THE IMPACT OF SUSTAINABLE ISLAMIC BANKING FINANCING FOR INFRASTRUCTURE PROJECTS ON MALAYSIA'S ECONOMIC GROWTH

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ABSTRACT

Infrastructure is widely recognized as a catalyst for economic development in many countries; however, a significant funding gap persists. Alternative funding sources are required to address this deficit. Islamic finance presents one such alternative for infrastructure funding. Consequently, this study examines the impact of sustainable Islamic banking financing for infrastructure projects on Malaysia's economic growth. The research employs a quantitative methodology utilizing Autoregressive Distributed Lag (ARDL) analysis to examine the long-run and short-run relationships between Islamic infrastructure financing in economic, environmental, and social sectors and Malaysia's real Gross Domestic Products (GDP) using quarterly data from the first quarter of 2015 to the second quarter of 2024. The economic sectors include transportation and storage, and information and communication technology (ICT). The environmental sectors encompass electric, gas, and steam, and agriculture, forestry, and fishing. The social sectors comprise education, and human health and social work. The findings reveal that Islamic infrastructure financing in the transportation and storage, and ICT sectors demonstrates a positive but statistically insignificant effect on economic growth in the long run. Electric, gas, and steam financing also exhibits a positive but insignificant long-run impact, while agriculture, forestry, and fishing financing presents a negative and insignificant long-run effect. Notably, Islamic financing for education, and human health and social work sectors exhibits a positive and statistically significant long-run relationship with economic growth. The short-run analyses yield heterogeneous results across different lags for all sectors. Robustness checks utilizing FMOLS, DOLS, and CCR models corroborate the ARDL findings. The study elucidates the potential of Islamic financing from Islamic banking in promoting sustainable infrastructure development and economic growth, with implications for policymakers, Islamic financial institutions, and investors. It also identifies areas for future research, such as cross-country comparisons and sector-specific analyses.

Keywords: Economic growth in Malaysia, Sustainable financing, Infrastructure projects, Islamic banking, ARDL (Autoregressive Distributed Lag) analysis

ABSTRAK

Infrastruktur diiktiraf secara meluas sebagai pemangkin untuk pembangunan ekonomi di banyak negara; walau bagaimanapun, jurang pembiayaan yang ketara masih wujud. Sumber pembiayaan alternatif diperlukan untuk menangani kekurangan ini. Kewangan Islam merupakan salah satu alternatif untuk pembiayaan infrastruktur. Oleh itu, kajian ini mengkaji kesan pembiayaan perbankan Islam yang mampan untuk projek infrastruktur terhadap pertumbuhan ekonomi Malaysia. Penyelidikan ini menggunakan metodologi kuantitatif dengan menganalisis *Autoregressive Distributed Lag* (ARDL) untuk mengkaji hubungan jangka panjang dan jangka pendek antara pembiayaan infrastruktur Islam dalam sektor ekonomi, alam sekitar, dan sosial serta Keluaran Dalam Negeri Kasar (KDNK) sebenar Malaysia menggunakan data suku tahunan dari suku pertama 2015 hingga suku kedua 2024. Sektor ekonomi termasuk pengangkutan dan penyimpanan, serta teknologi maklumat dan komunikasi (ICT). Sektor alam sekitar merangkumi elektrik, gas, dan wap, serta pertanian, perhutanan, dan perikanan. Sektor sosial merangkumi pendidikan, dan kesihatan manusia serta kerja sosial. Hasil dapatan menunjukkan bahawa pembiayaan infrastruktur Islam dalam sektor pengangkutan dan penyimpanan, serta ICT menunjukkan kesan positif tetapi tidak signifikan secara statistik terhadap pertumbuhan ekonomi dalam jangka panjang. Pembiayaan elektrik, gas, dan wap juga menunjukkan kesan jangka panjang yang positif tetapi tidak signifikan, manakala pembiayaan pertanian, perhutanan, dan perikanan menunjukkan kesan jangka panjang yang negatif dan tidak signifikan. Perlu diperhatikan, pembiayaan Islam untuk sektor pendidikan, kesihatan manusia, dan kerja sosial menunjukkan hubungan jangka panjang yang positif dan signifikan secara statistik dengan pertumbuhan ekonomi. Analisis jangka pendek menghasilkan keputusan yang berbeza-beza merentasi pelbagai lag untuk semua sektor. Pemeriksaan ketahanan menggunakan model FMOLS, DOLS, dan CCR mengesahkan penemuan ARDL. Kajian ini menjelaskan potensi kewangan Islam daripada perbankan Islam dalam mempromosikan pembangunan infrastruktur yang mampan dan pertumbuhan ekonomi, dengan implikasi untuk pembuat dasar, institusi-institusi kewangan Islam, dan para pelabur. Ia juga mengenal pasti bidang untuk penyelidikan masa depan, seperti perbandingan antara negara dan analisis khusus sektor.

