the pilot policy significantly enhances green innovation in a dynamically sustainable manner. Mechanism analysis revealed that the policy drives green innovation by advancing

urban informatization, attracting technological talent, and optimizing the green, with the latter having the most substantial effect.

The importance of green technology in e-commerce is highlighted in a study by Skare et al. (2023), who assess the correlations between innovative activity and the outcomes of B2C, B2B, and B2G e-commerce by enterprises, as well as the economic development of EU member states. Using annual panel data from 2013 to 2021, the study examined twelve e-commerce indicators, classified according to enterprise size. The panel regression results indicate that higher innovation rates are associated with increased e-commerce activity, which in turn contributes to stronger economic performance. These relationships were particularly evident in B2C and B2B segments, though variation exists across regions. Notably, the study revealed that countries like Bulgaria and Romania lag in leveraging innovation for e-commerce growth. While green technology is not explicitly addressed, the emphasis on innovation suggests that integrating eco-innovations within e-commerce ecosystems could further enhance both environmental sustainability and economic outcomes. This reinforces the idea that e-commerce, when supported by green and digital innovation, can become a key driver of sustainable development.

However, few studies have observed a negative effect of innovation under certain e-commerce structures. For instance, Dai et al., (2022) study the development the concept of digital economy to explores the relationship between digital economic utilize panel data analysis in China that approaching 30 data on provincial administration in enhancing regional green innovation. This paper emphasizes the digital economic and green innovation has no significant relationship and found negative result on green innovation in country that personally influence by R&D in region innovation. This suggests that the digital economy alone may not be sufficient to drive green innovation, especially in areas lacking strong innovation infrastructure or policy support. Interestingly, Jia et al., (2022) revealed a negative relationship between green economic performance and the current levels of environmental and economic indicators. This indicates that although digital applications and innovation are often assumed to support green growth, this study suggests that their impact may be limited or even counterproductive without strong regulatory frameworks.

From another perspective, Wang et al. (2023) investigated the impact of e-commerce on urban green innovation development, emphasizing its role in achieving carbon neutrality and promoting sustainable urban growth. Using a multi-period

double difference model, the study analyzed how e-commerce fosters green innovation by enhancing entrepreneurial vitality, attracting investment, and creating favourable social and financial conditions. The findings indicate that the effect of e-commerce on green innovation follows a "U-shaped" trend, meaning its influence strengthens as urban green innovation advances. Additionally, the impact is significantly influenced by a city's resource endowments. The study highlights the need to leverage e-commerce for green innovation to unlock new opportunities for sustainable economic growth.

To date, several studies have examined the role of green technological innovation (GTI). According to Yassin et al., (2022), innovation in green technology is more in line with the goal of sustainable development. For Instance, Yu et al. (2023) investigated the impact of e-commerce development on GTI, focusing on its mechanisms and spatial spillover effects. Using a multi-period Difference-in-Differences (DID) model and panel data from 240 prefecture-level cities in China from 2006 to 2019, the study evaluated the effects of the National E-commerce Demonstration Cities (NEDC) strategy. The findings emphasize the pivotal role of GTI in promoting both economic growth and environmental sustainability. This is further supported by Pan et al. (2023), who underscore the importance of green innovation, particularly environmental R&D (E-R&D), in reducing manufacturing-related emissions.

After that, Wei et al., (2024) conduct research to explore how impact of international digital trade, green technology innovation, and renewable energy consumption on ecological footprint (EFP) in BRICST countries. The analysis included information from 1995 to 2022. The longitudinal augmented autoregressive distributed lag model shows that ecological footprint has a negative long and short-term correlation between trade diversification, renewable energy consumption (REC), and green technology innovation. These countries have a significant presence of environmentally friendly items in their trade portfolios, and their production processes are changing to green technology innovation. The goal is to increase REC information while reducing EFP use. In contrast, rising economic growth within this income group has a compounding effect on the environment's decline since it magnifies the greenhouse gases caused by greater consumption. To decrease the level of ecological footprint, the report advises boosting investment in GTI, expanding global digital trade, and adopting renewable energy sources.

Even though, Ni, (2024), studies the impact of the digitalization economy upon the rural per capita disposable income in China. A multiple linear regression model of digital economic and rural per capita disposable income is built using panel data from 31 Chinese provinces from 2017 to 2020, and it is calculated using the two-stage least squares approach. The results indicate that digital economic can enhance rural PCDI. From the standpoint of the intermediate impact, DE can enhance rural PCDI by reducing agricultural product output, because the development of DE broadens the income channels for growing crops while lowering production and operating expenses. From the standpoint of the adjustment impact, technical innovation has a large negative adjustment effect on the effects of DE on PCDI, demonstrating that, while technological innovation compensates for certain weaknesses in rural regions, it also accelerates resource loss.

While, Jiang et al. (2024) examine how e-commerce development, through the National E-Commerce Demonstration City (NEDC) program, affects carbon emission efficiency (CEE) in 240 Chinese cities. Their findings reveal that e-commerce promotes green technological innovation, energy efficiency, and industrial upgrading, thereby improving local carbon emissions. However, negative spillover effects were observed in surrounding cities, indicating uneven regional impacts and the need for coordinated low-carbon strategies. In a broader context, Paun et al. (2024) investigate the global drivers of e-commerce adoption across 133 countries and find that factors such as ICT infrastructure, digital financial access, and the use of frontier technologies like AI and blockchain are critical. While not directly focused on green outcomes, these enablers of e-commerce indirectly support green innovation by fostering efficient digital ecosystems, especially in developed economies. Together, these studies highlight the interconnected role of e-commerce and digital infrastructure in shaping both economic progress and green technological transformation.

There is growing interest in the environmental impacts of e-commerce and green technology, with studies showing both benefits and challenges. While Yu et al. (2023), Jiang et al. (2024), and Pan et al. (2023) highlight how digitalisation and innovation improve green performance and carbon efficiency, others like Jia et al. (2022) and Yuan et al. (2023) caution that poor regulation and rapid digital expansion may harm ecological outcomes. Despite growing global interest in the environmental impact of e-commerce and green technology, limited studies have focused on Asia, particularly in developing economies. Much of the existing literature is centered on

China and Europe, often overlooking the diverse digital readiness, environmental challenges, and policy landscapes in other Asian countries. Moreover, although interest in environmental sustainability is increasing, studies that directly examine the relationship between green technological innovation (GTI) and e-commerce remain very limited.

2.5.2 E-Commerce and Political Stability Index

Political stability is a crucial variable that significantly influences economic growth (Alesina et al., 1992; Barro, 1991 & 1996; Mavisakalyan & Gebremedhin, 2011). According to Khan (2013) and Alyoubi et al. (2020), multiple factors contribute to the flourishing of the e-commerce sector, including social, economic, technological, and political elements. The process of digitalizing the economy and society plays a vital role in ensuring stability, development, and efficiency (Volkova et al., 2021). However, political dynamics can also lead to policy uncertainty and non-optimal solutions, which may hinder e-commerce growth Stahl (2007). Regulatory reforms and policy stability are essential in fostering e-commerce expansion (Jehangir et al., 2011).

As noted by Shepherd (2010) and Palladan & Adamu (2019), political stability fosters strong institutions, adherence to the rule of law, effective bureaucracy, a conducive business environment, and low corruption. However, political stability does not always imply the absence of ideological rivalries or diverse perspectives on state responsibilities. The risk of political instability arises from unpredictable shifts in governance, legal frameworks, or political climates, which could directly impact e-commerce operations. Ouedraogo et al. (2020), for instance, found that political instability in Ivory Coast led to a significant reduction in firm productivity, with affected businesses experiencing an annual sales loss of 840,000 USD. This demonstrates how unstable political environments can negatively affect business sectors, including e-commerce firms.

According to Frynas, (2002), one of the most significant challenges internet-based firms face today is navigating political and legal complexities in international markets. The sustainability of e-commerce depends not only on technological advancements but also on social and political innovation (Wilsdon, 2003). Political stability directly affects market confidence, influencing whether its impact on e-

commerce will be positive or negative. As noted by Wei (2024), China's cross-border e-commerce exports to RCEP countries are influenced by economic scale and trade openness rather than political stability. This suggests that while political factors are essential, other elements like economic policies and digital infrastructure can mitigate their effects on e-commerce.

Additionally, Haqqi & Murdani (2023) emphasize that Asian countries with stable political systems have developed more robust digital economies, reinforcing the link between political stability and digitalization. Liu (2018) further explores how China's government strategically delegates regulatory authority to private e-commerce platforms, allowing the country to maintain economic growth while preserving political control. This model demonstrates that political stability does not always require strong formal institutions, as alternative governance mechanisms can emerge to support market development.

Moreover, the expansions of the internet, advancements in ICT, and political stability have accelerated the evolution of e-commerce (Jehangir et al., 2011). However, political leaders can also create crises, either to serve their own interests or unintentionally disrupt markets (Oakeshott, 1990; Korosenyi et al., 2016). The absence of political stability remains one of the most significant barriers to long-term national economic growth, limiting e-commerce expansion in developing countries (Radu, 2015; Palladan & Adamu, 2019).

Thus, while political stability is not the sole determinant of e-commerce success, it plays a pivotal role in shaping regulatory environments, business confidence, and long-term economic sustainability. Countries with strong legal and policy frameworks are more likely to develop resilient e-commerce ecosystems, whereas those facing instability may struggle to attract investment, facilitate digital trade, and ensure business continuity.

2.5.2.1 Empirical Study on political Stability Index

Political stability plays a fundamental role in shaping the growth and adoption of e-commerce, particularly in Asia, where markets exhibit varying levels of governance and regulatory consistency. Empirical studies using panel data analysis confirm that countries with higher political stability experience greater e-commerce adoption, improved data security, and stronger digital trade competitiveness.

Conversely, politically unstable nations face barriers such as weak regulatory enforcement, low consumer trust, and fluctuating investment trends. This section examines key empirical findings related to the impact of political stability on e-commerce adoption, statistical analyses using panel regression models, and policy implications for digital economies.

According to Liu (2018), political stability in China has indirectly supported the rapid growth of e-commerce by enabling the state to adopt institutional outsourcing, where regulatory roles are delegated to private e-commerce platforms. This approach allows for large-scale economic exchange without requiring politically sensitive reforms to formal institutions such as the judiciary. As a result, it creates a stable environment for digital commerce to flourish while also reinforcing regime stability through economic growth and new governance mechanisms.

Political stability positively influences e-commerce by creating a secure and predictable environment for digital transactions, business investment, and market development. As demonstrated by Palladan and Adamu (2019), political stability enhances individuals' readiness to adopt e-commerce by reinforcing their sense of national security and institutional reliability. Their study found that business students' perceptions of political stability were positively associated with their willingness to embrace e-commerce technologies. Similarly, Alyoubi et al. (2020) identified political stability as one of the key factors contributing to the development of Saudi Arabia's start-up ecosystem, where e-commerce is positioned as a strategic tool to achieve economic diversification and women's empowerment under the Saudi Vision 2030. On the other hand, political instability can have damaging effects. Ouedraogo et al. (2020) found that firms operating in politically unstable environments, such as Ivory Coast, suffered significantly lower performance, with annual sales reduced by hundreds of thousands of dollars compared to firms in more stable settings. Uncertainty caused by instability discourages investment, disrupts supply chains, and weakens institutional support for digital commerce.

Meanwhile, Yang and Xu (2022) investigate the impact of political connections on green innovation development in Chinese enterprises, using panel data from A-share listed companies on the Shanghai and Shenzhen stock exchanges between 2008 and 2019. The study applies various econometric models, including panel two-way fixed-effect, panel Tobit, and mediation effect models, to explore the relationship and underlying mechanisms. The results indicate that political

connections tend to inhibit the development of green innovation in Chinese companies. Specifically, these connections have a stronger inhibitory effect on innovations related to alternative energy patents and administrative supervision design patents. The conclusion holds under several robustness tests. Further analysis reveals regional heterogeneity in the impact of political connections on green innovation, with the manufacturing industry being the most significantly affected sector. The study identifies two primary mechanisms through which political connections influence green innovation: R&D investment and excessive corporate debt. Political connections may lead firms to prioritize short-term gains or divert resources away from sustainable innovations. In conclusion, the paper suggests that government policy needs to account for the negative effects of political connections on green innovation. It also offers recommendations for enterprise development, emphasizing the need for a better alignment between political and environmental goals to encourage the growth of green technologies.

In the Asian context, political and economic factors play a significant yet varied role in shaping the development of the digital economy and e-commerce. Haqqi and Murdani (2023) examine the relationship between political and economic conditions and the digital economy in Asia through a qualitative political economy analysis. Their findings reveal that despite differing levels of political strength across Asian countries, some have successfully developed and maintained control over their digital ecosystems. This reflects the diverse political capacities and institutional arrangements among Asian nations, leading to uneven progress in e-commerce readiness and digital economy growth. Ahi et al. (2023) broaden the scope by analyzing both academic and policy documents, highlighting the need for targeted policies to strengthen formal institutions, promote the participation of less developed nations, and support small and medium enterprises in adopting e-commerce. Their study stresses the importance of policy coordination, international cooperation, and collaboration among governments and stakeholders to ensure that e-commerce development in Asia is inclusive and benefits all segments of society. The authors also point out that despite the rapid pace of digitalization in global commerce, where nearly all cross-border transactions in 2016 involved a digital component remains a lack of policy focused research in the e-commerce field.

Meanwhile, Wei (2024) provides a quantitative perspective by analyzing the factors influencing China's cross border e-commerce exports to RCEP countries using

a gravity model. The study identifies economic scale, trade openness, geographical distance, and levels of internet technology as key factors. Interestingly, variables such as political stability and internet infrastructure did not show significant differences between low- and high-income countries in the region, suggesting that their influence may be limited or offset by other elements. Wei emphasizes the importance of adopting market specific strategies, recommending affordable and quality products for lower income countries and premium products and services for higher income markets. This illustrates that success in cross border e-commerce depends not only on political or economic conditions but also on how businesses adapt to the characteristics of different markets.

Hence, Mia et al., (2024) explores the determinants of digitalization in the context of Asia and the Pacific countries, aiming to understand the macroeconomic and governance factors driving digital growth. The research highlights that while digitalization plays a crucial role in fostering economic development globally, there is a significant gap between developed and developing countries, with the latter often lagging behind in digital adoption. To analyze this, the study uses unbalanced panel data from 46 countries in the Asia-Pacific region spanning the years 2001 to 2021. It employs various econometric methods, such as pooled ordinary least squares (POLS), random-effects model, and fixed-effects model, along with endogeneity-corrected techniques and alternative proxies for digitalization to ensure the robustness of the findings. The study identifies economic development progress, government expenditure relative to country size, and political stability as key drivers of digitalization in these countries. On the other hand, corruption at the country level emerges as a significant impediment to digital growth. The results of the study remain robust even after employing alternative techniques to correct for endogeneity. Overall, the study offers valuable insights for policymakers, helping them to recognize the importance of macroeconomic and governance factors in promoting digitalization. These findings can guide decision-makers, particularly in countries with lower levels of digitalization, towards effective policy interventions that could help bridge the digital divide in the Asia-Pacific region. The research adds empirical value to the existing literature, quantifying the impact of governance and economic factors on digitalization in selected countries.

The relationship between digitalization and political stability is clearly reflected in the findings of both Mia et al. (2024) and Zhang et al. (2025), though each

study engages with the concept from different vantage points. Mia et al. (2024) explicitly identify political stability as a key driver of digitalization across countries in the Asia Pacific region. Their empirical analysis demonstrates that countries with more stable political environments are more likely to implement sustained digital development strategies. Political stability fosters policy continuity, effective governance, and investor confidence, all of which are essential for the expansion of digital infrastructure, regulatory frameworks, and institutional capacity. Moreover, politically stable environments are more capable of addressing issues such as corruption, which Mia et al. recognize as a significant barrier to digital progress. Thus, political stability is foundational to creating the conditions needed for equitable and widespread digital transformation.

Zhang et al. (2025), while not placing political stability index at the centre of their analysis, still underscore its indirect relevance through their discussion of governance quality, regulatory structures, and institutional effectiveness. Innovation ecosystems, digital readiness, and sustained digital commerce, core themes in Zhang et al.'s study, require a stable and predictable policy environment. Strong governance and low levels of corruption, both of which are more achievable in politically stable settings, support long term investments in innovation and the expansion of digital trade. Although the study emphasizes technological and innovation capability, it implicitly recognizes that these cannot thrive in contexts marked by instability or institutional fragility.

2.5.3 Other Factors Influence E-commerce

Economic growth serves as an essential indicator of a country's stability, with Gross Domestic Product (GDP) per capita being the most widely used measure (Solomon & Van Klyton, 2020; Volkova et al., 2021). The level of GDP per capita reflects the overall development of a nation, including the degree of digitalization and e-commerce penetration. As GDP increases, it signifies a more robust economy, which may contribute to the expansion of e-commerce infrastructure, technological advancement, and consumer purchasing power. However, while GDP is a fundamental macroeconomic determinant, it does not necessarily guarantee the success of e-commerce in a country (John, 2017). Other contributing factors, such as digital infrastructure, consumer preferences, and regulatory frameworks, play a crucial

role in fostering e-commerce growth. Despite this, the rapid expansion of e-commerce across the globe, particularly in Asia, highlights the potential relationship between economic growth and the digital marketplace. Given that Asian countries dominate global e-commerce sales, it is essential to explore whether an increase in GDP has a direct positive impact on e-commerce growth.

International trade plays a pivotal role in facilitating the expansion of cross-border e-commerce. The advancement of communication technologies and information systems has significantly reduced operational costs for firms while enhancing collaboration with international business partners (Carballo et al., 2022). This has led to an increase in the volume of cross-border trade, with a rising trend in both imports and exports driven by e-commerce platforms. According to He and Wang (2019), cross-border e-commerce has witnessed rapid growth, with countries increasingly relying on digital trade to expand their market reach and optimize supply chains. This trend is particularly evident in Asia, where e-commerce platforms facilitate seamless global transactions, contributing to overall economic integration.

The size and characteristics of a country's population significantly influence the growth of e-commerce. As the internet became a global tool for commerce, over two billion people worldwide were using it for information and online purchases as early as 2011 (Terzi, 2011; Kovac et al., 2018). The increasing reliance on digital platforms highlights the importance of population size and internet penetration in shaping e-commerce trends. Ozekenci et al. (2019) emphasize that population is a key determinant of online purchasing behaviour, as a larger population represents a greater potential consumer base for e-commerce platforms. He and Wang (2019) further reinforce this argument, stating that a country's population size directly correlates with its e-commerce market potential. China, as the world's largest economy and e-commerce leader, exemplifies this relationship. With a high population and a well-developed digital economy, the country presents significant opportunities for both domestic firms and foreign businesses seeking to leverage cross-border e-commerce (Qi et al., 2020). Conversely, in regions where population growth stagnates, such as Ukraine, a decline in purchasing power can lead to slower economic growth and limited e-commerce expansion (Zatonatska et al., 2018).

The interplay between GDP, trade, and population creates a dynamic environment that influences the development of e-commerce. While GDP growth reflects economic stability and technological advancement, it is not the sole

determinant of e-commerce success. Trade facilitation and cross-border digital transactions further enhance market accessibility, while population size serves as a fundamental driver of e-commerce adoption. Given the dominance of Asian markets in global e-commerce sales, understanding these macroeconomic factors is essential for policymakers and businesses looking to capitalize on digital trade opportunities. Future research should explore the extent to which each of these factors contributes to e-commerce growth, particularly in emerging economies with high digital adoption rates.

2.5.3.1 Empirical Study of Other Factor on E-commerce

This study employs a systematic review of academic research to examine the relationship between other factors that affect e-commerce such as GDP, trade and population. The methodology integrates findings from panel data analysis, econometric modelling, and case studies, providing a structured analysis of how macroeconomic influences e-commerce sustainability at different economic levels. The selection of studies follows a rigorous process, focusing on empirical research that provides quantitative and qualitative evidence on macroeconomic impact on e-commerce.

Deljavan & Norouzi (2016) investigated the impact of e-commerce, innovation, and two other variables on economic development based on 21 selected countries. This study used panel data techniques with the Generalised Least Squares Regression (GLS) method during the period of 2005 to 2013. The results showed that e-commerce and innovation proxy by R&D had a positive and significant impact on GDP (gross domestic product) per capita based on purchasing power parity, with e-commerce having a stronger development-enhancing effect in comparison to R&D. Health expenditure and government size as other dependent variables also had a positive influence on GDP per capita, which could be effective in improving and growing the economy.

In addition, Mansaray & Bin, (2016) conduct a study on the impact of e-commerce on trade in Africa, using panel data from 1990 to 2013 in Africa country. Several more factors were included in the model to account for omitted variable bias. The analysis with fixed effects methodologies, both using the ordinary least squares (OLS) and generalised method of moments (GMM) estimators, indicates a substantial

positive link between ecommerce and trade openness in Africa. Furthermore, the study concludes that foreign direct investment may or may not have an impact on trade openness, depending on which industries benefit from it. Based on basic policy assumptions, there is no link between country size and trade openness. Given several obstacles to improving ecommerce trade in Africa, this study emphasises the necessity for more research focussing on how Africa might overcome its many problems.

Furthermore, He and Wang (2019) study the impact of economic globalization and digital network expansion on the development of cross-border e-commerce trade. Their study, which focuses on ASEAN countries, that analyses the key macroeconomic to determinants the affecting for both export and import activities in the e-commerce sector. Using panel data from 1998 to 2016, the study employs dynamic ordinary least squares and the error correction model to assess the long-term relationship between cross-border e-commerce trade and various economic indicators such as import and export, GDP, exchange rate, population, and term of trade. The results of this study highlight a long-term association between cross-border e-commerce trade and pertinent factors. In general, GDP has positive effect and the real exchange rate has negative effect on export & positive effect for import that has an impact on cross-border e-commerce trade. However, the population also have positive while trade has negative solely affect cross-border e-commerce imports. Empirical research shows that GDP and real exchange rates always have an impact on the growth of cross-border e-commerce trade. As a result, all ASEAN nations should do every possible thing to promote economic growth while focussing on the exchange rate regime in order to fulfil the need for cross-border e-commerce trade development.