Kata kunci: Pertumbuhan ekonomi di Malaysia, Pembiayaan Lestari, Projek infrastruktur, Perbankan Islam, Analisis ARDL (*Autoregressive Distributed Lag*)

DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and any editorial work, paid or unpaid, carried out by a third party is acknowledged.

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IN THE NAME OF ALLAH, THE MOST GRACIOUS THE MOST MERCIFUL

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
BIC	Bayesian Information Criterion
CCR	Canonical Cointegration Regression
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMQ	Cumulative Sum of Recursive Residuals of Square
DOLS	Dynamic Ordinary Least Squares
ECM	Error Correction Model
ECT	Error Correction Term
ESG	Environmental, Social, and Governance
FMOLS	Fully Modified Ordinary Least Squares
GDP	Gross Domestic Product
GCC	Gulf Cooperation Council
ICT	Information and Communication Technology
IsDB	Islamic Development Bank
LLF	Lives and Livelihoods Fund
NPF	Non-Performing Financing
OIC	Organization of Islamic Cooperation
OD	Ordered Data
PSIFIs	Prudential and Structural Islamic Financial Indicators
REIT	Real Estate Investment Trust
SBSN	Surat Berharga Syariah Negara (State Shariahh Securities)
SDG	Sustainable Development Goal
SSB	Shariahh Supervisory Board

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The concept of Islamic banking has its basis from Islamic Law which forbids any transactions that bear interests (*riba*). Literally, *riba* is seen as implying only an addition, an increase, growth or enhancement (Borhan and Saari, 2004). Technically, it refers to a surplus or an excess definition of advocate. Further, values and transactions must be entirely created on the basis of risk sharing where every participant shares all risks pertaining to any profit generated or a loss that may be borne according to the terms of the business itself. The main principle set out in Islamic law regarding the Islamic bank is the making of moral investments. The activities, transactions and products provided by Islamic banking will be in accordance with the ethics of Al-Quran and Al-Sunnah.

The development and growth of the Islamic banking industry is observed in different areas such as retail, corporate and international trade. The average growth rate of this industry ranges from 12% to 15% on an annual basis (Güngoren, 2013). In particular, Islamic banking has made steady progress in the retail business in countries such as Malaysia. Malaysia has established a complete Islamic retailing system where the consumer is provided with a variety of Shariahh-compliant products and services (Venardos, 2010). This development has enhanced the participation and access of faith-based clients to financial services.

Mudarabah and *Murabahah*, along with other tools and services, have been incorporated into Islamic banking for international trade and corporate business. ICT's guide on Islamic finance describes the methods by which small businesses in developing countries can export and penetrate the world market with the help of Islamic banking tools (ITC, 2009). They have not only these but have also begun to offer investment funds, asset management, and takaful insurance companies to the corporate sector (Güngoren, 2013). New Shariahh-compliant products and high demand have surged this industry to cater to the expectations of the general market. Nevertheless, the simplest Islamic accounts and trading in foreign markets have various limitations. The primary challenge is, for example, to find a balance between economic aims and basic Islamic tenets in the case of complex financial instruments and trade finance.

Infrastructure development in Malaysia requires significant investment, with Southeast Asian countries needing at least $150 billion annually to maintain economic growth (Rogozhin, 2019). Malaysia, like other countries in the region, faces challenges in financing infrastructure projects solely through public funds or foreign capital. This suggests a potential funding gap that needs to be addressed. Furthermore, Islamic finance has emerged as a viable alternative for funding infrastructure projects in Malaysia, addressing the gap between infrastructure demand and available finance (Biancone & Shakhatreh, 2015).

Islamic banking has started to position itself as a critical option in the infrastructural projects financing market, which raises some opportunities and challenges. There is evidence which suggests that Islamic banks offer an infrastructure development financing option, which is compliant with the Islamic law (Biancone & Radwan, 2018). This method has proved to achieve fantastic levels in the last couple of decades, even maintaining itself throughout depressions (Shaikh, 2014).