Additionally, Zatonatska et al., (2018), conduct a study of modern trends that impact on economic development of countries for e-commerce and R&D. The purpose of this study is to establish a collection of economic and mathematical models to measure the influence of e-commerce and R&D investment on the country's economic development. When the results of modelling in three countries were compared, it was determined that the value of e-commerce and R&D expenditures is more significant for GDP per capita growth in Ukraine and Poland due to Austria's higher level of ICT development and its proximity to the saturation point relative to the growth rates of innovation industries. When the levels of exposure to e-commerce and R&D expenses in these nations were compared, it was shown that only Austria ranks first in terms of e-commerce exposure. While analysing the parameters of three different models, it

was discovered that the Ukrainian model's GDP per capita is the most sensitive to changes in the indicators. This reveals that Ukraine's economy is less stable than that of Poland and Austria. Investing in R&D and e-commerce has a substantial influence on the country's economic development, helping to boost GDP and manufacturing productivity.

Likewise, Ozekenci et al. (2019) analyze the determinants of e-commerce growth in Turkey and European countries, focusing on macroeconomic factors influencing digital transactions. Using panel data from 2004 to 2015, the study examines key variables that impact e-commerce expansion. The empirical findings indicate that internet usage, GDP per capita, inflation, and employment rate by educational level all have a positive effect on e-commerce adoption. This highlights the role of technological accessibility, economic stability, and human capital in driving the growth of digital trade. The study emphasizes the importance of digital infrastructure and economic policies in fostering e-commerce development across different regions.

Wulansaria and Parwantob (2020) explore the role of e-commerce in promoting trade openness and economic growth in Asian countries. Their study highlights that trust, security concerns, and ICT access are key challenges to expanding digital trade. Using panel data analysis from 2012 to 2017 across 17 Asian countries, they examine the influence of ICT, social, and security indicators on trade openness. The findings reveal that fixed telephone and broadband subscriptions significantly enhance trade openness, particularly in emerging economies where these infrastructures remain central. Additionally, crime rates have a significant impact, whereas interpersonal safety, trust, and quality of life show a positive but statistically insignificant effect. The study concludes that countries like Hong Kong and Singapore lead trade openness growth, emphasizing the importance of strengthening ICT infrastructure and security measures to foster digital trade in Asia.

Besides He & He, (2021) examine the impact of cross-border e-commerce development in Southeast Asia on China's export trade. Using principal component analysis and panel data from 11 Southeast Asian countries (2010–2019), the study evaluates e-commerce levels across the region. Employing a trade gravity model, the authors construct an empirical framework to analyze how these e-commerce levels influence China's exports. The findings indicate that higher levels of cross-border e-commerce in Southeast Asia positively affect China's export trade, although

development remains uneven across the region. The study underscores the importance of enhancing China's e-commerce infrastructure to facilitate trade transformation and boost exports in the post-pandemic era and highlight to Increase the degree of cross-border e-commerce development to encourage the transformation and upgrading of export trade.

Additionally, Aryani et al. (2021) examine the impact of ICT on Indonesia's trade with ASEAN partner countries, particularly in the context of e-commerce and business activities. Using static panel data analysis with a gravity model approach, the study analyzes trade patterns between Indonesia and nine ASEAN countries from 2010 to 2018. The findings reveal that ICT development and utilization, measured by the ICT Development Index (IDI) and B2B e-commerce index, significantly enhance Indonesia's trade value. Additionally, macroeconomic factors such as GDP growth, economic distance, and market size also have a substantial impact on trade flows. The study concludes that ICT development should be a priority for the Indonesian government, as it plays a crucial role in boosting trade performance and strengthening economic integration within ASEAN.

More importantly, Shanmugalingam et al., (2023) explore the relationship between e-commerce and international trade in Asian countries, emphasizing the role of technology in economic growth. Using panel data from 38 Asian countries covering the period 2010–2020, the study applies various econometric techniques, including stationarity tests, cointegration tests, and the two-step system Generalized Method of Moments (GMM) estimator, to ensure robust analysis. The findings reveal that e-commerce has a significant positive impact on international trade, highlighting its role in enhancing market accessibility and economic integration. The authors suggest that governments should implement policies to improve telecommunication technologies, enabling further e-commerce expansion and maximizing trade benefits.

2.6 Research analysis for E-Commerce for Green Technology Innovation, and Political Stability

The integration of green technology into e-commerce represents a promising pathway toward sustainable digital development. However, existing research in this area remains limited, particularly in assessing the long-term impact and scalability of green innovation across different economic sectors. While some studies have explored

technologies in supporting environmentally sustainable e-commerce (Chin et al. 2022; Prajapati et al. 2022), the majority focus on digital adoption, trade, with limited attention to how environmental sustainability is integrated into e-commerce platforms. Even when green innovation is addressed, it is often treated as a secondary concern rather than a core driver of long-term e-commerce transformation.

Political stability is another underexplored factor in the development of e-commerce. While some studies have linked political instability to reduced firm performance and slower economic growth (Ouedraogo et al., 2020), few have directly examined how political stability shapes the e-commerce systems. On the other hand, political uncertainty can hinder infrastructure development, disrupt environmental policy implementation, and weaken incentives for sustainable innovation. Despite this, empirical research on the connection between political stability and the growth of environmentally responsible e-commerce remains limited, particularly in Asian countries.

2.7 Summary

In short, this chapter firstly has a review on related concepts, and detail introduction on the theoretical basis including the theory of new growth. The above review aims to identify the influencing factors of e-commerce in Asian countries. From the literature review in this chapter, the current literature innovation and e-commerce mainly focus on the impact of improving scientific and technological levels on e-commerce. There is still a certain research gap in the impact of green technology innovation on e-commerce. In addition, relevant literature on political stability index and e-commerce specifically in Asian country is limited. Hence, the next chapter will discuss the measurement of the impact of green technology innovation and political stability index on e-commerce based on the conceptual framework and discuss the proposed model that will be used in next chapter.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Overview of Research Methodology

This chapter will discuss in detail the panel data method used which is the static panel data. To answer this study research questions, this study proposed two empirical models to capture the effect of green technology innovation and political stability on e-commerce in selected ASIAN Countries. First, this chapter discuss the conceptual framework based on the literature review in the previous chapter. This follows by the specification of empirical model to estimate, and variables included in the model. Diagnostic checks are explained in this chapter, which are intended to demonstrate whether there are any econometric problems in the model. At the end of the chapter, a flow of the research techniques is shown and illustrates how the study was conducted.

3.2 Framework for Analysis

As mentioned in the previous chapter, the main purpose of this study is examining the effect of green innovation and political stability towards e-commerce in Asia countries. The theoretical frameworks for this study are based on the New Growth Theory, Schumpeter Theory and Institutional Theory. In response to the research questions, this study adopted a panel data framework in 20 Asian countries from 2000 to 2020 by adopting static panel data analysis which include selection of Random Effects (RE) and Fixed Effects (FE) estimations and perform the diagnostic testing including Panel Unit Root Test, Multicollinearity Test, Autocorrelation Test and Heteroscedasticity Test. The data involved in this paper are from the economic and social data of countries published on the official website of the World Bank Data, the Global Competitiveness Report over the years and the OECD database.

Figure 3.1 depicts the conceptual framework of this study where the e-commerce will be influence by the Green Technology Innovation and Political Stability Index as independent variables and Control variables (GDP, Trade, population). The control variables were obtained from Ozekenci *et al.*, (2019).

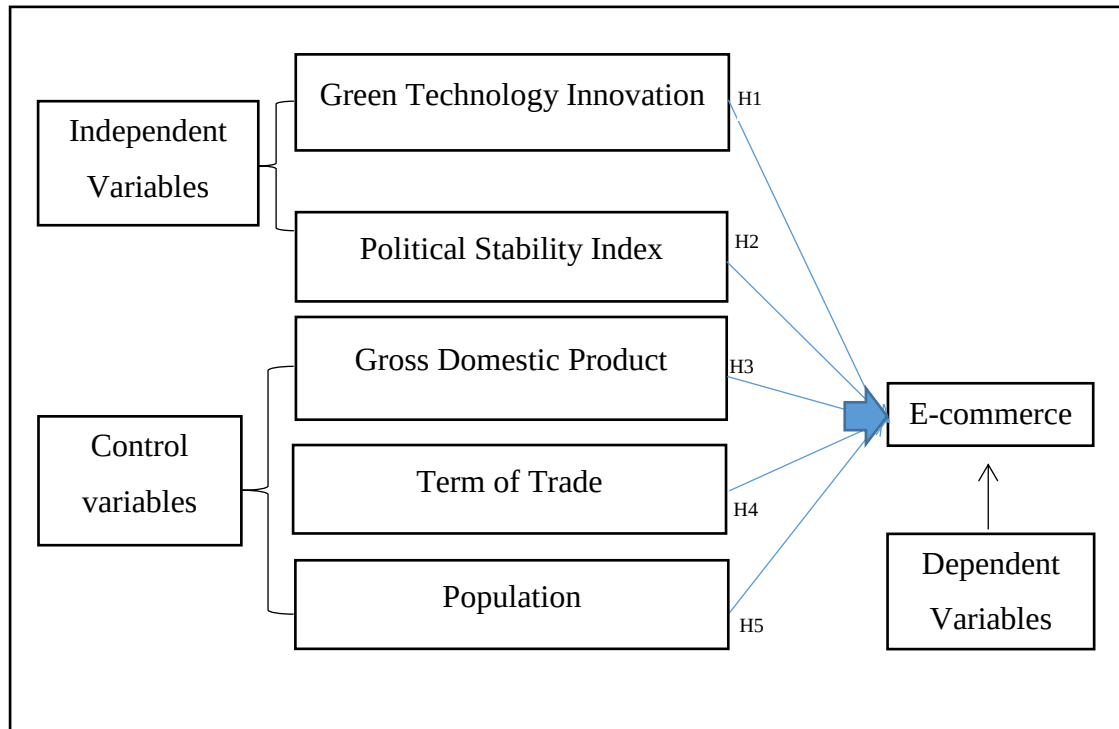


Figure 3.1 Conceptual Framework

Sources : Compute by Author

Based on the literature review, the expected results of this study suggest that Green Technology Innovation and Political Stability are likely to have positive and significant effects on e-commerce development in Asian countries. In addition, the control variables, namely Gross Domestic Product (GDP), Terms of Trade, and Population, are also expected to contribute positively to e-commerce growth.

Firstly, Green Technology Innovation is expected to positively influence e-commerce because technological advancement enhances digital infrastructure, improves energy efficiency, and supports sustainable business operations. Previous studies indicate that countries with higher levels of technological innovation tend to experience faster digital transformation and stronger adoption of online commercial activities. The Schumpeter Theory supports this relationship by emphasizing innovation as a key driver of economic progress and market expansion. Therefore, countries with stronger green innovation capabilities are expected to demonstrate higher levels of e-commerce development.

Secondly, Political Stability is anticipated to have a positive relationship with e-commerce growth. Stable political environments encourage investor confidence, improve institutional quality, and create favourable conditions for digital business activities. According to Institutional Theory, effective institutions and political

stability play an important role in supporting economic activities, including digital trade and online business platforms. Countries with stable governance systems are more likely to attract investments in information and communication technologies (ICT), leading to stronger e-commerce performance.

Regarding the control variables, GDP is expected to positively affect e-commerce since higher income levels increase purchasing power, internet accessibility, and consumer spending on digital platforms. Similarly, Terms of Trade may positively influence e-commerce through increased international trade activities and market openness, which encourage online transactions and cross-border digital trade. Population is also expected to positively contribute to e-commerce development because larger populations provide broader consumer markets and greater demand for online goods and services.

Overall, the expected findings of this study are consistent with the New Growth Theory, which highlights the importance of technological advancement, institutional quality, and economic factors in promoting long-term economic growth and digital economic development. Hence, it is anticipated that countries with higher green innovation, stronger political stability, and better economic conditions will exhibit higher levels of e-commerce development during the period of 2000 to 2020.

3.3 Specification of Empirical Model

Based on the new growth theory, this study aims to examine the effect of green innovation and political stability index towards e-commerce in Asia countries. The baseline model based Ozekenci et al., (2019) described as in equation 1. Suppose to have $i = 1 \dots k$, n countries and $t = 1 \dots T$ time periods with intercept β_0 and the slope coefficients β_i , then the panel estimation would be written as in equation 3.1.

$$y_{it} = \alpha + \beta_{it}x_{it} + \varepsilon_{it} \quad (3.1)$$

$$y_{it} = \beta_0 + \beta_1x_{1it} + \beta_2x_{2it} + \beta_3x_{3it}^1 + \beta_4x_{4it}^2 + \beta_5x_{5it}^3 + \varepsilon_{it} \quad (3.2)$$

The equation is explained as follows; where y is represent for Dependent Variables (DV), x for Independent Variables (IV), β is Coefficient, α is Intercept or Constant, x^x as control variables and ε represent for error term within entity. Where, i and t represent for years and times.

In order to answer research question number 1, the variable green technology innovation included estimating its effect on e-commerce in Model 1:

Model 1:

$$EC_{it} = \beta_{0it} + \beta_1 \ln GTI_{it} + \beta_2 \ln GDP_{it} + \beta_3 \ln Tra_{it} + \beta_4 \ln Pop_{it} + \varepsilon_{it} \quad (3.3)$$

The model 1 purpose an equation where EC represents the e-commerce variable as dependent variables while $\ln GTI$ as Green Technology Innovation (GTI). GTI represents the level of innovation in green and sustainable technologies, which are expected to enhance digital infrastructure, improve technological efficiency, and support the growth of e-commerce activities. In addition to the main variables, the model includes ($\ln GDP$) for Gross Domestic Product (GDP), Terms of Trade ($\ln Tra$), and Population ($\ln Pop$) as control variables. GDP is included to account for the overall level of economic development, as higher-income economies generally have better infrastructure and higher adoption of e-commerce. Tra controls for external trade conditions that may influence national income and economic stability, which indirectly affect digital economic activities. Pop is included to represent market size, since larger populations typically create greater demand for e-commerce goods and services.ve technological efficiency, and support the growth of e-commerce activities. The error term (ε) captures other unobserved factors that may influence e-commerce development but are not explicitly included in the model, such as digital literacy, regulatory differences, and cultural factors.

Secondly, this study also aims to examine how political stability will influence e-commerce in Asian countries. Hence, the political stability index (PSI) as independent variable measures the degree of political stability in a country, where a more stable political environment is expected to strengthen investor confidence, improve institutional quality, and encourage the expansion of digital and online markets. The second model is specified as follows:

Model 2:

$$EC_{it} = \beta_{0it} + \beta_1 \ln GTI_{it} + \beta_2 PSI_{it} + \beta_3 \ln GDP_{it} + \beta_4 \ln Tra_{it} + \beta_5 \ln Pop_{it} + \varepsilon_{it} \quad (3.4)$$

Where, *PSI* as independent variable for second variables and *lnGDP* purpose the Gross Domestic Product *lnTra* represents the term of trade and *lnPop* as population of country for control variables. In this model, *i* refers to the cross-sectional unit, which represents each country included in the study. The variable *t* refers to the time dimension, which represents the specific time period or year of observation. Therefore, *i* distinguish between different countries, while *t* captures changes over time.

3.4 Measurement of Variables

The dependent variable in this study is E-commerce. The explanatory variables consist of two independent variables namely green technology innovation and political stability which macroeconomic factors such as Gross Domestic Product, Term of trade population and inflation as control variables.

3.4.1 E-commerce

The e-commerce index is a composite indicator that represents the ability of a country and preparedness to participate in online commerce. By combining a proxy for digital infrastructure, technology adoption, and online engagement, it functions as a stand-in for determining the volume of e-commerce activity. This index offers a systematic baseline for assessing an economy to sustain readiness to maintain and grow e-commerce. According to OECD (2019), e-commerce is defined as the selling or purchase of products and services through computer networks using a technique particularly aimed for accepting or placing orders. Meanwhile, according to Mansaray and Bin (2016), e-commerce is a direct commercial transaction conducted via the Internet between suppliers and purchasers. They found the e-commerce index has three factors: online, telecommunication, and computer. Hence, this study adopted an indicator proposed by Mansaray & Bin, (2016), which is the proxy for e-commerce. In order to carry on this work, the total sum of e-commerce indexes present within each country for a given year. All data was collected from the World Bank (World Development Indicators). For the purpose of this study, the data utilised in this analysis were obtained covered the period 2000-2020. These data give a comprehensive time series of green technology innovation indicators, such as research

and development (R&D) activities, green patents, and investments in sustainable industries.

3.4.2 Green Technology Innovation

The data used in this study are obtained from the Organisation for Economic Co-operation and Development (OECD) database covering the period from 2000 to 2020. This time frame is selected to capture long-term trends in innovation, macroeconomic conditions, and e-commerce development across countries. The dataset provides consistent and comparable annual observations that are suitable for panel data analysis. According to the OECD (2009), innovation is defined as the introduction of a new or significantly improved product, service, or process, as well as new marketing methods or organisational structures. Innovation is widely recognised as one of the key economic drivers that contributes to societal progress, environmental sustainability, business performance, and national development.

Green technology innovation refers to all forms of innovation that facilitate the development of goods, services, or processes that reduce negative environmental impacts and environmental degradation, while improving the efficient use of natural resources (Leal-Millan et al., 2017). Similarly, Ye and Cheng (2019) define green innovation as technological advancement within industrial processes that aims to reduce production costs while integrating environmental considerations. In addition, green innovation or eco-innovation refers to the development and application of new technologies and production processes that reduce environmental risks such as pollution and the adverse effects of resource exploitation, particularly in energy use (Castellacci & Lie, 2017; Karimi Takalo et al., 2021).

The primary objective of green technology innovation is to achieve long-term sustainable development by balancing economic growth, social well-being, and environmental protection. It aims to promote energy efficiency and resource conservation while reducing or eliminating environmental pollution and degradation (Zhou et al., 2014; Li et al., 2018; Wang et al., 2021).

3.4.3 Political Stability

The data for the Political Stability Index are obtained from Global Economic Data (2021). According to Global Economic Data (2021), the Political Stability Index measures public perceptions of the likelihood that a government may be destabilised or overthrown through unconstitutional or violent means, including terrorism and politically motivated violence. Political stability is an important indicator of national stability and plays a key role in supporting business development and economic growth. Oudraogo et al. (2020) further highlight that political stability promotes economic activity and creates a peaceful environment conducive to development. The index is constructed from multiple sources, including the Economist Intelligence Unit, the World Economic Forum, and Political Risk Services, capturing risks such as government instability, conflict, social unrest, terrorism, and ethnic or religious tensions. The methodology is consistently applied over time to ensure comparability across countries, with additional governance indicators such as rule of law, political rights, and corruption perceptions included enhancing its comprehensiveness.

3.4.4 Control Variable

3.4.4.1 Gross Domestic Product

GDP (Gross Domestic Product) is the aggregate of the gross value contributed by all resident producers in the economy, plus any product taxes and minus any subsidies not included in the product value (World Bank Data, 2022). GDP is product that produces in country over the year and as a main indicator for the country where it will show the stability or the growth of the countries.

3.4.4.2 Term of Trade

Term of trade is the net total of exports and imports for goods and services that expressed as a percentage of GDP (World Bank Data, 2022). According to OECD (2022), when the percent of value for Trade is positive it means the country have strong stability of international trade. The formula for Terms of Trade is:

$$\text{Term of Trade} = \frac{\text{Index of Net Export}}{\text{Index of Net Import}} \times 100$$

In Trade, there are two main activities which Export and Import. Export refers to the selling of Goods and Services or product from country to other country or foreign country. The product we can export out of country is also referring to the Tariff or Tax, Quota, Exchange Rate value, Rules and Regulation of the country and any other factor that affects exports. Import in general term is buying or bring product or Goods and Services form foreign country. Imports are external sources of our country that give great advantages or benefits for home country. Import value cannot exceed the value of exports otherwise it would have a negative effect on the country. The value of exports and imports must be in balance or positive for export where it has a positive effect on the country. Trade also helps e-commerce to grow, and it also plays important roles in contributing toward economic growth.

3.4.4.3 Population

According to World Bank Data (2022), population defines every citizen regardless of legal status or citizenship where the total population is calculated using the de facto (a legal notion that refers to what occurs or practice) population definition. Human population growth, whether due to immigration or more births than deaths, can have an influence on natural resources and social infrastructure. This can put a strain on a country's long-term viability. A considerable increase in population will reduce the availability of agricultural land and increase demand for food, energy, water, social services, and infrastructure. Reduced population size, on the other hand, as a result of fewer births than deaths and people leaving a nation can have an influence on a government's willingness to maintain services and infrastructure.

3.5 Data Sources

The data used in this study are collected from secondary sources. The study employs secondary data to estimate the regression model and analyze the effect of the independent variables on e-commerce development. A panel data approach is used, which combines both time-series and cross-sectional data. According to Torres-Reyna (2007), panel data allow researchers to control for unobservable variables that cannot be directly measured, such as time-invariant cultural and institutional factors. In addition, Baltagi (2013) and John (2017) note that panel data analysis provides several

advantages, including more informative data, greater variability, reduced multicollinearity, increased degrees of freedom, and improved estimation efficiency.

The period of the data will be collected from 2000 to 2020 for the Asia country which is Indonesia, Malaysia, Philippines, Singapore, India, Sri Lanka, Japan, Kazakhstan, China, Thailand, Mongolia, United Arab Emirates, Korea Rep., Jordan, Uzbekistan, Saudi Arabia, Turkey, Iran, Pakistan and Kuwait. In the previous study such as Anvari & Norouzi (2016), He & Wang (2019) Hardilawati *et al.*, (2019), Capolupo, (2009), Ozekenzi *et al.*, (2019), and Xin *et al.*, (2021), used the data variables in study to test the variables. However, to analyse the impact of independent variables to the e-commerce, the data would be collected to form the World Bank Data, OCDE and The Global Economy. The variables data that have been collected are e-commerce as dependent variables by using the import and export data, macroeconomic factor such as Gross Domestic Product, Trade, Population, Political Stability Index and go green innovation data represent the independent variables.

3.6 Regression Analysis Method

3.6.1 Unit Root Test

Unit root testing is used to determine the stationarity of data by removing trends, prior to applying econometric techniques, in order to avoid spurious regression results (Khalid et al., 2019). Due to various policy changes and macroeconomic shifts, earlier unit root tests often failed to account for structural breaks in the data series, which may lead to biased regression estimates (Nasrullah et al., 2021). Several panel unit root tests are available, including Levin–Lin–Chu (LLC), Harris–Tzavalis, Im–Pesaran–Shin (IPS), Breitung, and Hadri tests. Among these, IPS is suitable for unbalanced panel data, while Breitung is typically applied to strongly balanced panels. This study employs two types of panel unit root tests to examine the stationarity properties of the variables.

$$\Delta y_{it} = \rho_i y_{t-1} + \sum_{i=1}^n \phi_{i,1} \Delta y_{i,t-1} + \alpha_i d_{it} + \varepsilon_{it} \quad (3.5)$$

Where, d_{it} deterministic components, $\rho_i = 0$ denotes that the process y has a unit root for individual i , whereas $\rho_i \neq 0$ indicates that the method is stationary around the deterministic component.

3.6.1.1 Levin–Lin–Chu (2002)

Levin–Lin–Chu one of the most difficult tests to do since the data from numerous people must be integrated into a single final regression.

$$y_{it} = \rho_i y_{t-1} + \sum_{i=1}^N \phi_{i,1} \Delta y_{i,t-1} + \alpha_i d_{it} + \varepsilon_{it} \quad (3.6)$$

Where, $\alpha = \rho - 1$, $\Delta y_{i,t-1}$ represent the auxiliary regressions, y_{it} are on lagged terms $\Delta y_{i,t-1}$, exogenous variables are d_{it} and N as asymptotic means $N(0, 1)$

Hypothesis Statement:

(H₀): $\rho = 0$ (there is unit root)

(H₁): $\rho < 0$ ((there is stationary)

3.6.1.2 Im, Pesaran and Shin test

Im, Pesaran and Shin (IPS) is a test for the presence of unit roots in panels that combines information from time series measurements with information from cross-sectional dimensions such that the test requires fewer time observations to be effective.

$$\Delta y_{it} = \alpha_i y_{t-1} + \sum_{i=1}^N \beta_{ij-1} \Delta y_{ij} + \varepsilon_{it} \quad (3.7)$$

(H₀): $\alpha_i = 0$ for all i .

(H₁): $\{\alpha_i = 0 \mid \alpha_i < 0 \mid i = 1, 2, \dots, Ni \mid i = Nt + 1, \dots, N\}$

(H₀): $\beta_i = 0$ unit root

(H₁): $\beta_i < 0$ unit root

$\underline{t}$ refer of the t -statistics for i from separate ADF regressions:

$$\underline{t} = \frac{1}{N} \sum_{i=1}^N t_i \quad (3.8)$$

3.6.2 Panel Data

Panel data or longitudinal data are data sets that comprise observations on numerous phenomena over multiple time periods and it has two parameters as a result: cross-sectional and time series (Vijayamohanan Pillai N., 2016). According to Torres-reyna, (2007), Panel data helps you measure for variables that are impossible to see or

cannot to observe or quantify, such as cultural differences or differences in business practises between firms, as well as variables that vary over time but not between organisations in examples national laws, federal legislation or international agreements.

In the POLS regression model, it is believed that there is basically no difference between cross-sections. Furthermore, under the assumption that the dataset is prior homogeneous, this model is beneficial (Asteriou & Hall, 2011). However, this situation has certain limitations. Because the panel data will be treated as pooled data by the model, which will not take into account its cross-sectional dimensions or time dimension. As a result, this model will estimate panel data using the least squares method, or OLS. As a result, the equation of PLOS is similar with an OLS as follows:

$$y_{it} = x_{it}\beta + \alpha_i + \varepsilon_{it} \quad (3.9)$$

The equation will be explained where y is representing for Dependent Variables (DV), x for Independent Variables (IV), β is Coefficient, α is Intercept or Constant and ε represent for error term within entity. Where, i and t represent for years and times. The coefficient will calculate the relationship between DV and IV for examples in this study where DV is E-commerce and IV for Innovation, Political Stability Index and macroeconomic as control variables. Therefore, error term is to calculate the other variables that not include in other variables, incomplete data or missing data, wrong functional form.

Therefore, a high sample size provides more degrees of freedom, variability, information, and reduced multicollinearity among the variables, all of which are benefits that are immediately apparent (Vijayamohanan Pillai N., 2016). There are also have several advantages of using panel data according to Hsiao, (2007) the parameter of the model are more accurate. The observation of the data will give more information from the data and more efficient in estimate the data.

3.6.2.1 Fixed Effect Model

According to Torres-reyna (2007), Fixed-effects analysis is used to investigate the link between predictor and outcome variables within an entity by examining the impact of factors that change over time. In fixed effect we can make assumptions that the individual differences may influence or bias predictor or outcome variables, and

we must control for this. In order to use fixed effect model, the constant and the entity of error term must not correlate each other otherwise the Random Effect may be applied.

According to Vijayamohanan Pillai N., (2016), if the result of the cross sectional are significant, in panel data we cannot assume that the intercept of α is constant for all time and year. We must examine one-way or two-way error component models; if the errors are considered to be fixed and then we have a fixed effects model to identify the error. The slope coefficient of the population regression line is the same for all people or entities, while the intercept of the population regression line varies between individuals or entities.

$$y_{it} = \alpha_i + \beta_1 x_{it} + \varepsilon_{it} \quad (3.10)$$

The equation will be explaining where y represent for DV, x for (IV), β is Coefficient, α is Intercept or Constant and ε represent for error term within entity. Where, i and t represent for years and times. The coefficient will calculate the degree of freedom or relationship between variables. In this study, the coefficient will calculate the relationship between DV and IV for examples in this study where DV is E-commerce and IV for Macroeconomic, Innovation, and Political Stability Index.

The fixed effects approach has a major advantage of avoiding bias due to omitted variables factors that do not vary over time such as location or geography or that change over time equally for all entities such as the federal speed limit (Studenmund & Johnson, 1970).

3.6.2.2 Random Effects Model

According to Torres-reyna (2007), Random effect model refer to the variation among entities is believed to be random and unrelated to the independent variables but it is related to dependent variables. This is because random effects presume that the entity's error term is uncorrelated with the predictors, time-invariant variables can serve as explanatory variables. Random effect may describe which individual characteristics impact or do not influence the predictor variables. The issue here is that some variables may not be available, resulting in an omitted variable bias in the model. The advantage of Random Effect models a lot of degrees of freedom because, instead of estimating an intercept for almost every cross-sectional unit, we only need

to estimate the parameters that describe the distribution of the intercepts (Studenmund & Johnson, 1970).

Random Effects equation model:

$$y_{it} = \alpha_i + u_{it} + \beta_1 x_{it} + \varepsilon_{it} \quad (3.11)$$

Where: u is referring to error term between entities.

3.6.2.3 Hausman Test

According to Greene W.H (2008), in order to decide whether to use Fixed or Random Effect model the Hausman Test needs to be run to see whether the unique error term is correlated with the regression model or not. The Hausman test is to evaluate if a fixed effects or random effects model fits your panel data better. It can determine either the estimation for the parameter is consistent or not. If the error term is correlated with the independent variables, then random effect may be applied. In order to understand the Hausman Test, the p-value result will help to determine either is suitable Fixed effect or Random effect: if the p-value is <0.05 , then the error term is not correlated with the independent variables and Fixed Effect model will fit to the data. Otherwise, if the p-value >0.05 then Random Effect may be applied because the error term is correlated with independent variables.

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \quad (3.12)$$

Where, β represents for β_0 (Fixed Effect) and β_1 is (Random Effect). The hypothesis statements:

H_0 : β_0 and β_1 are consistent, but β_1 is efficient and β_0 is not

H_1 : β_0 is consistent, but β_1 is not

3.6.2.4 Panel models with Driscoll and Kraay standard errors

This study further employs panel regression models with Driscoll and Kraay standard errors to address potential econometric issues commonly found in panel data analysis, particularly heteroskedasticity, autocorrelation, and cross-sectional dependence. The Driscoll and Kraay estimator provides robust standard errors that

remain consistent even when the error terms are correlated across panels and over time.

The use of Driscoll and Kraay standard errors is appropriate for panel datasets involving multiple countries observed over several years because economic shocks, policy changes, and regional spillover effects may generate cross-sectional dependence among countries. In addition, the estimator is robust to serial correlation and heteroskedasticity, thereby improving the reliability and validity of statistical inference.

Driscoll and Kraay (1998) demonstrated that the standard nonparametric time series covariance matrix estimator can be modified to be robust to very general cross-sectional forms and time dependencies by relying on large T asymptotic behavior. Roughly speaking, Driscoll and Kraay are methods apply Newey West type corrections to the sequence of cross-sectional mean values under moment conditions. Adjusting the standard error estimate in this way ensures that the covariance matrix estimator is consistent and independent of the cross-sectional dimension N (i.e., also applicable to $N \rightarrow \infty$). Therefore, Driscoll and Kraay's methods eliminate the shortcomings of other large T consistent covariance matrix estimators, such as Parks Kmenta or PCSE methods, which often become inappropriate when the cross-sectional dimension N of a micro econometric panel gets large.

The operation command of xtsc in stata produces Driscoll and Kraay standard errors for coefficients estimated by pooled OLS and fixed-effects (within) regression, which is suitable for use with both, balanced and unbalanced panels, respectively. Furthermore, it is capable to handle missing values. Fixed-effects (within) regression models are estimated using Driscoll and Kraay standard errors by using the xtsc program's option fe. Implementing the corresponding fixed-effects estimator involves two steps. All model variables $z_{it} \in \{y_{it}, x_{it}\}$ are first within- converted in the manner described below:

$$\tilde{z}_{it} = z_{it} - \bar{z}_i + \bar{\bar{z}} \text{ where } \bar{z}_i = T_i^{-1} \sum_{t=t_{i1}}^{T_i} z_{it} \text{ and } \bar{\bar{z}} = (\sum T_i)^{-1} \sum_i \sum_t z_{it} \quad (3.13)$$

Recognizing that the within-estimator corresponds to the OLS estimator of below:

$$\tilde{y}_{it} = \tilde{x}_{it}' \theta + \tilde{\varepsilon}_{it} \quad (3.14)$$

The second step then estimates the transformed regression model in (3.14) by pooled OLS estimation with Driscoll and Kraay standard errors. The non-parametric covariance matrix estimator proposed by Driscoll and Kraay (1998) relied on large T asymptotic behavior, and the longer the time dimension T of the panel, the better the calibration of Driscoll Kraay's standard error.

3.6.3 Diagnostic Checking

The diagnostic checking is it important in the regression analysis that may not lead to the violation technique in estimates the equations. The classical assumption is to measure relationships strength and direction between two or more variables to the dependent variables (Hardilawati et al., 2019). According to Akinwande *et al.*, (2015), that in the regression analysis, the analysis should compare two or more variables. Factor or spouse to analysis the direction and strength of the correlation between variables.

3.6.3.1 Heteroskedasticity

Heteroskedasticity used to defines the unobserved factor that change across from different population to determine the values of the variables (Jeffrey M, 2012). In this study the heteroskedasticity will be used to determine the unobserved factor that gives an effect to the e-commerce. Heteroskedasticity may be used for this study because it is important factor in financial market to analysis (Studenmund & Johnson, 2017).

According to Yassin *et al.*, 2021 the existence_of heterogeneous slopes has become one of the problems in the panel data analysis. To identify the presence of heteroskedasticity in the data, the Breusch-Pagan test will be used whether there is error or not. To test the heteroskedasticity, the p-value for chi-square must be bigger than 5 percent of the significant level. The null hypothesis for the equation fails to reject. Therefore, if the result for the p-value is less than 5 percent the equations have heteroskedasticity. If the model regression has heteroskedasticity, the error term is not constant, resulting in bias in the t-statistic and confidence interval or p-value.

$$y_{it} = \beta_0 + \beta_1 x_{it} + \beta_2 x_{2it} + \varepsilon_i \quad (3.15)$$

$$\mathbf{Var}(\varepsilon_i) = \sigma^2 z_i$$

Where, Z_i may not be nor may one of the $\mathbf{x}$ in the equation where it is a proportionality factor. The higher the value of $\mathbf{Z}$, then the higher assumption of the error term in the data observation of i th in the variance of distribution.

$$\text{Var}(e_{it}) = \sigma_e^2, = \text{a constant } (i = 1, 2, \dots, n)$$

$$y_{it} = x_{it}\beta + u_2 + \varepsilon_{it}$$

$$\varepsilon_{it} = (u_2) + (e_{it})$$

$$\text{Var}(u_2) = \sigma_u^2, \text{Var}(e_{it}) = \sigma_e^2,$$

Heteroskedasticity hypothesis statement:

(H_0) : homoscedasticity

(H_1) : Heteroscedasticity

Homoscedasticity

$$y_{it} = x_{it}\beta + u_1 + \varepsilon_{it} \quad (3.16)$$

The formula for Homoscedasticity for fixed effect was the same with the random effect but, the difference where for fixed effect $\sigma_u^2 = 0$ and for random effect is $\sigma_u^2 > 0$.

3.6.3.2 Breusch-Pagan Test

The purpose of Breusch–Pagan test is to examine the method of heteroskedasticity if the squared residuals can be explained by potential proportionality factors for heteroskedasticity in the error term (Studenmund & Johnson, 2017). Breusch-Pagan test is to analyses the error across in the explanatory variable of variables of $\mathbf{y}$. The error variances are assumed to be a linear function of one or more explanatory variables in the model, according to the test. This heteroskedasticity may still exist in your regression model, but the errors are unrelated with the value of $\mathbf{y}$. The alternative hypothesis argues that error variances increase (or decrease) as expected values of $\mathbf{y}$ grow for examples the greater the projected value of $\mathbf{y}$, the greater the error variance (Williams, 2020).

$$e_i = y_i - \hat{y}_i = y_i - \beta_0 - \hat{\beta}_1 x_{1i} - \hat{\beta}_2 x_{2i} \quad (3.17)$$

Then the auxiliary regression:

$$e_i = \alpha_0 + \alpha_1 x_{1i} - \alpha_2 \alpha_{2i} + u_i \quad (3.18)$$

Breusch-Pagan test hypothesis statement:

$$(H_0): \alpha_1 = \alpha_2 = 0$$

$$(H_1): H_0 \text{ is false}$$

Thus, if the p-value is more than 0.05, heteroscedasticity exists, indicating that the residual has a non-equal variance distribution. The hypothesis for null assumes there is homoscedasticity the residuals are distributed with equal variance while the alternative there is heteroscedasticity the residuals are not distributed with equal variance.

3.6.3.3 Pesaran CD

In panel data analysis, it is crucial to test for cross-sectional dependence (CD) among the variables. The Pesaran CD test is widely used to detect cross-sectional dependence, particularly in datasets with large time-series and cross-sectional dimensions (Pesaran, 2004). Cross-sectional dependence arises when shocks in one country or entity affect others.

$$CD = \frac{\sqrt{2T}}{N(N-1)} \sum_{i=1}^{N-1} \cdot \sum_{j=i+1}^N \hat{\rho}_{ij} \quad (3.19)$$

Where, T is the number of time periods, N is the number of cross-sectional units, $\hat{\rho}_{ij}$ is the correlation between residuals of cross-sectional units i and j . A significant Pesaran CD test statistic the p-value less than 0.05 indicates the presence of cross-sectional dependence, meaning that a standard panel regression approach may not be appropriate.

3.6.3.4 Correlation Analysis

Correlation Analysis is a statistical method used to examine the strength and direction of the relationship between two variables. The primary goal is to determine if a linear relationship exists, and if so, to measure how closely these variables are related. The Pearson Correlation Coefficient is the most commonly used method for

correlation analysis and quantifies the degree to which two continuous variables are linearly related (Pearson, 1896). The formula for the Pearson correlation coefficient (r) is given by:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (3.20)$$

Where, r is the Pearson correlation coefficient, x is the values of the first variable, y is the Values of the second variable, n = is the number of paired values, $\sum x$ is the sum of the x-values, $\sum y$ is the sum of the y-values, $\sum y^2$ is the sum of the squared y –values, and $\sum y^2$ is the sum of the squared y-values.

The value of r can range from -1 to 1: A value of +1 indicates a perfect positive linear relationship, meaning as one variable increase, the other variable also increases proportionally. A value of -1 indicates a perfect negative linear relationship, meaning as one variable increase, the other variable decreases proportionally. A value of 0 indicates no linear relationship between the variables. Once the Pearson correlation coefficient is calculated, its interpretation can be done as follows: $r = 1$ is perfect positive linear relationship, $r = -1$ is perfect negative linear relationship, $r = 0$ is no linear relationship. This indicates a strong negative correlation between x and y , meaning as x increases, y decreases.

While correlation analysis is useful, it has limitations. It can only detect linear relationships between variables, meaning it may not capture non-linear correlations. Moreover, correlation does not imply causation. Two variables can be correlated without one causing the other, and external variables could influence both. Correlation analysis is a valuable tool for exploring the relationship between two variables, and the Pearson correlation coefficient provides a clear measure of this relationship. However, it should be applied with caution, particularly when assessing non-linear relationships or attempting to infer causality. High correlation between independent variables for multicollinearity can distort regression estimates, requiring additional tests like Variance Inflation Factor (VIF) to detect multicollinearity issues.

3.6.3.5 Ramsey RESET (Regression Equations Specification Error Test)

Ramsey RESET one of the most criteria used in the regression to determine the specification error, whether it is fit by using two or more term as proxy for omitted variables or incorrect functional form (Studenmund & Johnson, 1970). The regression may be analysis by add term of the variables which is $\hat{Y}$ and the term are from the

polynomial functional form. Ramsey also can define the correlation between variables either the test is having a specification error or otherwise. Ramsey consists with three steps:

$$\hat{y}_{it} = \hat{\beta}_0 + \hat{\beta}_1 x_{it} + \hat{\beta}_2 x_{2it} \quad (3.21)$$

The value of $\hat{y}_{it}$ will create the $\hat{y}_{it}^1, \hat{y}_{it}^2, \hat{y}_{it}^3, \hat{y}_{it}^4$ and $\hat{y}_{it}^5$. The term will be put on the original equation to change in the new equation in last equation:

$$\hat{y}_{it} = \beta_0 + \hat{\beta}_1 x_{it} + \hat{\beta}_2 x_{2it} + \beta_3 \hat{y}_{it}^1 + \beta_4 \hat{y}_{it}^2 + \beta_5 \hat{y}_{it}^3 + \beta_6 \hat{y}_{it}^4 + \beta_7 \hat{y}_{it}^5 + \varepsilon_{it} \quad (3.22)$$

Ramsey RESET hypothesis statement:

$$(H_0): \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$$

$$(H_1): \text{Otherwise}$$

To conclude the Ramsey test, if the value of F is bigger than critical F-value then we can reject the null and there is have a specification error. Otherwise, if the value of F is smaller than critical F-value then we can accept the null and there is no specification error.

3.6.3.6 Multicollinearity

Multicollinearity refers to the correlation between independent variables that usually used in invoked when some data are “large” in correlations but are not defining well. (Jeffrey M., 2012). Multicollinearity the issue will be arising if there have an approximate linear relationship between two or more variables (Akinwande *et al.*, 2015). According to Studenmund & Johnson (2017), Multicollinearity at the violations of Classical Assumptions VI which is there is no perfect linear function between two or more variables. The perfect multicollinearity is rarely faced but severe imperfect multicollinearity; still give causes to substantial problem to the study. The used of multicollinearity in this study will show the approximate linear relationship between dependent variables. Multicollinearity consists with two types: Perfect Multicollinearity and Imperfect Multicollinearity. Perfect multicollinearity refers to state that no explanatory variable is a perfect linear function of any other explanatory

variable when two or more explanatory variables are poorly linearly connected, imperfect multicollinearity emerges.

$$\begin{aligned} y_i &= \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \varepsilon_i \\ x_{1i} &= \alpha_0 + \alpha_1 x_{2i} (\text{perfect}) \\ x_{1i} &= \alpha_0 + \alpha_1 x_{2i} U_i (\text{imperfect}) \end{aligned} \quad (3.23)$$

U = stochastic error term

Let suppose in linear equation:

$$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \varepsilon_i \quad (3.24)$$

When the Coefficient of β_1 is the increase in y for each unit increase in x_1 while remain x_2 constant. However, due to x_1 and x_2 are closely linked, changes in x_1 would also induce changes in x_2 , making it impossible to detect the individual relationship. According to (Daoud, 2022), in order to the detect multicollinearity in the data, the Variance Inflation Factor (VIF). The VIF is a technique for calculating and quantifying how much variation is overstated. The rules of Thumbs would be measuring the VIF to that will conclude the result. However, if the value for VIF equal to 1 which means the data is not correlated, if the value for VIF less than 5 not less than 1 it means the data moderately correlated and if the VIF more than 5 it means the data highly correlated. VIF Equation:

Step one:

$$x_1 = \alpha_1 + \alpha_2 x_2 + \alpha_3 x_3 + \cdots + \alpha_k x_k + v$$

v = stochastic error term

Step two:

$$VIF(\hat{\beta}_i) = \frac{1}{(1 - R^2)}$$

3.7 Hypothesis

This part is to explain the nexus between e-commerce and independent variables to understand more from the previous studies explanation. Models may help to understand the flow of objective in chapter one and how this model explains the model. The outcomes of the drives analysis will lead to the hypothesis formulation for this study.

3.7.1 Green Innovation Technology and E-commerce

According to Mu *et al.*, (2021) and Wang *et al.*,(2021), improving the green technology will improve the greater degree of business transaction and expected to improve the e-commerce. Therefore, these studies propose for Hypothesis 1:

H1: The Green Technology Innovation of the country has a positive effect on e-commerce.

3.7.2 Political Stability and E-commerce

As countries with unstable political climates are in flux, they may experience more challenges in encouraging and instituting needed governance tools including e-participation (Astrom *et al.*, 2012; Katchanovski & La Porte, 2005). Moreover, unstable governments are less likely to elicit citizens' trust with regard to using technologies to improve citizens' interactions and perceptions of responsiveness (Tolbert & Mossberger, 2006). Therefore, these studies propose for Hypothesis 2:

H2: A country's political stability is positively associated with its e-commerce

3.7.3 Control Variable and E-commerce

According to Ho *et al.*, (2007), GDP is the main driver factors to promote new technology. Therefore, GDP will help a nation to adopt a new technological improvement such as internet and e-commerce (Ozekenci *et al.*, 2019). The previous studies above show that the nexus between e-commerce and GDP of the country positive strong relationship which is the positive relationships. Therefore, these studies propose for Hypothesis 3:

H3: GDP has a positive effect on e-commerce.

Trade also helps e-commerce to grow. According to Terzi (2011) trade activities improve the e-commerce development. This study supported by He and Wang (2019) where the terms of trade have a positive effect on e-commerce (Y. He & Wang, 2019). Therefore, these studies propose for Hypothesis 4:

H4: The term of trade has a positive effect on e-commerce.

According to Ozekenci *et al.*, (2019), population is also considered as an important demographic factor that affects the nations on many levels and founded that population are essential determination of online business or e-commerce. Therefore, these studies propose for Hypothesis 5:

H5: The population of the country has a positive effect on e-commerce.

3.8 Regression Analysis Flows

The methodology of this study is developed systematically to ensure that the empirical findings are valid, reliable, and consistent with the objectives of the study. Given that the study involves multiple countries over several years, panel data analysis is employed as the primary econometric approach.

At the initial stage, secondary data are collected from reliable international databases. The dataset comprises variables related to e-commerce development, green technology innovation, political stability, GDP, population, and terms of trade. The study focuses on 20 selected Asian countries over the period 2000 to 2020. Panel data combines both cross-sectional and time-series dimensions, where cross-sectional data refer to observations across countries and time-series data refer to observations over time. This combination allows the study to examine variations across countries and over time simultaneously. The use of panel data provides several advantages, including higher degrees of freedom, greater data variability, reduced multicollinearity, and more efficient econometric estimation compared to pure cross-sectional or time-series approaches. It also allows the capture of country-specific effects and dynamic changes influencing e-commerce development.

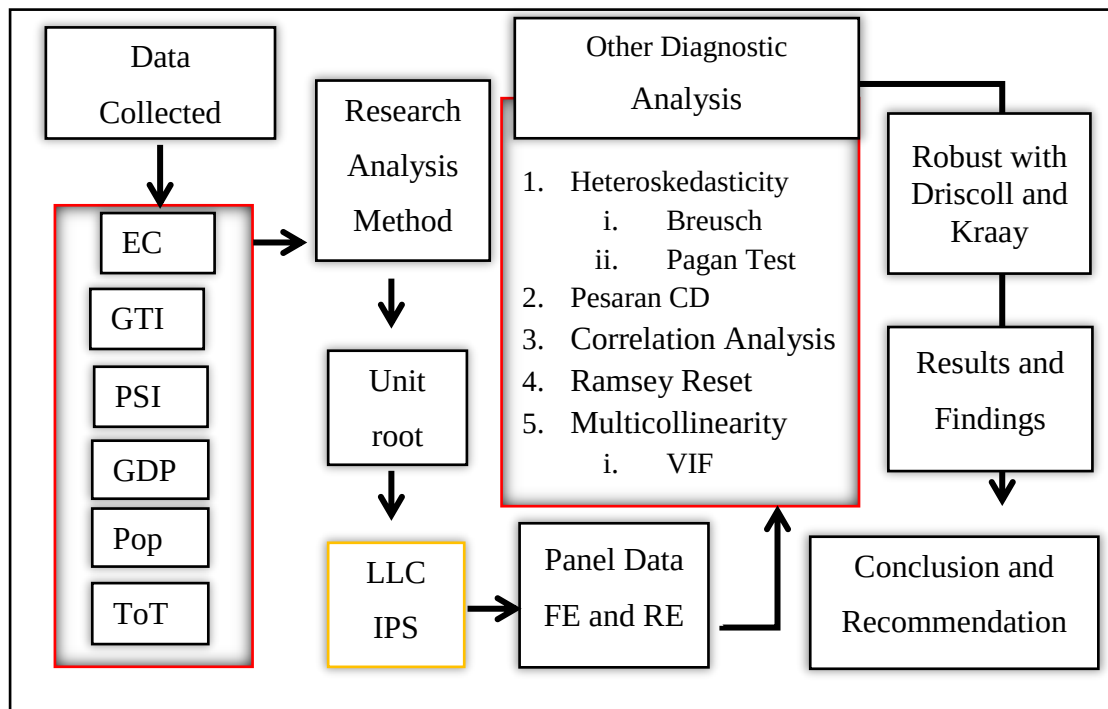


Figure 3.2 Regression Analysis Flows

Before estimating the regression model, panel unit root tests are conducted to examine the stationarity properties of the variables and to avoid spurious regression results. A spurious regression may arise when non-stationary variables produce misleading relationships. Therefore, this study applies the Levin, Lin and Chu (LLC) test and the Im, Pesaran and Shin (IPS) test. The LLC test assumes a common unit root process across countries, while the IPS test allows for heterogeneity in stationarity behaviour across cross-sectional units. If variables are found to be non-stationary, first-difference transformation is applied.

Following stationarity testing, panel regression analysis is conducted using both the Fixed Effects Model (FEM) and Random Effects Model (REM). The Hausman test is then used to determine the appropriate model by testing whether individual effects are correlated with explanatory variables. The null hypothesis supports the Random Effects Model, while the alternative supports the Fixed Effects Model.

To ensure robustness, the study employs Driscoll and Kraay standard errors to address heteroskedasticity, autocorrelation, and cross-sectional dependence. This approach is particularly suitable for macro-panel datasets involving interdependent countries, as it produces consistent standard errors under general forms of spatial and temporal dependence.

Several diagnostic tests are also conducted to validate the econometric model. The Breusch-Pagan Lagrange Multiplier test is used to detect heteroskedasticity, while the Pesaran Cross-Sectional Dependence (CD) test examines interdependence across countries. Correlation analysis is conducted to assess the direction and strength of relationships among variables. The Ramsey RESET test is used to detect model misspecification, and the Variance Inflation Factor (VIF) test is applied to assess multicollinearity among explanatory variables.

The empirical results are interpreted based on coefficient signs, statistical significance, economic meaning, and consistency with theoretical expectations. The findings are further compared with previous studies and relevant theoretical frameworks to ensure robustness and validity.

3.9 Summary

In conclusion, this chapter employs the panel data method through two empirical models to address the research question. The framework analysis elucidates the impact of independent and control variables on e-commerce, providing a comprehensive understanding of variable definitions. The data collected for analysis is historical and sourced from secondary data. The subsequent regression analysis, discussed in the following chapter, will interpret the results obtained from this data. Panel data will undergo testing for Random or Fixed effects, assessing data correlation to ascertain its compatibility with the error term. Diagnostic tests will further examine data, checking for errors, residual fit, inter-variable correlation, functional form, and more. The significance of these diagnostic tests lies in identifying errors, ensuring data compatibility, and validating variable relationships. The chapter's hypotheses explore the positive or negative effects of e-commerce based on previous studies. Finally, the flow of the research regression in Chapter 3 will illustrate the development of this chapter.

CHAPTER 4

RESULTS OF THE EMPERICAL RESEARCH

4.1 Framework for Analysis

This chapter presents the results of a statistical analysis of panel data, focusing on the impact of green technology innovation, the political stability index, and macroeconomic factors on e-commerce across Asian countries using the panel data consist with $t = 21$ year of time periods and $i = 20$ countries for individuals from 2000 to 2020. Initially, a descriptive analysis was conducted on the dependent, independent, and control variables, which included calculating mean values, standard deviations, and minimum and maximum values. Graphical representations illustrated the heterogeneity among countries and years, highlighting the relationships between independent and dependent variables within each country. Subsequently, correlations between the dependent and independent variables were assessed for each country to evaluate the nature and statistical significance of these relationships. Appropriate panel analysis methods were selected for the dataset, employing Driscoll and Kraay standard errors to validate and adjust the data, thereby allowing the application of either the Random Effects (RE) or Fixed Effects (FE) model. To address potential issues such as heteroskedasticity, correlation analysis, specification using Ramsey RESET and multicollinearity, diagnostic tests were performed. Finally, panel data models were presented to analyze the effects of independent and control variables on the dependent variable, enabling a comparison between model 1 and model 2.

4.2 Descriptive Statistics

The panel data is balanced, although it includes some missing values, which were addressed using interpolation methods. To preserve the integrity and correlation of the time series and to address issues such as homoscedasticity or heteroscedasticity, error terms, residuals, correlation into dependent variable e-commerce and key explanatory variables which is green technology innovation, political stability index, GDP, population and trade.

Descriptive statistical analysis is a method used to explore and summarize the characteristics and relationships within data. It included key information such as

mean, variance, range, median, and distribution. This method is applied to various types of data, including surveys, experiments, and records. By organizing and statistically assessing data, descriptive analysis helps researchers to deliver valuable data or insights and understand underlying patterns and trends. Table 4.1 provides the observed values, along with the mean, standard deviation, maximum, and minimum values for all variables in this model. The result presents a comprehensive overview of the descriptive statistics for the dependent, independent, and control variables utilized in the analysis.

Table 4.1
Descriptive Statistics Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
EC	420	0.0997	0.060	0.017	0.666
lnGTI	420	4.152	3.141	-2.398	11.137
lnGDP	420	26.201	1.75	20.852	30.318
lnPop	420	7.62	0.75	6.287	9.15
lnTra	420	1.866	0.273	1.291	2.641
PSI	420	-0.328	0.943	-2.810	1.599

Table 4.1 the descriptive statistic data are based on overall data that provided summary regression encompasses with 420 observations for each variable. E-commerce indexes the variable show lowest value of e-commerce variable is 0.017 per cent and the highest value is 0.667 per cent indicating a relatively low level of e-commerce engagement among the observed entities while the mean value is 0.0997 per cent with standard deviation 0.06 per cent. Develop country may have high penetration of online retails sales and digital payment system transactions while low-income country with minimal online transaction.

Therefore, green technology innovation has a mean of 4.152 per unit and a standard deviation of 3.141 per unit, reflecting a broad range of innovation levels, as evidenced by the minimum of -2.398 per unit and maximum of 11.137 per unit. The negative minimum value implies the presence of countries with limited or negative

green technology outputs. The minimum value might have A negative score could reflect high emissions or rollback of green policies while maximum value with high score country could indicate leadership in renewable energy patents and clean technology R&D.

The log of GDP reveals a mean of 26.201 or 26.201 billion USD and a standard deviation of 1.75 billion USD, with a range from 20.852 billion USD to 30.318 billion USD, indicating substantial economic output among the countries in the sample. The relatively small standard deviation suggests a degree of homogeneity in GDP levels across the dataset.

lnPop exhibits a mean of 7.62 and a standard deviation of 0.75, indicating relatively stable population size variation compared to other macroeconomic variables. The range (6.287 to 9.15) still shows meaningful cross-country differences in demographic scale.

However, the trade of inTra has a mean of 1.866 per cent and a standard deviation of 0.273 per cent, with a minimum of 1.291 per cent and a maximum of 2.641 per cent. This indicates a moderate level of trade activity among the countries, with some exhibiting significantly higher trade volumes. Countries with low inTra values often have large domestic markets, while higher values indicate trade-driven economies.

Lastly, the data for the political stability index shows a mean value of -0.328 with a standard deviation of 0.943, a minimum of -2.810, and a maximum of 1.599. This reflects a wide variation in political stability across the countries in the sample, with some experiencing significant political stability with -2.810 per cent while others demonstrate relatively high levels of stability for 1.599 per cent. Country with less than zero might be undergoing conflict or governance crises, while country more than zero represents a highly stable democratic system.

In summary, the descriptive statistics highlight notable heterogeneity across countries, particularly in innovation (lnGTI) and political stability (PSI), while population and trade variables show comparatively lower dispersion. These patterns justify the use of panel data estimation techniques to account for both cross-sectional and temporal variation.

4.3 Panel Unit Root Tests

To begin the empirical estimation procedure, the panel unit root tests proposed by Hashem Pesaran, M. Hashem Pesaran and Shin (2003), as well as the Levin, Lin, and Chu (LLC) test, are employed to examine the stationarity properties of the panel data series. These tests are important to ensure that the variables are stable over time and free from unit root problems, which could otherwise lead to spurious regression results. The stationarity tests are conducted under specifications with intercept and without trend at the level form, first difference, and second difference. By identifying the order of integration for each variable, the study is able to determine the appropriate econometric techniques for subsequent panel data estimation.

Table 4.2 presents the results of the Unit Root Test using the Im, Pesaran, and Shin (IPS) method, applied to assess the stationarity of various variables within the dataset. The table shows the test results at three levels: the original level, first difference, and second difference.

Table 4.2
Results of Unit Root Test with IPS test model 1 and model 2

Variable	Level	1 st Dif.	2 nd Dif.
EC	-0.2008	-3.1651 ***	-5.9185 ***
lnGTI	-2.5090 ***	-6.0957 ***	-8.6315 ***
PSI	-2.3360 ***	-6.2626 ***	-9.7095 ***
lnGDP	-1.7635 *	-3.0053 ***	-5.7224 ***
lnPop	-5.3758	-1.1988	-2.9745 ***
lnTra	-1.2890	-3.8788 ***	-6.0715 ***

Note: IPS represents the testing of the stationarity of intercepts by Im, Pesaran, and Shin (2003) at level, first difference and second differences. (*) significant at the 10% level, (**) significant at the 5% level, and (***) significant at the 1% level. The null hypothesis is that variable is non-stationary.

In Table 4.2, the results of the Unit Root Test are presented using the Im, Pesaran, and Shin (IPS) test, which is a popular method to test the stationarity of variables in panel data models. The table shows the results for model 1 and model 2

across three stages: Level, First Difference, and Second Difference. The null hypothesis of the IPS test is that the variable is non-stationary. The table also indicates the significance levels to assess whether the variables are stationary at each differencing level.

At the Level, EC has a test statistic of -0.2008, which is not significant at level, indicating non-stationarity at the level. After the First Difference, the test statistic result becomes -3.1651, which is significant at the 1 per cent level, meaning that EC becomes stationary after differencing once. After the Second Difference, the test statistic is -5.9185, which is also significant at the 1 per cent level, confirming that EC remains stationary after the second differencing, though differencing once is sufficient for stationarity, suggesting it exhibits time-dependent trends that must be controlled for. Log of Green Technology Innovation at the Level, lnGTI has a test statistic of -2.5090, which is significant at the 1 per cent level, indicating that it is stationary at the level. After the First Difference, the test statistic is -6.0957, which is also significant at the 1 per cent level, reinforcing that lnGTI is stationary after the first difference. The Second Difference statistic of -8.6315, again significant at the 1 per cent level, shows that lnGTI remains stationary even after the second differencing, though it is already stationary at the level. Hence, lnGDP is only weakly stationary at the 10% level at level but shows strong stationarity after first differencing, implying it too should be differenced to ensure valid inference.

While, the political stability index only for model 2 result equation at the Level, PSI has a test statistic of -2.3360, which is significant at the 1% level, indicating that PSI is stationary at the level. After the First Difference, the test statistic of -6.2626 is significant at the 1 per cent level, confirming that PSI is also stationary at the first difference. The Second Difference statistic of -9.7095 is significant at the 1 per cent level, confirming that PSI remains stationary even after a second differencing, though it is already stationary at the level, the lnGTI and PSI indicating consistent statistical properties over time and suitability for direct inclusion in regression without transformation. In contrast, the log of GDP at the Level, lnGDP has a test statistic of -1.7635, which is significant at the 10 per cent level, suggesting it is close to stationary but not quite significant at the 5 per cent level. After the First Difference, the test statistic of -3.0053 is significant at the 1 per cent level, confirming that lnGDP becomes stationary after the first differencing. The Second Difference statistic of -5.7224, significant at the 1 per cent level, also confirms that lnGDP is stationary after

the second differencing, though it is already stationary after the first differencing. The lnGDP is only weakly stationary at the 10% level at level but shows strong stationarity after first differencing, implying it too should be differenced to ensure valid inference.

For population at the Level, lnPop has a test statistic of -5.3758, which is not significant, meaning it is non-stationary at the level. After the First Difference, the test statistic of -1.1988 is not significant, indicating that lnPop remains non-stationary even after the first differencing. After the Second Difference, lnPop becomes stationary with a test statistic of -2.9745, which is significant at the 1 per cent level, indicating that it requires second differencing to achieve stationarity, suggesting significant long-term trends in population across countries. However, is non-stationary even after first differencing and only becomes stationary at the second difference, suggesting significant long-term trends in population across countries. Similarly, the logarithm of trade (lnTra) is non-stationary at level but stationary at first difference. The trade at the Level, lnTra has a test statistic of -1.2890, which is not significant, meaning it is non-stationary at the level. After the First Difference, the test statistic of -3.8788 is significant at the 1 per cent level, meaning that lnTra becomes stationary after the first differencing. The Second Difference statistic of -6.0715, significant at the 1 per cent level, indicates that lnTra remains stationary after the second differencing, but it is already stationary after the first differencing.

In Model 1, the primary independent variables like lnGTI, lnGDP, and lnTra mostly become stationary after the first differencing, while EC requires second differencing to achieve stationarity. In lnPop is non-stationary at the level and requires second differencing for stationarity. In model 2, PSI the additional independent variable in this model is stationary at the level and after first and second differencing, similar to lnGTI and lnGDP in model 1. However, lnPop remains non-stationary after the first difference and requires second differencing to achieve stationarity, just as in model 1.

Most variables achieve stationarity after the first differencing, except for EC and lnPop, which require second differencing. Model 2 for PSI and lnGTI remain stationary at the level and after the first differencing, while lnPop and lnTra require first or second differencing, similar to model 1. The test results in both models show that most variables achieve stationarity at the 1 per cent level, with some exceptions like lnGDP, which is only significant at the 10 per cent level in model 1 at the level, but becomes significant at the 1 per cent level after the first differencing.

Both models show that lnGTI, PSI, lnGDP, and lnTra are generally stationary, with most variables in Model 1 and Model 2 requiring first differencing. The addition of PSI in Model 2 does not affect the overall stationarity patterns, as it behaves similarly to lnGTI in Model 1. The lnPop in both models requires second differencing for stationarity.

Overall, the IPS unit root test results demonstrate mixed orders of integration among the variables, with some variables stationary at level, others at first difference, and all variables becoming stationary at second difference. These findings confirm the absence of persistent unit root problems after differencing and support the suitability of proceeding with further panel data estimation techniques.

Table 4.3 displays the results of the panel data unit-root test conducted using the Levin, Lin, and Chu (LLC) method. This test assesses the stationarity of various economic and demographic variables across the dataset at three levels: the original level, first difference, and second difference.

Table 4.3
Results of Unit-Root Test with LLC test for model 1 and model 2

Variable	Level	1 st Dif.	2 nd Dif.
EC	-2.6102	-10.5189 ***	-19.7476 ***
lnGTI	-8.7278 ***	-16.7517 ***	-28.1873 ***
PSI	-11.4159 ***	-19.5060 ***	-25.4287 ***
lnGDP	-9.9348 ***	-10.4458 **	-21.7963 ***
lnPop	-4.0869 ***	-3.6911*	-13.7420 ***
lnTra	-5.6233 *	-14.7809 ***	-22.1808 ***

Note: LLC represents the testing of the stationarity of intercepts by Levin Lin Chu (LLC) at level, first difference and second differences. (*) significant at the 10% level, (**) significant at the 5% level, and (***) significant at the 1% level. The null Hypothesis is that variable is non-stationary.

In this table 4.3 the results of the Unit Root Test are presented using the Levin-Lin-Chu (LLC) test for two models, labelled as model 1 and model 2. The results of the Levin, Lin, and Chu (LLC) unit root test in this table provide further validation of

the stationarity properties of the variables used in the panel regression models. The LLC test assumes a common unit root process across the panel and tests whether variables are stationary over time. This test is used to examine whether a time series variable is stationary, which is important in econometrics because non-stationary data can lead to misleading conclusions in regression models. The results of the Levin, Lin, and Chu (LLC) unit root test provide detailed insights into the stationarity properties of the variables used in the study of e-commerce determinants across Asian countries. The table shows the results for each variable at three different levels of differencing: level, first difference, and second difference.

Starting with the dependent variable, the e-commerce index is non-stationary at level test, as indicated by a not statistically significant test statistic result -2.6102. However, it becomes strongly stationary after the first difference at 1 per cent of significant level for -10.5189 and remains so at the second difference for -19.7476 at 1 per cent significant level, implying that differencing is necessary before including it in regression models to avoid biased results and suitable for regression after differencing.

In contrast, green technology innovation is highly stationary across all levels, beginning with a strong significance at level test -8.7278 with 1 per cent significant level, suggesting that this variable maintains stable behaviour over time and does not require transformation. This means green innovation shows no systematic drift over time and can be safely used in its original form. No transformation is required this variable is robustly stationary across time. Similarly, the political stability index (PSI) also demonstrates strong level stationarity at -11.4159 for 1 per cent of significant level, reinforcing its reliability as an explanatory variable in the model without the need for differencing. This confirms that political stability does not exhibit a unit root and its time-series characteristics are stable supporting its use in model 2 without differencing.

For the control variables, the log of GDP (lnGDP) is stationary at level -9.9348, though its significance slightly drops at the first difference at 5 per cent of significant level for -10.4458 and it still confirms the absence of a unit root, while at second difference test also significant at 1 per cent level. This confirms that economic size is stable enough across countries and time. The population variable for lnPop also passes the stationarity test at level test -4.0869 and significant at 1 per cent of significant but with a comparatively smaller magnitude, while at first differences the

significant of population was slope into 5 per cent of significant level and it turn into 1 per cent of significant level at second difference, its stationarity improves in subsequent differences.

Lastly, the log of trade (lnTra) shows weak stationarity at level test with -5.6233 and 10 per cent of significant level, suggesting marginal confidence in its stability. However, it becomes strongly stationary at the first difference -14.7809 at 1 percent of significant level and for second difference, indicating it should ideally be used in its differenced form for robustness. Most variables especially key independent variables like lnGTI and PSI are stationary at level and can be used directly in panel data regressions. However, variables like EC and lnTra should be differenced to ensure statistical validity and to prevent spurious inference, thus supporting the integrity of the regression models used in the analysis.

Initially, EC is non-stationary at the level test as indicated by the test statistic of -2.6102 . However, after the first difference, it becomes stationary test statistic of -10.5189 , suggesting that the original economic variable has a trend or pattern, which disappears once the trend is removed by differencing. Hence, lnGTI the Index of Green Technology Innovation, lnPSI (Political Stability Index), and lnGDP all show significant stationarity at the level, meaning these variables do not require differencing to become stationary. These indices, which might reflect underlying structural factors, appear to be stable in their original form, indicating that their values do not exhibit trends or patterns over time. Population is significant at the 1 per cent level at both the level and second difference stages, which means that it is stationary after both the first and second differencing. This suggests that population growth rates are subject to fluctuations over time and may need to be adjusted for trends. The results from the LLC unit-root test indicate that some variables are stationary at their level, while others require differencing to achieve stationarity. The table highlights the importance of transforming non-stationary data into stationary forms before further analysis, as using non-stationary data could lead to unreliable results in econometric models.

Models 1 and 2 both employ panel data from several Asian countries. Model 1 focuses on variables such as lnGTI, lnGDP, lnPop, and lnTra, which tend to exhibit similar trends across countries; hence, the LLC test may be appropriate, as it assumes homogeneity in the panel data. In contrast, Model 2 incorporates political stability, a variable that can differ significantly across nations due to variations in governance, economic structures, and political systems. This inclusion introduces greater

heterogeneity, making the IPS test more suitable, as it accommodates cross-sectional differences and diverse stationary processes. Accordingly, LLC is recommended for homogeneous panels, while IPS is preferred for heterogeneous panels. For this study on The Influence of Green Innovation and Political Stability on E-commerce, if Asian countries are assumed to share similar stationary trends, the LLC test is appropriate; however, if each country is expected to follow its own unique stationary process, the IPS test provides a more reliable framework.

4.4 Panel Data Estimation

In order to facilitate the comparison of estimation results, this study reports the regression results of the fixed effect model, and random effect model and Driscoll-Kraay fixed effect model for model 1-2 respectively. In Model 1 in table 4.4 estimate the relationship between Green Technology Innovation (lnGTI), GDP (lnGDP), Population (lnPop), Trade (lnTra), and E-commerce (EC). Based on the Hausman test results, the fixed effects model is deemed more appropriate than the random effects model, hence, Hence, the Driscoll-Kraay standard errors are applied to the fixed effects model to address issues of cross-sectional dependence and heteroskedasticity.

Table 4.4
Regression Analysis Result for panel data Model 1

Variables	FEM	REM	DKFE
lnGTI	-0.0013 (0.0029)	-0.0031 (0.0025)	-0.0013 (0.0033)
lnGDP	0.0516 *** (0.0053)	0.0484 *** (0.0046)	0.0516 *** (0.0094)
lnPop	0.0517 (0.0446)	-0.0565 *** (0.0128)	0.0517 (0.0329)
lnTra	0.0736 *** (0.0276)	0.0538 ** (0.0232)	0.0736** (0.0609)
Cons	-1.7777 *** (0.2904)	-0.8243 *** (0.1514)	-1.7777 *** (0.4517)
N	420	420	420
R-sq	0.2540	0.2640	0.3802
F	60.72	172.28	35.55
corr	-0.9134	0	-
rho	0.8816	0.3513	-
Hausmen Test	145.30***		-

Notes: (*) significant at the 10 per cent level, (**) significant at the 5 per cent level, and (***) significant at the 1 per cent level. Figures in parentheses are standard error.

The variable lnGTI result indicates negatively not statistically significant effects on EC under fixed effect. The random effect model also presents insignificant negative effects on EC, where it is demonstrated that the increase of green technology innovation 1 per unit in Asian countries will cause the decrease of e-commerce by 0.0013 per cent but this relationship is not statistically strong. This study has similar

finding with Jia et al., (2022) that green innovation has negative relationship due to the lack of support on regulatory on digital economic and green growth that will may has limited impact. This implies that an increase in green technology innovation does not appear to have a significant impact on the e-commerce index. Driscoll-Kraay robustness tests showed that the regression results were consistent with the fixed effects model, and the regression coefficient of the explanatory variable $\ln GTI$ remained negative and not significant at the 1 per cent significance level, indicating that the fixed effects model regression results are robust and convincing (Hoechle, 2007).

Next, the $\ln GDP$ indicates that there are significant positive effects on EC at 1 per cent significant level under fixed effect and random effect model, where it demonstrates that based on fixed effect model, 1 per cent increase in per capita GDP will leads the Asian countries increase by 0.0516 per cent for EC. Specifically, this result shows that countries with higher economic output are more likely to have higher levels of e-commerce, which aligns with expectations that a stronger economy supports the growth of online business activities. Therefore, there are few study based on previous study that supporting this study such as Deljavan and Norouzi (2016) and Mansaray & Bin, (2016) also found positive relationship between EC with $\ln GDP$. This result demonstrating that higher economic output tends to promote growth in the e-commerce sector. This shows the importance of economic size for the growth of e-commerce. Due to heteroscedasticity, cross-sectional correlation, and sequence correlation in the panel data model, the Driscoll-Kraay approach was utilised for robustness testing. The regression findings were consistent with the fixed effects model, revealing that the fixed effects model regression results are robust and persuasive.

The $\ln Pop$ result indicates that there are not significant positive effects on EC under fixed effect, while for random effect model negative significant at 1 per cent level for EC at Asian countries indicating that population size does not have a clear relationship with e-commerce in these models. Where it demonstrates that based on fixed effect model, 1 per cent increase in per of population will cause the Asian countries increase by 0.0516 per cent. The results show that in the context of the random effects model, a higher population could be associated with a decrease in e-commerce activity. The negative relationship in the random effects model may suggest that other factors, such as urbanization or access to technology could offset

the effects of population size on e-commerce growth. The population size has a more complex relationship with the e-commerce index. For examples, China is the country with high populations people in Asian and in the world. Based on previous study also has positive significant result such as He and Wang (2019) that population has positive effect on cross-border e-commerce. This study confirm that cross border trade may has positive effect especially country with high population will give positive outcomes between two countries. In the fixed effects model, a 1 per cent increase in population would increase the e-commerce index by 0.0517 per cent, but in the random effect model, a 1 per cent increase in population would lead to a 0.0565 per cent decrease in the e-commerce index. This could indicate that, in some countries, larger populations may not always correlate with e-commerce growth. The reason for this could be that large populations may have lower individual purchasing power or more competition in the online marketplace, which could reduce e-commerce growth.

The lnTra show that there are significant positive effects on EC at 1 per cent significant level for fixed effect and random effect model at 5 per cent of significant level, where it demonstrates that based on fixed effect model, 1 per cent increase in per capita GDP will cause the Asian countries increase by 0.0736 per cent. This is consistent with the expectation that greater trade can lead to higher e-commerce activity, as countries that are more integrated into the global economy tend to have better access to international markets and e-commerce platforms. Based on previous study according to He and He (2021), that by using trade gravity model it found positive relationship between these variables and confirm that the trade will give advantages especially in South Asia. This result suggests that international trade plays an important role in boosting e-commerce, possibly by improving access to global markets and fostering competition. This shows that trade has a positive impact on the E-commerce index.

R-squared measures how well the model explains the variation in the dependent variable e-commerce. The Fixed Effect model has an R-squared of 0.254, which means 25.4 per cent of the variation in the E-commerce Index (EC) is explained by the variables in this model. Consistently, the Driscoll-Kraay Fixed Effect model has an R-squared of 0.3802 or 38 per cent, suggesting it explains an even larger proportion of the variation, accounting for heteroscedasticity and autocorrelation in the data. Besides, the The F-statistics for all models are statistically significant, confirming the overall validity of the estimations. Furthermore, the rho value under

the Fixed Effect model is relatively high at 0.8816, indicating that a large proportion of the total variance is attributed to cross-sectional differences among countries rather than within-country variations over time. This supports the suitability of using panel data estimation techniques that account for individual country heterogeneity.

In summary, the findings suggest that green technology innovation has yet to become a significant driver of economic complexity in Asian countries. On the other hand, the regression results consistently demonstrate that economic growth and trade openness are the primary drivers of economic complexity in Asian countries. Countries with higher GDP levels and stronger trade integration tend to possess more diversified and sophisticated economic structures. Meanwhile, population do not show consistent or statistically significant effects across models, indicating that these variables may not have a major direct impact on e-commerce in the context of this study.

Meanwhile, in model 2 for political stability index variable included in this table 4.5. Similarly, based on the Hausman test results, the fixed effects model is deemed more appropriate than the random effects model, hence, the Driscoll-Kraay standard errors are applied to the fixed effects model to address issues of cross-sectional dependence and heteroskedasticity.

The coefficient value of lnGTI result of the fixed effect model presents positive but insignificant effects on e-commerce where it is demonstrated that the increase of green technology innovation 1 per unit in Asian countries will cause the increase of e-commerce by 0.0013 per cent. Driscoll-Kraay robustness tests showed that the regression results were consistent with the fixed effects model, and the regression coefficient of the explanatory variable lnGTI remained negative and not significant at the 1 per cent significance level, indicating that the fixed effects model regression results are robust and convincing.

Table 4.5
Regression Analysis Result for panel data Model 2

Variables	FEM	REM	DKFE
lnGTI	0.0013 (0.0029)	-0.0034 (0.0025)	0.0013 (0.0022)
PSI	0.0229 *** (0.0056)	0.0105 ** (0.0051)	0.0229 ** (0.0083)
lnGDP	0.0482 *** (0.0053)	0.0452 *** (0.0046)	0.0482 *** (0.0073)
lnPop	0.0652 (0.0439)	-0.044 *** (0.0135)	0.0652 (0.0381)
lnTra	0.0993 *** (0.0278)	0.0543 ** (0.0229)	0.0993 (0.0679)
cons	-1.8421 *** (0.2852)	-0.8297 *** (0.1496)	-1.842 *** (0.4641)
N	420	420	420
R-sq	0.0520	0.1791	0.4056
F	53.90	171.61	79.20
corr	-0.9183	0	-
rho	0.8895	0.3154	-
Hausman Test	145.30***		-

Notes: (*) significant at the 10 per cent level, (**) significant at the 5 per cent level, and (***) significant at the 1 per cent level. Figures in parentheses are standard error.

The coefficient value for Political Stability Index (PSI) is positive across all results, and it is statistically significant at the 1 per cent level in the fixed effect

regression result with the coefficient value for fixed effect 0.0229 and at the 5 per cent level in the random effect and Driscoll-Kraay Fixed Effect models with the coefficient value for Random Effect 0.0105 and Driscoll-Kraay Fixed Effect 0.0229. This result indicates that political stability significantly contributes to the growth of e-commerce, where the increase of PSI by 1 per cent EC will increase by 0.0229 per cent in Asian countries. In other words, countries with higher political stability tend to have higher e-commerce development. The method Driscoll-Kraay also used to test the robust result due to heteroscedasticity, cross-sectional correlation, and sequence correlation in the panel data model, the Driscoll-Kraay approach was utilised for robustness testing. The regression findings were not consistent with the fixed effects model, revealing that the fixed effects model regression results are robust and persuasive.

Meanwhile, the result for lnGDP show that there are significant positive effects on EC at 1 per cent significant level under fixed effect and random effect model, where it demonstrates that based on fixed effect model, 1 per cent increase in per capita GDP will lead the Asian countries increase by 0.0482 per cent for EC in Asian. Due to heteroscedasticity, cross-sectional correlation, and sequence correlation in the panel data model, the Driscoll-Kraay approach was utilised for robustness testing. The regression findings were consistent with the fixed effects model, revealing that the fixed effects model regression results are robust and persuasive.

The lnPop result indicates that there are positively not significant effects on EC under fixed effect, while for random effect model negative significant at 1 per cent level for EC at Asian countries. Where it demonstrates that based on fixed effect model, 1 per cent increase in per of population will cause the Asian countries increase by 0.0652 per cent in country. Hence, due to heteroscedasticity, cross-sectional correlation, and sequence correlation in the panel data model, the Driscoll-Kraay approach was utilised for robustness testing. The regression findings were consistent with the fixed effects model, revealing that the fixed effects model regression results are robust and persuasive.

The lnTra show that there are significant positive effects on EC at 1 per cent significant level for fixed effect and random effect model at 5 per cent of significant level, where it demonstrates that based on fixed effect model if 1 per cent increase in per capita GDP will cause the Asian countries increase by 0.0736 per cent. The method Driscoll-Kraay also used to test the robust result due to heteroscedasticity, cross-sectional correlation, and sequence correlation in the panel data model, the

Driscoll-Kraay approach was utilised for robustness testing. The regression findings were not consistent with the fixed effects model, revealing that the fixed effects model regression results are robust and persuasive.

R-squared values are low in the fixed effects model 0.0520, indicating that the model does not explain much of the variation in e-commerce. However, the RE model has a higher R-squared 0.1791, suggesting that random effects account for more variation in e-commerce. The Driscoll-Kraay Fixed Effects model has the highest R-squared 0.4056, indicating that it explains a greater proportion of the variation in e-commerce, making it the best-fitting model. The F-statistics are high in all models, with values of 53.90 for Fixed Effect, 171.61 Random Effect and 79.20 Driscoll-Kraay. This result indicates that the models are statistically significant overall.

The correlation between the residuals of the model is -0.9183 in the Fixed Effect model, suggesting high correlation between country-level errors, while Random effect has no correlation. The rho value indicates the proportion of the variance explained by country-specific factors. Fixed Effect has a high rho of 0.8895 found that country-specific effects are highly important in explaining e-commerce in variation. In contrast, the Random Effect model has a lower rho of 0.3154, indicating that random effects play a smaller role.

Overall, the findings indicate that green technology innovation has not yet become a significant driver of economic complexity among Asian economies, possibly due to limited technological diffusion, weak industrial integration, and insufficient innovation capacity. In contrast, political stability emerges as a crucial determinant of economic complexity, highlighting the importance of strong institutions, governance quality, and stable policy environments in supporting industrial sophistication and structural transformation.

In comparison, Model 1 shows that the relationship between green technology innovation (lnGTI) and economic complexity is negative and statistically insignificant. However, in Model 2, the coefficient of lnGTI becomes positive, although it remains statistically insignificant across all estimation models. This finding indicates that the inclusion of the Political Stability Index (PSI) in Model 2 slightly changes the direction of the relationship between green technology innovation and economic complexity, but the effect of green technology innovation remains weak and insignificant. The result suggests that green technology innovation has not yet

become a major driver of economic complexity among Asian countries during the study period.

The population variable shows varying results across the two models. In Model 1, the results further indicate that population size (lnPop) produces mixed effects across the models. In Model 1, population has a statistically significant negative effect, suggesting that larger populations may reduce e-commerce growth if not accompanied by sufficient technological capability, infrastructure development, and purchasing power. However, in Model 2, after the inclusion of the Political Stability Index (PSI), the relationship between population and e-commerce becomes positive in the Fixed Effect model, although it remains statistically insignificant in both the Random Effect and Driscoll–Kraay Fixed Effect models. This inconsistency suggests that the role of population in influencing e-commerce growth is complex and may depend on broader institutional and economic conditions, particularly political stability. A larger population alone does not necessarily translate into higher e-commerce activity unless supported by stable governance, digital infrastructure, and improved market efficiency.

Meanwhile, trade openness (lnTra) continues to demonstrate a positive and statistically significant impact on e-commerce across both Model 1 and Model 2. The coefficient is slightly larger in Model 2, particularly in the Fixed Effect and Driscoll–Kraay Fixed Effect estimations. This finding indicates that trade becomes a stronger determinant of e-commerce growth when political stability is included in the model. The result suggests that politically stable environments enhance the effectiveness of trade by improving market confidence, facilitating cross-border transactions, and supporting international commercial integration. Greater trade openness enables countries to access larger markets, advanced technologies, and global digital platforms, which collectively contribute to the expansion of e-commerce activities.

In terms of overall model performance, Model 2 generally provides a better fit compared to Model 1. This improvement is reflected in the higher R-squared values and F-statistics across all estimations after the inclusion of PSI. Specifically, the R-squared values in Model 2 increase to 0.0520 for the Fixed Effect model and 0.4056 for the Driscoll–Kraay Fixed Effect model, indicating stronger explanatory power. The F-statistics also remain relatively high, particularly in the Driscoll–Kraay Fixed Effect model with a value of 79.20, confirming that Model 2 offers a more robust estimation framework.

Overall, the analysis shows that political stability (PSI) has a positive and statistically significant effect on e-commerce growth in Asian countries, while Green Technology Innovation (lnGTI) does not exhibit a strong significant impact. The inclusion of PSI improves the explanatory power of the model and highlights the crucial role of institutional stability in fostering e-commerce development. Additionally, GDP and trade openness remain consistently positive and significant determinants across both models, indicating that economic growth and international trade are key drivers of e-commerce expansion in the region. These findings suggest that economic and institutional factors are more important in driving e-commerce growth than green technology innovation or population size in the sampled Asian economies.

4.5 Other Diagnostic Test Results

This section will explain the result for other diagnostic regression result such as Heteroscedasticity, Breusch-Pagan LM, Pesaran CD, Correlation Analysis, Ramsey Reset Test and Multicollinearity.

Table 4.6
Heteroscedasticity Test for Model 1 and Model 2.

Modified Wald test for group-wise heteroskedasticity in fixed effect model		
Model 1	chi2 (20) =	13990.26; Prob>chi2 = 0.0000
Model 2	chi2 (20) =	13829.37; Prob>chi2 = 0.0000

Note: The modified Wald test respectively for group-wise heteroskedasticity

Table 4.6 presents the results of the Modified Wald test for group-wise heteroskedasticity in the fixed effects regression models for both Model 1 and Model 2. The null hypothesis of this test assumes homoskedasticity, meaning that the error variances are constant across cross-sectional units ($\sigma_i^2 = \sigma^2$ for all i).

The results show that both models strongly reject the null hypothesis of homoskedasticity. In Model 1, the chi-square statistic is 13,990.26 with a p-value of 0.0000, while in Model 2, the chi-square statistic is 13,829.37 with a p-value of 0.0000. Since the p-values are statistically significant at the 1 percent level, this indicates the presence of group-wise heteroskedasticity in both models.

The existence of heteroskedasticity suggests that the variance of the error terms differs across countries in the panel dataset. This implies that the variability of economic relationships is not constant across cross-sectional units, which is a common issue in macro-panel data involving heterogeneous economies such as those in Asia. If not properly addressed, heteroskedasticity may lead to inefficient estimates and biased standard errors, potentially affecting statistical inference. Therefore, the results justify the use of robust estimation techniques, such as the Driscoll-Kraay standard errors, which are employed in this study to correct for heteroskedasticity as well as potential cross-sectional dependence and autocorrelation. Overall, the findings confirm that both Model 1 and Model 2 are subject to heteroskedasticity, reinforcing the need for robust panel estimation methods in the empirical analysis.

Next, table 4.7 presents the results of the Breusch–Pagan Lagrange Multiplier (LM) test for cross-sectional dependence in the fixed effects models for both Model 1 and Model 2. The null hypothesis of this test assumes cross-sectional independence, meaning that the residuals across countries are not correlated.

Table 4.7

Breusch-Pagan LM Test Fixed Effect for Model 1 and Model 2.

Breusch-Pagan LM test of independence: Based on 21 complete observations over panel units	
Model 1	chi2(190) = 1532.196, Pr = 0.0000
Model 2	chi2(190) = 1339.082, Pr = 0.0000

The results strongly reject the null hypothesis for both models. In Model 1, the chi-square statistic is 1532.196 with a p-value of 0.0000, while in Model 2, the chi-square statistic is 1339.082 with a p-value of 0.0000. Since both p-values are statistically significant at the 1 percent level, this confirms the presence of cross-sectional dependence in the panel data for both models.

The existence of cross-sectional dependence suggests that economic shocks or unobserved factors affecting one country are likely to be correlated with those affecting other countries in the sample. This is a common characteristic in macro-panel datasets, particularly when countries are economically interconnected through trade, investment, and regional integration. For example, global financial conditions,

regional policy spillovers, or common technological trends may simultaneously influence multiple economies.

The presence of cross-sectional dependence has important econometric implications, as it violates the assumption of independence across cross-sectional units and may lead to biased standard errors if not properly addressed. Cross-sectional dependence could arise due to common shocks or shared factors across countries that are not captured in this model. Therefore, the results justify the use of estimation techniques that are robust to cross-sectional dependence, such as the Driscoll–Kraay standard error approach applied in this study.

Overall, the findings confirm that both Model 1 and Model 2 are subject to significant cross-sectional dependence, indicated that unobserved factors affecting e-commerce in one country may also be affecting other countries. It is essential to address this issue in the model to avoid biased results and improve the reliability of the study conclusions. This highlighting the importance of using robust panel data methods to ensure reliable and consistent empirical results.

Table 4.8 presents the results of the Pesaran Cross-Sectional Dependence (CD) test for the Fixed Effects regression models in both Model 1 and Model 2. The test is used to examine whether residuals across cross-sectional units (countries) are independent or correlated. The null hypothesis of the Pesaran CD test assumes cross-sectional independence. However, the results strongly reject this hypothesis for both models, as indicated by the statistically significant p-values of 0.0000. In Model 1, the Pesaran CD statistic is 6.361, while in Model 2 it is 3.955, both confirming the presence of cross-sectional dependence.

Table 4.8
Pesaran CD Test Fixed Effect

Regression	Pesaran CD	Average value of off-diagonal	P-value
Model 1	6.361	0.544	0.0000
Model 2	3.955	0.508	0.0000

The positive CD statistics suggest that there is a moderate degree of correlation among the residuals across countries. This implies that economic shocks or unobserved factors affecting one country are likely to spill over to other countries

within the panel. Such interdependence is common in macroeconomic panel data, especially in studies involving economically integrated regions such as Asia, where countries are linked through trade, investment flows, financial markets, and shared exposure to global economic conditions.

The average values of off-diagonal elements, 0.544 for Model 1 and 0.508 for Model 2, further confirm the existence of positive cross-sectional correlation among the panel units. Although the degree of dependence is slightly lower in Model 2, it remains substantial, indicating that inter-country linkages persist even after the inclusion of additional explanatory variables such as political stability.

Overall, the results of the Pesaran CD test reinforce the findings from the Breusch-Pagan LM test, confirming that cross-sectional dependence is present in both models. This highlights the importance of employing econometric techniques that account for such dependence, such as Driscoll–Kraay standard errors, to ensure robust and reliable inference in the empirical analysis.

Meanwhile, Table 4.9 presents the correlation analysis results for Model 1 and Model 2, examining the pairwise relationships among economic complexity (EC), green technology innovation (lnGTI), political stability index (PSI), economic growth (lnGDP), population (lnPop), and trade openness (lnTra). The correlation matrix provides an initial indication of the direction and strength of linear relationships among the variables, which is useful for assessing potential multicollinearity issues and understanding the basic associations in the data.

Table 4.9
Correlation Analysis Model 1 and Model 2

Variables	EC	lnGTI	PSI	lnGDP	lnPop	lnTra
EC	1.0000					
lnGTI	0.2436	1.0000				
PSI	0.3848	0.2294	1.0000			
lnGDP	0.2156	0.8447	0.0014	1.0000		
lnPop	-0.1086	0.5202	-0.5203	0.7045	1.0000	
lnTra	0.1525	-0.1284	0.4932	-0.3865	-0.6578	1.0000

The results show that economic complexity (EC) has a positive correlation with most explanatory variables, except population (lnPop), which shows a weak negative correlation of -0.1086 . In particular, EC is positively correlated with political stability (PSI) at 0.3848 , suggesting that countries with higher political stability tend to exhibit higher levels of economic complexity. Similarly, EC is positively correlated with green technology innovation (lnGTI) at 0.2436 , GDP at 0.2156 , and trade openness (lnTra) at 0.1525 . These positive correlations indicate that improvements in institutional quality, innovation, economic scale, and trade integration are generally associated with higher economic complexity.

For the relationship among independent variables, lnGTI shows a strong positive correlation with lnGDP (0.8447), indicating that countries with higher income levels tend to invest more in green technology innovation. However, lnGTI has relatively weak correlations with PSI (0.2294) and a negative correlation with trade openness (-0.1284), suggesting that green innovation does not strongly move together with trade openness in the sample.

Political stability (PSI) shows a moderate positive correlation with trade openness (0.4932), implying that more stable countries tend to be more open to international trade. However, PSI is negatively correlated with population (-0.5203), suggesting that more populous countries in the sample tend to experience lower levels of political stability, which may reflect governance challenges in larger economies.

GDP (lnGDP) is positively correlated with population (0.7045), indicating that

larger economies tend to have larger populations, which is expected in macroeconomic contexts. However, GDP shows a negative correlation with trade openness (-0.3865), suggesting that more economically advanced countries in the sample may rely relatively less on trade intensity compared to smaller economies that depend more on external markets. Population ($\ln\text{Pop}$) is negatively correlated with trade openness (-0.6578), indicating that more populous countries tend to be less trade-dependent, possibly due to larger domestic markets reducing reliance on international trade.

Overall, the correlation matrix does not indicate severe multicollinearity concerns, although the relatively high correlation between $\ln\text{GTI}$ and $\ln\text{GDP}$ (0.8447) suggests that some caution is needed in interpreting their joint effects in regression analysis. Nevertheless, the relationships generally remain within acceptable ranges for panel data estimation. The findings also provide preliminary support for the empirical model, particularly the positive associations between economic complexity and key variables such as political stability, green technology innovation, GDP, and trade.

The test follows by Ramsey RESET as presented in Table 4.10 in both Model 1 and Model 2. The test is used to examine whether the regression models suffer from omitted variable bias or functional form misspecification.

Table 4.10
Ramsey RESET result analysis for fixed effect

Ramsey RESET test using powers of the fitted values of EC.	
Model 1	$F(3, 412) = 6.18$
	$\text{Prob} > F = 0.0004$
Model 2	$F(3, 411) = 0.63$
	$\text{Prob} > F = 0.5930$

The Ramsey RESET test is being used to check if there are any omitted variables in the model, with the null hypothesis Ramsey RESET test using powers of the fitted values of EC H_0 : model has no omitted variables for model 1. In Model 1, the Ramsey RESET test gives an F-statistic of 6.18, with a p-value of 0.0004. This result is statistically significant because the p-value is less than 0.05, indicating that

there might be omitted variables or model specification errors.

The Ramsey RESET test checks for omitted variable bias by testing whether higher powers of the fitted values are significant predictors of the dependent variable, E-commerce activity (EC). The null hypotheses in the model show that it has no omitted variables. Since the p-value is 0.0004, which is less than the threshold of 0.05, we reject the null hypothesis. This result suggests that there may be omitted variables or that the model's functional form is mis specified. The model might need further refinement to account for variables that have been excluded but could significantly affect the dependent variable (EC).

In Model 2, the F-statistic is 0.63, and the p-value is 0.5930. This p-value is greater than 0.05, indicating that there is no significant evidence to reject the null hypothesis. The result confirms that the hypotheses fail to reject the null hypothesis, suggesting that there is no strong evidence of omitted variable bias in the model. This implies that the variables included in the model sufficiently explain the relationship between E-commerce activity, Green Technology Innovation, Political Stability, and the control variables. The Ramsey RESET test results show that the model does not suffer from omitted variable bias, indicating that the included predictors such as Green Technology Innovation, Political Stability, GDP, Population, and Trade capture the key determinants of E-commerce activity in Asian countries adequately. Therefore, Model 2 does not show significant omitted variable bias, and the model specification seems to be appropriate without the need for additional variables. Based on Ramsey RESET test model 2 results on the provided information on regression analysis result, if p-value < 0.05 means no misspecification in the functional form or omitted variables. The model has no omitted variables indicating that the functional form is correct.

Model 1 likely has some specification errors, with omitted variables or incorrect functional forms that could be influencing the e-commerce index (EC). This could suggest that further improvements or adjustments are needed in the model, such as incorporating additional variables or exploring different functional forms. Model 2, however, shows no signs of specification errors. The absence of omitted variables is suggested, and the model appears to be properly specified. Based on the Ramsey RESET test results, it is clear that Model 1 requires additional adjustments due to potential model specification issues, while Model 2 appears well-specified and does not need further modifications. The inclusion of appropriate control variables like

lnGDP, lnPop, lnTra, and PSI, as well as independent variables like lnGTI, has likely contributed to the stability of Model 2. For Model 1, further investigation into omitted variables or model structure is necessary to improve its fit and accuracy.

To conclude, the analysis of the Ramsey RESET test indicates that the model may not adequately capture all relevant relationships, that some important variables might be missing or that the specified model form could be incorrect. This finding implies that further investigation is needed to refine the model, potentially by including additional variables or reconsidering the functional form to better represent the relationship between e-commerce and green technology innovation. In summary, the results of the Ramsey RESET test indicate potential issues with omitted variables or model specification, highlighting the need for model refinement.

Subsequently, Table 4.12 presents the results of the Variance Inflation Factor (VIF) test for Model 1, which is used to detect the presence of multicollinearity among the explanatory variables. Multicollinearity refers to a situation where independent variables are highly correlated, which may distort the reliability and stability of coefficient estimates in regression analysis

Table 4.11
Variance Inflation Factor (VIF) Model 1

Variable	VIF centered	1/VIF	VIF uncentered	1/VIF
Intercept Means				
lnGTI	1.00	1.0000	2.75	0.363490
lnGDP	1.00	1.0000	225.76	0.004429
lnPop	1.00	1.0000	104.52	0.009568
lnTra	1.00	1.0000	47.92	0.020870
Means				

The Variance Inflation Factor (VIF) table for Model 1 provides important insights into potential multicollinearity issues among the explanatory variables. Multicollinearity refers to the degree of correlation between independent variables in a

regression model, which can inflate standard errors and affect the reliability of the estimated coefficients. The centered VIF values for all variables in Model 1 are 1.00, indicating that there is no significant multicollinearity when the variables are centered. This suggests that the variables are not highly correlated with each other in the regression model, ensuring that the estimated coefficients are stable and interpretable.

Hence, the uncentered VIF values, however, show much higher values for some variables, particularly $\ln\text{GDP}$ (225.76), $\ln\text{Pop}$ (104.52), and $\ln\text{Tra}$ (47.92). These higher uncentered VIF values indicate potential multicollinearity problems, especially with $\ln\text{GDP}$, suggesting that these variables are highly correlated with each other when the mean is not subtracted, which could inflate the variance of the estimated coefficients. The VIF for $\ln\text{GTI}$ is relatively low (2.75), indicating less concern for multicollinearity in this variable. Thus, the $1/\text{VIF}$ values provide the inverse of the VIF and show the potential for more reliable coefficient estimates. As the $1/\text{VIF}$ value decreases, the likelihood of multicollinearity increases, which aligns with the high uncentered VIF values for $\ln\text{GDP}$, $\ln\text{Pop}$, and $\ln\text{Tra}$.

In conclusion, while the centered VIF values suggest no significant multicollinearity, the high uncentered VIF values for $\ln\text{GDP}$, $\ln\text{Pop}$, and $\ln\text{Tra}$ signal that these variables are potentially highly correlated when not adjusted for their means. This issue could affect the stability of the regression model's coefficients and suggest the need for further diagnostic checks or potential transformations to mitigate multicollinearity, ensuring the robustness and reliability of the regression results in this thesis.

The Variance Inflation Factor (VIF) table for Model 2 provides further insights into the potential multicollinearity issues, now including the additional variable PSI (Political Stability Index) alongside the variables from Model 1. The centered VIF for all variables in Model 2 is 1.00, indicating no significant multicollinearity when the variables are centered. This suggests that the variables do not exhibit high correlation with one another, which is beneficial for the stability and interpretation of the estimated coefficients in the regression model. Therefore, the uncentered VIF for $\ln\text{GTI}$ remains 2.75, which is consistent with the VIF in Model 1 and indicates that there is little concern about multicollinearity for this variable. The VIF for PSI is 1.12, which is much lower than the VIF for other variables. This suggests that PSI does not experience significant multicollinearity, making it a useful addition to the model. The VIFs for $\ln\text{GDP}$ (225.76), $\ln\text{Pop}$ (104.52), and $\ln\text{Tra}$ (47.92) remain very high,

indicating that these variables are highly correlated with other predictors in the model, particularly when the mean is not subtracted.

These high uncentered VIF values signal potential multicollinearity concerns, particularly for $\ln\text{GDP}$, which has the highest uncentered VIF. The $1/\text{VIF}$ values for the variables in Model 2 show a similar trend to the uncentered VIFs. The low $1/\text{VIF}$ for PSI (0.891899) supports the observation that this variable is not contributing significantly to multicollinearity. However, for $\ln\text{GDP}$, $\ln\text{Pop}$, and $\ln\text{Tra}$, the low $1/\text{VIF}$ values suggest that multicollinearity may still be present, especially with $\ln\text{GDP}$, which has the lowest $1/\text{VIF}$ value (0.004429). This suggests that these variables could inflate the standard errors of the model's coefficients, affecting the model reliability and interpretation.

Table 4.12
Variance Inflation Factor (VIF) Model 2

Variable	VIF centered	1/VIF	VIF uncentered	1/VIF
Intercept Means				
$\ln\text{GTI}$	1.00	1.000	2.75	0.363490
PSI	1.00	1.000	1.12	0.891899
$\ln\text{GDP}$	1.00	1.000	225.76	0.004429
$\ln\text{Pop}$	1.00	1.000	104.52	0.009568
$\ln\text{Tra}$	1.00	1.000	47.92	0.020870
Means				

In summary, model 2 includes PSI , which does not show multicollinearity based on the VIF results. However, the high uncentered VIFs for $\ln\text{GDP}$, $\ln\text{Pop}$, and $\ln\text{Tra}$ raise concerns about multicollinearity in these variables. Despite the centered VIF values indicating no severe multicollinearity, the uncentered VIF values suggest that the relationships between these variables could be problematic. It may be necessary to consider potential adjustments, such as variable transformation or using

principal component analysis (PCA) to address the multicollinearity issue for more reliable regression results.

When comparing Model 1 and Model 2 in terms of their Variance Inflation Factor (VIF) results, a few key differences emerge that are important for interpreting multicollinearity in the regression analysis. Both models have centered VIF values of 1.00 for all variables, suggesting that, when adjusted for their means, there is no significant multicollinearity within the models. This indicates that the independent variables in both models are not highly correlated with each other, making the coefficients stable and interpretable.

However, the uncentered VIF values reveal notable differences between the two models. In Model 1, variables such as $\ln\text{GDP}$, $\ln\text{Pop}$, and $\ln\text{Tra}$ exhibit extremely high uncentered VIFs, with $\ln\text{GDP}$ reaching 225.76, $\ln\text{Pop}$ at 104.52, and $\ln\text{Tra}$ at 47.92. These values indicate a strong correlation between these variables, which may lead to multicollinearity issues, potentially inflating the standard errors of the model's coefficients and distorting the results. In Model 2, the introduction of PSI (Political Stability Index) provides additional context for the analysis. The VIF for PSI is relatively low at 1.12, suggesting that this new variable does not contribute to multicollinearity concerns. However, despite the inclusion of PSI, the high VIF for $\ln\text{GDP}$, $\ln\text{Pop}$, and $\ln\text{Tra}$ persist in Model 2, with $\ln\text{GDP}$ still showing a problematic uncentered VIF of 225.76. This suggests that the core issue of multicollinearity remains with these variables, even after adding PSI.

The key takeaway from comparing these two models is that while both models show no multicollinearity when the variables are centered, the uncentered VIFs highlight a potential issue with the correlation between $\ln\text{GDP}$, $\ln\text{Pop}$, and $\ln\text{Tra}$ in both models. The addition of PSI in Model 2 does not alleviate this issue, but it does help clarify the potential role of political stability in the analysis, with the VIF for PSI being low and not contributing to multicollinearity. To improve the models' reliability, further steps may be needed to address the high uncentered VIF for the core economic and demographic variables, possibly through variable transformations or other methods to reduce multicollinearity.

4.6 Summary

This chapter presents a comprehensive empirical analysis examining the determinants of economic complexity across selected Asian countries, with a particular focus on green technology innovation, political stability index, economic growth, population, and trade. The analysis is conducted using panel data estimation techniques, including Fixed Effects, Random Effects, and Driscoll–Kraay standard errors, alongside a series of diagnostic and robustness tests to ensure the reliability of the results.

The main regression results indicate that green technology innovation (LnGTI) consistently shows an insignificant relationship with economic complexity across all models. Although the sign of the coefficient varies slightly between models, the overall evidence suggests that green innovation has not yet translated into measurable improvements in economic complexity within the sampled countries. This may be due to the early stage of green technology adoption, limited diffusion across sectors, and weak integration into broader industrial structures.

In contrast, political stability (PSI) emerges as a strong and robust determinant of economic complexity. Across all models, PSI is positive and statistically significant, indicating that stable political environments enhance economic complexity by improving governance quality, strengthening investor confidence, and supporting long-term structural transformation. The inclusion of PSI in Model 2 also improves overall model performance and explanatory power.

Economic growth (LnGDP) and trade (LnTra) are consistently positive and statistically significant, indicating that larger and more open economies tend to achieve higher economic complexity. This highlights the importance of economic scale and international integration in supporting structural transformation and export sophistication. In contrast, population (LnPop) shows mixed and a has negative effect, suggesting that population size alone does not enhance economic complexity unless supported by improvements in productivity, human capital, and institutional quality.

Based on the diagnostic test results, there is a clear and strong need for robustness in the empirical estimation to ensure reliable and unbiased inference. First, the Modified Wald test confirms the presence of group-wise heteroskedasticity in both Model 1 and Model 2, indicating that the error variances are not constant across countries. This violates one of the classical regression assumptions and implies that

standard errors from conventional Fixed Effect estimations may be inefficient. Second, both the Breusch–Pagan LM test and the Pesaran CD test strongly reject the null hypothesis of cross-sectional independence. This shows that there is significant cross-sectional dependence among countries, meaning that economic shocks and unobserved factors are correlated across units. In macro-panel settings such as this study, this is a common issue due to global spillovers, regional integration, and shared macroeconomic shocks. Third, the Ramsey RESET test indicates that Model 1 suffers from potential specification problems, including omitted variables or incorrect functional form, while Model 2 is correctly specified. This suggests that model specification improves when Political Stability (PSI) is included. Fourth, the VIF results show no serious multicollinearity problem in the centered Fixed Effect estimation, confirming that the regression is not strongly linearly dependent and that coefficient estimates remain stable.

Given these diagnostic findings, the use of robustness techniques is essential. In particular, the application of Driscoll–Kraay standard errors is appropriate because it corrects for heteroskedasticity, autocorrelation, and cross-sectional dependence simultaneously. This ensures that the estimated coefficients remain reliable even when classical assumptions are violated. Overall, the diagnostic tests strongly justify the need for robust estimation methods, and they support the study’s approach of using Driscoll–Kraay Fixed Effect estimation as a more reliable specification for inference.

CHAPTER 5

CONCLUSION

5.1 Introduction

The primary objective of this study was to investigate the influence of green technology innovation (lnGTI) and political stability index (PSI) on e-commerce (EC) development in selected Asian countries. It also aimed to assess how control variables, such as GDP (lnGDP), population (lnPop), and trade (lnTra), contribute to e-commerce growth. Two models were developed: Model 1 explores the impact of green technology innovation on e-commerce, with GDP, population, and trade as control variables while model 2 adds political stability (PSI) as an independent variable to the analysis, expanding the scope to consider how political environments influence e-commerce.

This study focused on providing actionable insights into the interplay of innovation, political conditions, and economic factors, ultimately aiming to guide policymakers and industry leaders in fostering e-commerce development. The methodology and scope of this study employed to panel data regression analysis covering 20 Asian countries over 21 years 2000 to 2020. The methodology involved the following key components such as Unit Root Tests to ensure data stationarity IPS and LLC tests were conducted for both models. Other diagnostic tests has various tests were applied to confirm the robustness and reliability of the models, including, Heteroskedasticity Tests, Breusch-Pagan LM tests were used to check for variance inconsistency across countries. The cross-sectional dependence such as Pesaran CD test to identified correlations among countries and serial correlation issues. The Ramsey test has verified whether the model was correctly specified and free of omitted variable bias. Lastly, multicollinearity was assessed to ensure that independent variables were not highly correlated, using VIF analysis to confirm the absence of significant multicollinearity issues.

The model also adopted Hausman select between Fixed Effect and Random Effect models. Additionally, Driscoll and Kraay standard errors were applied to address cross-sectional and serial dependence issues. This chapter is divided into the following sections such as conclusions to synthesize key findings from the analysis in

Chapter 4, emphasizing the impact of green technology innovation, political stability, and control variables on e-commerce. This section will highlight the relationships revealed by fixed and random effects models and discuss the broader implications for e-commerce development in Asia.

The policy implications and recommendations offer actionable strategies for governments and stakeholders, focusing on promoting innovation, enhancing political stability, and addressing economic factors to foster e-commerce growth. While, limitations of this study discuss the challenges such as data availability, potential biases in the analysis, and the generalizability of results beyond Asian countries. The direction for future researchers suggests avenues for further research, including expanding the scope to other regions, incorporating more variables an example digital infrastructure and employing alternative methodologies like dynamic panel models or machine learning techniques.

This chapter presents the overall conclusion of the study by summarizing the key findings related to green technology innovation and political stability index and their effects on e-commerce in Asian countries. The study's significance is discussed in relation to its contributions to policy-making and academic literature, followed by an acknowledgment of its limitations and recommendations for future research.

5.2 Summary of Findings

This study investigates the relationship between green technology innovation, political stability and e-commerce using panel data analysis. The key findings reveal how these factors contribute to the regions of digital e-commerce landscape. This study aimed to examine how green technology innovation and political stability influence e-commerce in Asian countries. The research was guided by three hypotheses: green technology innovation positively influences e-commerce, political stability positively influences e-commerce and control variable for GDP, trade and population has positively influence e-commerce.

5.2.1 The Green Technology Innovation and E-Commerce in Asian Countries

The results for green technology innovation indicate mixed but statistically insignificant effects on e-commerce across the two models. In Model 1, green technology innovation shows a negative relationship with e-commerce, whereas in

Model 2, the coefficient turns positive after the inclusion of the Political Stability Index (PSI). However, in both specifications, the relationship remains statistically insignificant. This suggests that green technology innovation does not have a robust or consistent impact on e-commerce development in the sampled countries.

Overall, the findings imply that the hypothesis regarding green technology innovation is not supported. While the direction of the effect changes between models, neither result is statistically significant, indicating weak empirical evidence of a meaningful relationship between green technology innovation and e-commerce. This inconsistency across models suggests that the influence of green innovation on e-commerce may be context-dependent and sensitive to model specification, particularly when institutional factors such as political stability are included.

These results contrast with several previous studies that have reported a positive relationship between green technology innovation and e-commerce or digital economic development. For instance, Mu et al. (2021), Islam et al. (2022), Wang et al. (2021), Yu et al. (2023), and Paun et al. (2024) find that green innovation positively contributes to digital transformation and e-commerce expansion. In particular, Paun et al. (2024), using data from 133 countries between 2014 and 2020, highlights that technological advancement, including green innovation, plays a significant role in shaping e-commerce adoption and economic development. Similarly, Yu et al. (2023) emphasizes that green technology innovation enhances marketization processes and strengthens human capital development, which indirectly supports digital economic activities.

However, the findings of this study suggest that in the selected Asian countries, green technology innovation has not yet translated into measurable gains in e-commerce activity. This may reflect differences in development stages, limited diffusion of green technologies, or weaker integration between environmental innovation and digital market structures.

Several factors may explain these findings. First, while green innovation is crucial for broader environmental goals, its immediate impact on e-commerce development may be limited without supportive infrastructure, market incentives, and integrated regulatory frameworks (Roszko *et al.*, 2024). Without these enabling conditions, e-commerce platforms may struggle to integrate sustainable technologies effectively, resulting in minimal short-term influence on digital trade performance despite long-term environmental benefits. Secondly, consumer awareness and demand

for environmentally friendly products and practices may still be relatively underdeveloped in many parts of Asia, which reduces market pressure on firms to adopt sustainable technologies. In addition, green technologies are often associated with more expensive goods and higher production costs, which can make environmentally friendly products less competitive in price-sensitive markets. As a result, both firms and consumers may prioritise affordability over sustainability, limiting the adoption of green innovation and reducing its measurable impact on e-commerce development.

Thirdly, while green technology innovation may enhance operational efficiency, reduce carbon footprints, and promote sustainability, its adoption within the e-commerce sector remains limited. This is often due to high production costs, a lack of specialized infrastructure, and limited regulatory pressure, especially in Asian countries. Without strong institutional support or consumer-driven demand, many e-commerce businesses prioritize short-term profitability over long-term environmental commitments

5.2.2 Political Stability Index and E-Commerce in Asia Countries

The regression results finding for political stability on e-commerce have a positive relationship and have significant effect on e-commerce. These results highlight the critical role of governance in shaping the digital economy, with political stability being a stronger determinant of e-commerce success than green technology innovation. The hypothesis 2 for political stability has a positive influence on e-commerce and has similar expectation on the result on the regression on the effect of e-commerce. Meanwhile, model 2 adds the element of political stability, which shows a consistent and significant positive relationship with e-commerce development. Political stability plays an important role in creating a good environment for economic and e-commerce growth.

The previous study has found the finding that political stability has positive effect on e-commerce such as Palladan & Adamu (2019), Wei, T., (2024), Mia et al., (2024) while Yang & Xu (2022) and Ouedraogo et al., (2020) found that political stability has negative effect on e-commerce sector. Liu (2018) found that China e-commerce sector thrived due to institutional outsourcing, where private e-commerce platforms were entrusted with certain regulatory functions as strategy that not only

stimulated economic growth but also reinforced political stability. Mia et al., (2024) has explores the determinants of digitalization in the context of Asia and the Pacific countries to understand the macroeconomic and governance factors driving digital growth, the study uses unbalanced panel data from 46 countries in the Asia-Pacific region spanning the years 2001 to 2021. This study found that political stability is an important factor, with strong and progressive governments more likely to give priority to funding for online platforms and internet access.

The unstable political country may give an effect on the country where deterring investors from contributing to development of high rate of corruption country or high instability of the political country. Ouedraogo et al., (2020) study the performance in country using the data from for 2016 and found that the instability of political in the country may give negative effect on the business performance in country. Conversely, political instability, policy uncertainties, or corruption can discourage digital trade and deter foreign investments in e-commerce infrastructure.

These findings underscore the importance of stable governance and policy frameworks in creating a sustainable and thriving e-commerce ecosystem in Asian countries. The study confirms that political stability plays a crucial role in enhancing e-commerce development, consistent with previous literature emphasizing institutional strength, regulatory clarity, and governance quality. Political stability helps minimize disruptions caused by regulatory uncertainty, corruption, or conflicts, enabling smoother e-commerce operations. Political stability provides consistent trade regulations, reduced investment risks, and a favourable business environment, all of which are critical for the expansion of e-commerce.

5.2.3 Other Factor Influences E-commerce

The results for GDP, trade openness, and population indicate that these control variables generally have a positive relationship with e-commerce, although their statistical significance varies across variables. GDP is found to have a strong and statistically significant positive effect on e-commerce, highlighting that economic size and income level are key drivers of e-commerce development. This suggests that countries with higher levels of economic output are more likely to support digital infrastructure, consumer purchasing power, and business capacity needed for e-commerce adoption.

In contrast, trade openness and population size both show positive but statistically insignificant effects on e-commerce. Although the direction of the relationship is consistent with theoretical expectations, the lack of statistical significance suggests that trade integration and population size alone do not guarantee higher levels of e-commerce activity. This implies that the impact of these variables may depend on other supporting factors such as digital infrastructure, institutional quality, and technological readiness. Overall, the findings support the prediction of Hypothesis 3 that control variables collectively have a positive relationship with e-commerce, with GDP emerging as the most important and robust determinant among them.

These findings are consistent with previous studies. For example, Deljavan and Norouzi (2016), He and Wang (2019), Ozekenci et al. (2019), and He and He (2021) also report positive relationships between macroeconomic factors and e-commerce development. In particular, He and Wang (2019), using panel data from 1998 to 2016, find that GDP and population positively influence cross-border e-commerce by enhancing export and import activities through economic globalization and digital network expansion. Similarly, Ozekenci et al. (2019), in their study of Turkey and European countries from 2004 to 2015, highlight that macroeconomic conditions, alongside digital infrastructure and policy support, play an important role in fostering e-commerce growth.

Furthermore, trade openness, although not statistically significant in this study, still shows a positive relationship with e-commerce, indicating its potential importance in expanding access to global markets and international digital platforms. Greater trade integration can facilitate business expansion and cross-border online transactions, thereby supporting e-commerce development. Therefore, governments should continue to promote international trade and strengthen trade facilitation policies, ensuring that local firms can better access global markets and participate in the digital economy.

5.3 Implications of Results

5.3.1 Body of Knowledge

The integration of green technology innovation into the digital economy has become a prominent focus of sustainable development discourse, especially as

countries aim to balance economic growth with environmental preservation. E-commerce, as a key driver of the digital economy, presents both opportunities and challenges in achieving this balance.

Existing literature highlights the potential of green technology to improve energy efficiency, reduce carbon emissions, and promote sustainable consumption and production practices within the e-commerce sector (Bilal et al., 2022; Yuan et al., 2023). However, most of these studies are concentrated in developed economies, particularly in Europe, the United States, and parts of East Asia. Research in these contexts shows that government incentives, consumer demand, and regulatory frameworks play important roles in encouraging businesses to adopt eco-innovations.

In term of body of knowledge, this study addresses these gaps by introducing a green technology innovation and a political stability indicator to evaluate the interplay between environmental objectives and e-commerce development in Asian Countries. Political stability is another essential component influencing the success of e-commerce ecosystems. The results suggest that political stability and supportive government policies play a crucial role in fostering a positive relationship between e-commerce development and green technology innovation. These findings offer fresh insights into the existing body of knowledge and underscore the importance of holistic governance in promoting sustainable digital economies. The findings add to the existing literature by providing new insights from less-studied regions such as Asia, and highlight the important role of strong and coordinated governance in supporting sustainable digital growth.

On the other hand, unlike traditional growth models that treat technological progress as exogenous, New Growth Theory considers innovation to be the result of intentional investment decisions made by firms and governments. In the context of this study, green technology innovation aligns with the principles of New Growth Theory, where green technology innovations are regarded as forms of knowledge capital that can stimulate economic development. Moreover, political stability plays a foundational role in facilitating innovation-led growth by creating an environment that encourages investment in green technologies and digital infrastructure.

5.3.2 Policy Recommendation

This study contributes to several critical policy domains relevant to green technology innovation in Asia, including environmental protection, renewable energy, clean technology, and climate change mitigation. The research supports national planning and strategic alignment with frameworks such as Malaysia's *Green Technology Master Plan 2017–2030*, regional digital economy initiatives like the *ASEAN Digital Masterplan 2025*, and global commitments under the *Paris Agreement*. The findings underscore that the successful adoption of green technologies within the e-commerce sector is not solely contingent on the existence of climate policies or digital strategies. Rather, political stability emerges as a pivotal enabler that ensures these policies are not only implemented effectively but also sustained over time. Furthermore, the analysis reveals that countries with strong climate ambitions but insufficient regulatory support for e-commerce tend to exhibit lower levels of green technology adoption, highlighting the need for an integrated policy approach that harmonizes environmental, digital, and governance frameworks.

The roles of policymaker in green technology innovation should focusing on supporting green technology innovation in e-commerce sector, governments and e-commerce industry should actively promote green technology innovation adoption by providing incentives such as tax reductions, subsidies, reward or grants to encourage businesses to integrate green innovations into their e-commerce operations to sustain e-commerce sector. However, collaboration of between governments and tech companies may help in developing the e-commerce performance for examples create green policy in creating eco-friendly product to promote sustainability.

In addition, Asian country should align environmental policies with digital economy strategies to foster a unified approach. Evidence from countries such as Sweden and Denmark who ranked among the most prepared for the green tech transition shows that institutional readiness is a key driver for green innovation which specifically in the aspect of ICT, Skills, Industry, Research and Development and Finance (World Economic Forum, 2023).

Next, governments and industry stakeholders should implement campaigns to increase consumer awareness about environmentally friendly products and international cooperation with leading countries in green tech readiness can support knowledge exchange and policy innovation

5.4 Recommendation to Future Research

Based on the findings and limitations of this study, future research could explore several areas to provide a more comprehensive understanding of the relationship between green technology innovation, political stability, and e-commerce. First, expanding the geographical scope would allow researchers to determine whether regional differences influence the relationship between GTI, political stability, and e-commerce. This study focused on 20 Asian countries, but including nations from other regions such as Europe, Africa, or Latin America could reveal how different economic and political environments shape e-commerce development. A broader dataset could help in identifying global patterns and country-specific variations in the impact of GTI and political stability on e-commerce growth.

Second, future studies should consider alternative methodologies, particularly dynamic panel models, to better capture the evolving nature of e-commerce and green technology innovation over time. Unlike static models, dynamic panel approaches such as the Generalized Method of Moments (GMM) can account for time-dependent relationships and address issues related to endogeneity and unobserved heterogeneity. This would provide a more robust understanding of how past levels of e-commerce or green technology influence current developments, offering deeper insights into the temporal dynamics and policy impacts across different countries.

Third, industry-specific analysis could provide a more granular understanding of how different sectors within e-commerce respond to political and environmental changes. For example, studying B2B (business-to-business), B2C (business-to-consumer), and fin-tech (financial technology) sectors separately would help identify sector-specific challenges and opportunities. Certain industries may be more sensitive to political risks or green innovation adoption, requiring tailored strategies for sustainable e-commerce growth.

Finally, conducting longitudinal studies could offer valuable insights into long-term trends in e-commerce development. A long-term perspective would help track how political stability fluctuations, regulatory changes, and technological advancements impact e-commerce growth over time. This would also enable researchers to assess the effectiveness of government policies and private-sector initiatives in promoting sustainable and stable e-commerce ecosystems. By addressing these areas, future research can build upon the current findings, fill existing

knowledge gaps, and offer stronger policy recommendations for governments, businesses, and stakeholders involved in the digital economy.

5.5 Limitations of the Study

This study has several limitations that should be considered when interpreting its findings. First, data availability and country coverage pose a significant constraint. The research focused on 20 Asian countries, as data for e-commerce and green innovation was either missing or unavailable for some nations. This limitation restricts the generalizability of the findings beyond the selected countries, making it difficult to draw broader conclusions about e-commerce trends in Asia as a whole.

Second, there is a limited body of literature exploring the intersection between e-commerce, green technology innovation, and political stability. While e-commerce and macroeconomic factors have been widely studied, empirical research examining how green technology innovation and political stability affect e-commerce in Asia remains scarce. This gap in the literature makes it challenging to develop a fully comprehensive theoretical framework, requiring future studies to build on these preliminary findings.

Third, time constraints affected the depth of data collection and analysis. The study was conducted within a restricted timeframe, limiting opportunities for more extensive data collection and longitudinal analysis. A longer study period could allow for a more in-depth examination of trends over time, providing a richer understanding of how political and technological factors shape e-commerce growth.

Finally, methodological constraints should be acknowledged. This study primarily relied on quantitative analysis which useful for identifying statistical relationships, that may not fully capture the nuanced effects of political stability and green innovation on e-commerce. Future research could benefit from qualitative approaches, such as case studies, expert interviews, or surveys, to provide a deeper, more contextualized understanding of e-commerce development dynamics.

Despite these limitations, the study provides valuable insights into the factors influencing e-commerce in Asia, offering a foundation for future research to expand upon and refine its findings.

5.6 Summary

Chapter 5 provides the conclusion, implications, limitations, and recommendations of this study on the relationship between green technology innovation, political stability, and e-commerce growth in Asia. This chapter highlights the key findings, discusses their significance, acknowledges research limitations, and offers suggestions for businesses, policymakers, and future researchers.

This study provides empirical evidence that political stability significantly influences e-commerce growth in Asia, while green technology innovation has a positive but non-significant effect. The findings highlight that political stability fosters a conducive environment for e-commerce expansion by ensuring regulatory consistency, reducing investment risks, and promoting institutional strength. In contrast, while green innovation contributes to the sustainability of e-commerce, its adoption remains limited due to high costs, regulatory uncertainties, and slow policy implementation.

Additionally, strong economic performance such as GDP remains a primary driver of e-commerce growth, reinforcing that market size and economic stability are crucial determinants in shaping digital trade. However, beyond economic factors, policy consistency, institutional quality, and innovation incentives also play a significant role in determining the long-term sustainability of e-commerce ecosystems.

To ensure sustainable e-commerce development, governments, businesses, and policymakers must collaborate to implement effective policies, invest in digital infrastructure, and promote innovation-friendly regulations. A stable political environment, coupled with strong institutional frameworks and green technology incentives, will be essential for fostering a resilient and inclusive digital economy in Asia and beyond.

Despite these limitations, the study provides valuable insights into the determinants of e-commerce development in Asian countries, particularly the roles of Green Technology Innovation and Political Stability Index. The findings contribute to the existing literature by offering empirical evidence based on panel data analysis and robust econometric techniques. Furthermore, the application of Driscoll-Kraay robust standard errors enhances the reliability and validity of the regression estimations by addressing issues related to heteroskedasticity, autocorrelation, and cross-sectional dependence. Nevertheless, future studies are encouraged to expand the scope of the

analysis by incorporating additional variables, broader geographical coverage, and longer time periods to provide a more comprehensive understanding of e-commerce development across different economic environments.

Based on these findings, recommendations for future research include examining the long-term impact of green technology innovation, investigating the role of digital infrastructure in e-commerce growth, conducting country-specific case studies, and exploring the influence of AI and block-chain on sustainable e-commerce development. In conclusion, this study provides valuable insights into the economic, political, and technological factors influencing e-commerce in Asia. By integrating political stability, economic resilience, and digital innovation, businesses and governments can foster a more sustainable and future-proof e-commerce ecosystem. By integrating political stability, economic resilience, and digital innovation, businesses and governments can foster a more sustainable and future-proof e-commerce ecosystem.

REFERENCES

- Abecassis, D., Teo, D., Myrie, N., & Hussain, N. (2022). *E-Commerce And Social Commerce Landscape In Apac* (Issue July).
- Ahi, A. A., Sinkovics, N., & Sinkovics, R. R. (2023). E-commerce Policy and the Global Economy: A Path to More Inclusive Development? *Management International Review*, 63(1), 27–56.
- Akinwande, M. O., Dikko, H. G., & Samson, A. (2015). Variance Inflation Factor: As a Condition for the Inclusion of Suppressor Variable(s) in Regression Analysis. *Open Journal of Statistics*, 05(07), 754–767.
- Alesina, A., S. Ozler, , N. Roubini, P. Swagel (1992). Political Instability and Economic Growth, working paper 4173, National Bureau of Economic Research, 1992.
- Aoki, M. (2007). Endogenizing institutions and institutional changes. *Journal of institutional economics*, 3(1), 1-31.
- Arora, P., & Dharwadkar, R. (2011). Corporate governance and corporate social responsibility (CSR): The moderating roles of attainment discrepancy and organization slack. *Corporate governance: an international review*, 19(2), 136-152.
- Anvari, R. D., & Norouzi, D. (2016). The Impact Of E-Commerce And R&D On Economic Development In Some Selected Countries. *Procedia-Social And Behavioral Sciences*, 229, 354-362
- Aghion, P., & Howitt, P. (1998). Endogenous growth theory. The MIT Press.
- Aluchna, M., & Roszkowska-Menkes, M. (2017). CSR and organizational responses to institutional pressures. The perspective of neo-institutional theory. Preliminary results. In *EURAM 2017. Making knowledge work*.
- ASEAN. (2020). ASEAN e-commerce.
- Asia, C. (2023, November 16). Consultancy.Asia.
- Astrom, J., Karlsson, M., Linde, J., & Pirannejad, A. (2012). Understanding the rise of e-participation in non-democracies: Domestic and international factors. *Government Information Quarterly*, 29(2), 142–150.
- Alyoubi, B. A., Alharbi, I. M., Alyoubi, A. A., Qaffas, A. A., & Almazmomi, N. K. (2020). Management of E-Commerce: Impact on Start-Up Ecosystem. *Marketing and Management of Innovations*, 6718(2), 247–255.

- Alorse, R. W. (2019, December 8). *The digital economy's environmental footprint is threatening the planet*. The Conversation.
- Barforoush, N., Etebarian, A., Naghsh, A., & Shahin, A. (2021). Green innovation a strategic resource to attain competitive advantage. *International Journal of Innovation Science*, 13, 645–663. <https://doi.org/10.1108/IJIS-10-2020-0180>
- Baltagi, Badi H. (2013). *Econometric Analysis of Panel Data*, 5th Edition. New Jersey, USA: John Wiley & Sons
- Bauer, J. M. (1997). Market power, innovation, and efficiency in telecommunications: Schumpeter reconsidered. *Journal of Economic Issues*, 31(2), 557-565.
- Barro, R. J. (1990). Government spending in a simple model of endogenous growth. *Journal of Political Economy*, 98(S5), S103–S125.
- Buii, M. (2023, December 19). Asia e-commerce marketing.
- Bilal, A., Li, X., Zhu, N., Sharma, R., & Jahanger, A. (2022). Green technology innovation, globalization, and CO2 emissions: Recent insights from the OBOR economies. *Sustainability (Switzerland)*, 14(1), 1–17.
- Capolupo, R. (2009). The New Growth Theories and Their Empirics after Twenty Years. *Economics E-Journal*, 3(1). <https://doi.org/10.5018/economics-ejournal.ja.2009-1>
- Castellacci, F., & Lie, C. M. (2017). A taxonomy of green innovators: Empirical evidence from South Korea. *Journal of Cleaner Production*, 143, 1036-1047.
- Chin, T., Shi, Y., Singh, S. K., Agbanyo, G. K., & Ferraris, A. (2022). Leveraging blockchain technology for green innovation in ecosystem-based business models: a dynamic capability of values appropriation. *Technological Forecasting and Social Change*, 183, 121908.
- Commerce, B. (2022). Your guide to global e-commerce: How to expand into foreign markets and increase e-commerce sales. BigCommerce
- Coppel, J. (2000). E-commerce: impacts and policy challenges
- Corredera, D. N. (2020). *“UPU e-commerce Guide” 2020*. Universal Postal Union (UPU) Berne, Switzerland.
- Cortright, J. (2001). New Growth Theory , Technology and Learning : A Practitioner ' s Guide New Growth Theory , Technology and Learning A Practitioners Guide Joseph Cortright. *Economic Development Administration, U.S.A*, 4, 40.
- Cramer-Flood, E. (2023, October 13). Global retail e-commerce forecast 2023. Insider Intelligence. Retrieved from

- Dai, D., Fan, Y., Wang, G., & Xie, J. (2022). Digital Economy , R & D Investment , and Regional Green Innovation — Analysis Based on Provincial Panel Data in China. *MDPI*.
- Dahlman C, Mealy S, Wermelinger M. Harnessing the digital economy for developing countries[J]. OECD Development Centre Working Papers, 2016.
- Daoud, J. I. (2022). Multicollinearity and Regression Analysis. *Journal of Physics: Conference Series*, 949(1).
- Deng, Z., Zhu, Z., Johanson, M., & Hilmersson, M. (2022). Rapid internationalization and exit of exporters : The role of digital platforms. *International Business Review*, 31(1).
- Doidge, C., Andrew Karolyi, G., & Stulz, R. M. (2007). Why do countries matter so much for corporate governance? *Journal of Financial Economics*, 86(1), 1–39.
- Deeg, R., & Jackson, G. (2007). Toward a more dynamic theory of capitalist variety. *Socio-Economic Review*, 5(1), 149–179.
- Deephouse, D. L. (1996). Does Isomorphism Legitimate? *The Academy of Management Journal*, 39(4), 1024–1039.
- DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, 48(2), 147–160.
- Easterly, W., & Levine, R. (2001). It's not factor accumulation: Stylized facts and growth models. *World Bank Economic Review*, 15(2), 177–219.
- Easterly, W., & Levine, R. (2003). Tropics, germs, and crops: The role of geography in development. *Journal of Monetary Economics*, 50(1), 61–99.
- Feng, L., & Jin, M. (2022). Platform vs. Manufacturer: Who should implement innovation in e-commerce supply chains? *Transportation Research Part E: Logistics and Transportation Review*.
- Frynas, J. G. (2002). The limits of globalization – legal and political issues in e-commerce. *Management Decision*, 40(9), 871–880.
- Gevaers, R., Van de Voorde, E., & Vanelander, T. (2014). Cost modelling and simulation of last-mile characteristics in an innovative B2C supply chain environment with implications on urban areas and cities. *Procedia - Social and Behavioral Sciences*, 125, 398-411.
- Gibbs, J., Kraemer, K. L., & Dedrick, J. (2003). Environment and policy factors shaping global e-commerce diffusion: A cross-country comparison. *The*

- information society, 19(1), 5-18
- Giaoutzi, M., Storey, D. J., & Nijkamp, P. (2016). Small and medium size enterprises and regional development. Routledge.
- Greene, W. H. (2008). The econometric approach to efficiency analysis. The measurement of productive efficiency and productivity growth, 1(1), 92-250.
- Greenwood, R., & Hinings, C. R. (1996). Understanding radical organizational change: Bringing together the old and the new institutionalism. *The Academy of Management Review*, 21(4), 1022–1054.
- Grossman, G. M., & Helpman, E. (1991). Innovation and growth in the global economy. *MIT Press*.
- Gourevitch, P. A. (2003). The politics of corporate governance regulation. *Yale Law Journal*, 112(7), 1829
- Haqqi, H., & Murdani, A. D. (2023). The Relations of Economic-Political Power to the Development of Digital Economy in Asia. *Jurnal Ekonomi Dan Bisnis Digital*, 2(2), 583–602.
- Hardilawati, W. L., Sandri, S. H., & Binangkit, I. D. (2019). The Role of Innovation and E-Commerce in Small Business. *Advances in Social Science, Education and Humanities Research*, 373, 83–87.
- He, C., & He, W. (2021). An Empirical Analysis of the Level of Cross-border E-commerce Development on China ' s Export Trade : 11 Countries in Southeast Asia as an Example. *Journal Of Simulation*, 9(1), 65–72.
- He, Y., & Wang, J. (2019). A Panel Analysis on the Cross Border E - commerce Trade : Evidence from ASEAN Countries. *Journal of Asian Finance, Economics and Business*, 6(2), 95–104.
- Hellsmark, H., Mossberg, J., Söderholm, P., and Frishammar, J. (2016). Innovation System Strengths and Weaknesses in Progressing Sustainable Technology: the Case of Swedish Biorefinery Development. *J. Clean. Prod.* 131, 702–715.
- Heil, D., & Prieger, J. E. (2009). The Macroeconomic Impacts of E-Business on the Economy. *SSRN Electronic Journal*, expected 2010, 24.
- Ho, Shu-Chun, Robert J. Kauffman, and Ting-Peng Liang. 2011. “The Impact of Internet-Based Selling Technology: A Hybrid Growth Theory Perspective with Cross-Model Inference.” *Information Technology and Management* 12 (4): 409–29
- Ho, S. C., Kauffman, R. J., & Liang, T. P. (2008). A Growth-Theoretic Empirical

- Analysis Of Simultaneity In Cross-National E-Commerce Development. *Proceedings of the 41st Hawaii International Conference on System Sciences - 2008, May 2014.*
- Hossain, M. B., Dewan, N., Senin, A. A., & Illes, C. B. (2023). Evaluating the utilization of technological factors to promote e-commerce adoption in small and medium enterprises. *Electronic Commerce Research*, 1-20.
- Hoechle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence. *Stata Journal*, 7(3), 281–312.
- Hsiao, C. (2007). Panel data analysis-advantages and challenges. *Social Science Research Network*, 16(1), 56–57.
- Hagemann, H. (2003). Schumpeter's Early Contributions On Crises Theory And Business-Cycle Theory. *History of Economic Ideas*, 11(1), 47–67.
- Ifinedo, P., Anwar, A., & Cho, D. (2021). Using panel data analysis to uncover drivers of e-participation progress: A global insight and regional perspectives. *Journal of Global Information Management*, 29(3), 212–235.
- Jain, V., Malviya, B., & Arya, S. (2021). An Overview of Electronic Commerce (e-Commerce). *Journal of Contemporary Issues in Business and Government*, 27(May).
- Jeffrey M. Wooldridge (Michigan State University). (2012). *Introductory Econometrics :A Modern Approach 5th Edition* (5 th Editi).
- Jensen, J. C., & Berg, N. (2012). Determinants of traditional sustainability reporting versus integrated reporting. An institutionalist approach. *Business Strategy and the Environment*, 21(5), 299-316.
- Jia, L., Hu, X., Zhao, Z., He, B., & Liu, W. (2022). How Environmental Regulation , Digital Development and Technological Innovation Affect China ' s Green Economy Performance : Evidence from Dynamic Thresholds and System GMM Panel Data Approaches. *MDPI*.
- Jiang, H., Hu, W., Guo, Z., Hou, Y., & Chen, T. (2024). E-commerce development and carbon emission efficiency: Evidence from 240 cities in China. *Economic Analysis and Policy*, 82(April), 586–603.
- John, V. k. (2017). *A Panel Data Model on e-Business Development of Nations*. 4–31.
- Joseph A. Schumpeter, *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process* (1939)
- J. Bradford De Long, Lawrence H. Summers, Equipment Investment and Economic

- Growth, *The Quarterly Journal of Economics*, Volume 106, Issue 2, May 1991, Pages 445–502,
- Jones, L. (2022, July 20). How has the war impacted e-commerce in Russia and Ukraine?. Grips Intelligence.
- Jones, L. E., & Manuelli, R. (1990). A Convex Model of Equilibrium Growth: Theory and Policy Implications. *Journal of Political Economy*, 98(5), 1008–1038.
- Kang, J. W., Wang, T., & Ramizo, D. (2021). The Role Of Technology In Business-To-Consumer: Evidence from Asia. In *Asian Development Bank Economic* (Issue 632).
- Kang, N., & Moon, J. (2012). Institutional complementarity between corporate governance and corporate social responsibility: A comparative institutional analysis of three capitalisms. *Socio-Economic Review*, 10(1), 85-108.
- Kabakova, O., & Plaksenkov, E. (2018). Analysis of factors affecting financial inclusion: Ecosystem view. *Journal of business Research*, 89, 198-205
- Karimi Takalo, S., Sayyadi Tooranloo, H., & Shahabaldini parizi, Z. (2021). Green innovation: A systematic literature review. *Journal of Cleaner Production*, 279, 122474.
- Keenan, M. (2023, August 27). Global e-commerce statistics. Shopify.
- Khalid, N. M., Noman, N., & Begam, A. (2019). SMEs Output and GDP Growth: A Dynamic Perspective. *Journal of Asian Business Strategy*, 9(1), 53–65.
- Kimura, F., & Chen, L. (2017). E-Commerce as Asia ' s New Growth Engine. *Economic Research Institute for ASEAN and East Asia*, 02.
- Kinda, T. (2019). E-commerce as a Potential New Engine for Growth in Asia. In *IMF Working Papers* (Vol. 19, Issue 135).
- Korosenyi, A., Illés, G., & Metz, R. (2016). Contingency and political action: The role of leadership in endogenously created crises. *Politics and Governance*, 4(2), 91–103.
- Katchanovski, I., & Porte, T. L. (2005). Cyberdemocracy or Potemkin e-villages? Electronic governments in OECD and post-communist countries. *International Journal of Public Administration*, 28(7–8), 665–681.
- Kusuma, T. M., & Marhaeni, A. A. I. N. (2019). E-commerce and related factors on the performance of small and medium scale industries. *Int. J. Hum. Capital Urban Manage*, 4(1), 61–68.
- Kwilinski, A., Volynets, R., Berdnik, I., Holovko, M., & Berzin, P. (2019). E -

- Commerce : Concept And Legal Regulation. *Journal of Legal, Ethical and Regulatory Issues*, 22(2), 1–6.
- Lakka, S., Stamati, T., Michalakelis, C., & Martakos, D. (2013). What drives eGovernment growth? An econometric analysis on the impacting factors. *International Journal of Electronic Governance*, 6(1), 20.
- Lawal, M. M., & Abdulkadir, K. (2012). An overview of e-commerce implementation in developed and developing country: A case study of United State and Nigeria. *International Journal of Modern Engineering Research (IJMER)*, 2(5), 80. t:
- Leal-Millán, A., Leal-Rodríguez, A. L., & Albort-Morant, G. (2017). *Green Innovation BT - Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship* (E. G. Carayannis (ed.); p. 2800). Springer New York.
- Liberto, D. (2021, February 26). What is new growth theory? Definition, how it's used, and example. Investopedia.
- Lin, J. Y., & Ménard, C. (2012). Institutions and economic development: Theory, policy and history. *World Bank Research Observer*, 27(2), 206–227.
- Liu, L. (2024). From click to boom: The political economy of e-commerce in China. Princeton University Press.
- Liu, T.K., J.R. Chen, C.C.J Huang, and C.H. Yang. 2013. E-commerce, R&D, and Productivity. *Information Economics and Policy*. 25(4). pp. 272–283
- Li, B. (2020). Analysis of the Impact of E-Commerce on Industrial Manufacturing Based on Big Data. *Journal of Physics: Conference Series*, 1648(4).
- Li, Z., Liao, G., Wang, Z., and Huang, Z. (2018). Green Loan and Subsidy for Promoting Clean Production Innovation. *J. Clean. Prod.* 187, 421–431.
- Lusch, R.F. and Nambisan, S. (2015), “Service innovation: a service-dominant logic perspective”, *MIS Quarterly*, Vol. 39 No. 1, pp. 155-176.
- Magnano, D. G., Grimstad, S. M. F., Glavee-Geo, R., & Anwar, F. (2024). Disentangling circular economy practices and firm's sustainability performance: a systematic literature review of past achievements and future promises. *Journal of Environmental Management*, 353, 120138.
- Mansaray, M., & Bin, H. (2016). E-Commerce And Trade Openness In Africa: A Panel Data Analysis. *International Journal of Development Research*, 06(05), 3–17.
- Mangiaracina, R., Marchet, G., & Perotti, S. (2015). A review of the environmental

- implications of B2C e-commerce: A logistics perspective. *International Journal of Physical Distribution & Logistics Management*.
- Mavisakalyan, A., & Gebremedhin, T. (2011). Immigration and Political Stability. *International Conference on Social Sciences*.
- Matten, D., & Moon, J. (2008). Implicit and explicit corporate social responsibility: A conceptual framework for a comparative understanding of corporate social responsibility. *Academy of Management Review*, 33(2), 404–424.
- Mccawley, P. (2021). Chapter 1: 50 Years of Asian Development. *Journal of Southeast Asian Economies*, 1–28. <https://kidb.adb.org/kidb>
- Mu, Z., Zheng, Y., & Sun, H. (2021a). Cooperative green technology innovation of an E-commerce sales channel in a two-stage supply chain. *Sustainability (Switzerland)*, 13(13).
- Muriu, P. W. (2021). Does the Quality of Institutions Matter for Financial Inclusion? Cross Country Evidence. *International Journal of Economics and Finance*, 13(7), 27.
- Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications policy*, 44(2), 101856.
- Nasrullah, M., Rizwanullah, M., Yu, X., Jo, H., Sohail, M. T., & Liang, L. (2021). Autoregressive distributed lag (ARDL) approach to study the impact of climate change and other factors on rice production in South Korea. *Journal of Water and Climate Change*, 2256–2270.
- Ni, Y. (2024). The influence of digital economy on rural per capita disposable income: evidence from China. *Environment, Development and Sustainability*, 892.
- North, D. (1990). Institutions, institutional change and economic performance. Cambridge, UK:Cambridge University Press.
- OECD. (2009). How do we measure innovation? *Innovation in Firms: A Microeconomic Perspective*, 11–20.
- OECD. (2019). Digital transformation and the role of data in the economy. OECD
- Ortiz, A. L., Rodriguez, J. C., & Gomez, M. (2020). E-commerce development in europe: A panel data analysis 2003–2017. *Business Administrative and Management*, 23(4), 89–101.
- Oudraogo, E., Quedraogo, I., & Lampo, E. (2020). Political Instability and Firm Performance: A Microeconomic Evidence from Ivory Coast. *American*

- Journal of Economics and Business Administration*, 12(1), 49–55.
- Ozekenci, E. K., Murat, G., & Cansu, U. E. (2019). The Determinants Of E-commerce in Turkey and European countries: A panel data anaysis. *Journal Of Business in the Digital Age*, 2(1), 51–66.
- Palladan, A. A., & Adamu, A. M. (2019). Toward Mitigating Graduate Unemployment for Political Stability : The Role Toward Mitigating Graduate Unemployment for Political Stability: The Role Electronic Commerce Technology . A PLS Approach. *Cross Current International Journal of Economics, Management and Media Studies.*, 1(February), 1.
- Park, C.-Y., Mikic, M., Wong, T. Y. J., Kang, J. W., Wang, T., Tayag, M. C., Kshetri, N., Anabo, D. J., & Tayag, M. C. (2018). *Embracing the E-commerce Revolution in Asia and the Pacific* (Issue June). www.adb.org
- Park, C. H., & Kim, K. (2019). E-government as an anti-corruption tool : Panel data analysis across countries. *Sage Journal*, 86(4).
- Pan, W., Cao, H., & Liu, Y. (2023). “Green” innovation, privacy regulation and environmental policy. *Renewable Energy*, 203, 245-254.
- Perkins, D. (2021). Understanding political influences on Southeast Asia’s development experience. *Fulbright Review of Economics and Policy*, 1(1), 4–20.
- Phan, S. T. (2021). International Journal of Data and Network Science The effect of PESTLE factors on development of e-commerce. *International Journal Of Data and Network Science*, 5, 37–42.
- Qi, X., Hooi, J., Hu, J., & Li, Y. (2020). Motivations for selecting cross-border e-commerce as a foreign market entry mode. *Industrial Marketing Management*, 89(October 2019), 50–60.
- Rahayu, R., & Day, J. (2015). Determinant factors of e-commerce adoption by SMEs in developing country: evidence from Indonesia. *Procedia-social and behavioral sciences*, 195, 142-150
- Raimi L, Bamiro NB (2025), "Moderating effect of market sophistication and political stability on the relationship between entrepreneurship and unemployment in Nigeria’s emerging market". *European Business*
- Relly, J. E. (2012). Examining a model of vertical accountability: A cross-national study of the influence of information access on the control of corruption. *Government Information Quarterly*, 29(3), 335–345.

- Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2), S71–S102.
- Roszko-Wojtowicz, E., Deep Sharma, G., Dańska-Borsiak, B., & Grzelak, M. M. (2024). Innovation-driven e-commerce growth in the EU: An empirical study of the propensity for online purchases and sustainable consumption. *Sustainability*, 16(4), 1563.
- Rodrik, D., & Subramanian, A. (2001). The primacy of institutions. *The Finance & Development*, 38(2), 17–20.
- Sal Arora, F. C. (2022, December 21). E-commerce is entering a new phase in Southeast Asia: Are logistics players prepared?. McKinsey & Company.
- Srivastava, S. C., & Teo, T. S. H. (2007). E-government payoffs: Evidence from cross-country data. *Journal of Global Information Management*, 15(4), 20–40.
- Shepherd, B. (2010). Political Stability: Crucial for Growth? IDEAS Report, SU004—Resurgent Continent? Africa and the World, 9.
- Stahl, B. C. (2007). The paradigm of e-commerce in e-government and e-democracy. *Developing Successful ICT Strategies: Competitive Advantages in a Global Knowledge-Driven Society*, January 2007, 281–296.
- Scott, W. R. (1995). *Institutions and organizations* (Vol. 2). Thousand Oaks, CA: sage.
- Scott, W. Richard, 2001. *Institutions and Organization*, second ed. Sage, Thousand Oaks, CA.
- Scott, W. R. (2014). *Institutions and Organizations: Ideas, Interests, and Identities* (4th ed.). Thousand Oaks, CA: Sage Publishing.
- Suddaby, R. (2013). Institutional theory. In *Encyclopedia of management theory* (pp. 379–384). Sage Publications.
- Shanmugalingam P, Shanmuganeshan A, Manorajan A, Kugathan M, Pathirana GY (2023) Does e-commerce really matter on international trade of Asian countries: Evidence from panel data. *PLoS ONE* 18(4): e0284503.
- Skare, M., Gavurova, B., & Rigelsky, M. (2023). Innovation activity and the outcomes of B2C, B2B, and B2G E-Commerce in EU countries. *Journal of Business Research*, 163, 113874.
- Studenmund, A. H., & Johnson, B. K. (1970). *A practical guide to using econometrics* (Seventh Ed). Pearson Education 2017. www.pearsonglobaleditions.com
- Team, C. F. (2022, November). New growth theory (NGT). Corporate Finance

Institute.

- Thomas, B. (2022, April 5). How the politics of “Big Tech” is threatening US small business. WARC.
- Tian, Y., & Stewart, C. (2007). History of E-Commerce. *Electronic Commerce, January 2007*, 9.
- Torres-reyna, O. (2007). *Panel Data Analysis Fixed and Random Effects using Stata* Panel data (also known as longitudinal or cross- sectional time-series data) is a dataset in which the behavior of entities are observed across time . Panel data looks like this. 4.2(December).
- TimeTrade. 2015. Study: 85% of Consumers Prefer to Shop at Physical Stores vs. Online. News Release. 18 May
- Tolbert, C. J., & Mossberger, K. (2006). The effects of e-government on trust and confidence in government. *Public Administration Review*, 66(3), 354–369.
- Uddin, M. saad. (2019). Evolution of online/E-commerce in the last Decade. *International Research Journal of Commerce Arts and Science*, 10(6), 166–178.
- United Nations Conference on Trade and Development. (2024). *Digital economy report 2024: Shaping an environmentally sustainable and inclusive digital future (Chapter5)*.
- Vijayamohanan Pillai N. (2016). Panel Data Analysis with Stata Part 1 Fixed Effects and Random Effects Models. *Munich Personal RePEc Archive*, 76869.
- Volkova, N., Kuzmuk, I., Oliinyk, N., Klymenko, I., & Dankanych, A. (2021). Development Trends Of The Digital Economy: E-Business, E-Commerce. *International Journal of Computer Science and Network Security*, 21(4), 186–198.
- Wang, M., Li, Y., & Liao, G. (2021). Research on the Impact of Green Technology Innovation on Energy Total Factor Productivity, Based on Provincial Data of China. *Frontiers in Environmental Science*, 9(June), 1–11.
- Wang, B., Zhang, L., Wang, D., & Jiang, G. (2023). The impact of E-commerce on urban green innovation development: evidence from Chinese cities. *Journal of Organizational and End User Computing (JOEUC)*, 35(1), 1-21.
- Wei, Y., Tao, X., Zhu, J., Ma, Y., Yang, S., & Ayub, A. (2024). Examining the relationship between international digital trade , green technology innovation and environmental sustainability in top emerging economics. *Heliyon*, 10(7),

e28210.

- Witell, L., Snyder, H., Gustafsson, A., Fombelle, P. and Kristensson, P. (2016), “Defining service innovation: a review and synthesis”, *Journal of Business Research*, Vol. 69 No. 8, pp. 2863-2872.
- World Economic Forum. (2023). Which countries are best prepared for the green tech transition?
- Williams, R. (2020). Lecture Notes on Heteroskedasticity. *Lecture Notes on Heteroskedasticity*, 1–16.
- Wilsdon, J. (2003). Digital Futures: e-commerce and sustainable development (Doctoral dissertation, Middlesex University).
- Wang, Y., Cheng, L.W. and Wang, H. (2014) Financial Inefficiency, Capital Misallocation and Heterogeneous Firm Two-Stage R&D. *Shanxi University of Finance & Economics*, 36, 46-57
- Xin, X., Miao, X., Chen, Q., & Shang, T. (2021). User participation , knowledge management capability and service innovation : e-commerce enterprises in the digital age the digital age. *Emerald Insigh.*
- Yassin, J., Wong, S. Y., & Marcus, H. R. (2021). Heterogeneous Effect of Sectoral Composition on the Green Technology Innovations in Asia’S Middle-Income Countries. *International Journal of Innovation and Industrial Revolution*, 3(6), 13–26.
- Ye, Q., & Cheng, C. (2019). Green Technological Innovation Efficiency and Financial Ecological Environment. *Open Journal of Social Sciences*, 07(12), 132–151.
- Younis, M., Lin, X. X., Sharahili, Y., & Selvarathinam, S. (2008). Political stability and economic growth in Asia. *American Journal of Applied Sciences*, 5(3), 203–208.
- Yu, Y., Hu, W., Dong, C., Gu, X., & Obrenovic, B. (2023). E-Commerce Development and Green Technology Innovation : Impact Mechanism and the Spatial Spillover Effect. *Sustainability (Switzerland)*, 21.
- Yuan, H., Cen, W., & Du, T. (2023). Digital Finance and County Ecological Performance—New Evidence from China Counties. *Sustainability (Switzerland)*, 15(24).
- Zatonatska, T., Rozhko, O., & Tkachenko, N. (2018). Modern Trends Of Impact On Economic Development Of Countries: E-Commerce And R&D. *Marketing And Management Of Innovation.*, 12 (4), 129–135.

- Zhang, L., Ham, T. D., Li, R., & Do, T. T. (2025). Enhancing the Sustainable Development of the ASEAN ' s Digital Trade : The Impact Mechanism of Innovation Capability. *Sustainability*, 1–18.
- Zhang, W., Zhao, S., Wan, X., & Yao, Y. (2021). Study on the effect of digital economy on high-quality economic development in China. *PLoS ONE*, 16(9 September), 1–27.
- Zhou, Z. F. (2014). On Evaluation Model of Green Technology Innovation Capability of Pulp and Paper Enterprise Based on Support Vector Machines. *Amr* 886, 285–288.
- Ziemnowicz, C. (2017). Joseph A. Schumpeter and innovation. In E. G. Carayannis (Ed.), *Encyclopedia of creativity, invention, innovation and entrepreneurship* (pp. 1517–1522). Springer.

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LIST OF PUBLICATION

Yassin, J., & Mansur, M. H. (2025). The influence of green innovation on e-commerce: Evidence from Asian country. *International Journal of Business and Technology Management*, 7(3) ,223-230. asianscholarsnetwork.com/asnet-journals.