There are various parts of the world where Islamic finance has been practiced in the completion of infrastructure projects. For example, in Indonesia, Islamic banks are active in infrastructure funding using Islamic schemes as evidenced by case studies of mini hydropower plants projects (Rarasati et al., 2019). In the same way, Islamic finance has been employed for infrastructure in the Gulf Cooperation Council (GCC) countries but its potential has not been fully utilized in these countries (Tariq, 2012). Islamic project financing is regarded as a tool to help resolve the deficit between what the infrastructure is requiring and what funding is in place, even in non-Muslim countries including Italy (Biancone & Shakhatreh, 2015).

Islamic principles are consistent with basic features of sustainability like fair allocation of resources, protecting the environment and the future generations of the planet. There is a lot of emphasis on safeguarding the environment, eliminating poverty, and maintaining a vibrant economy among the Islamic tenets. Islamic finance principles of equity, risk-sharing, no interest-bearing transactions and social justice can be applied to education and business management practices for improved efficiency, fairness and sustainability (Jinan et al., 2024). Such a strategy strengthens the financial viability of

institutions and at the same time strengthens the cultural and religious fabric of the Muslim populace. In addition, Islamic finance principles based on Islamic religious values advanced initiatives of Corporate Social Responsibility (CSR) that supported environmental and social sustainability (Setiawan, 2023).

The integration of the sustainability paradigms and Islam lends support to stewardship over the social, economic, and environmental spheres. If these values are integrated in decision-making, both in the public and private spheres, the Muslim communities can greatly contribute to achieving the goals of sustainable development without undermining their faith and morality. In order to achieve sustainability objectives, Islamic financial institutions are using instruments such as sukuk bonds in their efforts to finance infrastructure. It has become popular to use green sukuk in the implementation of infrastructure projects while at the same time having the objectives of maintaining sustainable development (Arifudin et al., 2024; Yulitasari et al., 2024). This is a novel approach, which allows Islamic financial institutions to accompany the process of transitioning to a sustainable economy whilst adhering to the tenets of Islam (Piratti & Cattelan, 2018). For instance, a number of sovereign green sukuk have successfully been introduced in, Indonesia as well as Malaysia as a way of financing green infrastructure (Saba et al., 2021; Yulitasari et al., 2024).

Islamic finance has something to offer in regard to economic development, considering the Islamic banks total deposits, total financing, and total assets, they are all positively correlated with long term economic development. In essence, these aspects assist in the overall development of the financial industry and also supply the prerequisites for

investments in different businesses. Another very shrewd and pertinent point is that Islamic banking enhances a nation's economic stability (El-Galfy and Khiyar, 2012), which is important for continuous economic development.

However, there are some researches that offer Islamic banking's impact on economic growth but see it from a more debateable perspective. For example, Azouzi and Echchabi (2013) coefficients point towards a negative and undeterminable long-term relationship between the growth of Islamic banking and development in Kuwait's economy. In the UAE, Echchabi and Azouzi (2015) reported an absence of relationship. Such inconsistencies call their relationships into question and perhaps even invite more investigation as to why these effects change throughout the context and time encountered.

The development of infrastructure is very critical in promoting economic growth and competitiveness as it lays the basis for further economic development, according to Farikhi et al. (2022). As one of the best alternatives to address infrastructure financing challenges, Islamic project finance is seen to be applicable particularly in emerging economies that have a significant investment base but shallow long-term financing (Farikhi et al., 2022). Islamic project finance is appropriate for infrastructure financing since it is based on the project as the basic asset as Farikhi et al. (2022) alone stated.

However, in the GCC areas, where Islamic finance has been touted as useful for the growth of infrastructure, Islamic finance and capital market activity in the sphere of infrastructure projects, excluding real estate, have not been active at all (Tariq, 2012).

Now, this provides opportunity for growth and expansion in the region. Besides, it has been observed that, in particular, some types of Islamic finance can be related with negative economic growth implications. For instance, for many observers, "*mudarabah* financing unpredictably shows a negative relationship with economic growth", Puspitasari et al. (2021) opined. With this, it would be clear that not all instruments of Islamic financing are useful for enhancement of the economy.

In the short run, some developments related to the Islamic bond market have been found to have a significant but adverse effect on GDP growth (Naz & Gulzar, 2020). This suggests that Islamic infrastructure financing through bonds would seem to have some adverse effects on economic growth in the short run. To sum up, even though Islamic finance is at most times regarded as a 'good' thing, particularly during aspiring for infrastructural investment, any particular component of its funding techniques or specific sectoral financing can also be detrimental. Such results suggest that Islamic financing for infrastructure projects should be handled quite cautiously and that strategies should be devised to achieve favourable results. Therefore, from many cases above regarding the difference impact of infrastructure financing toward economic growth, this research aims to further research especially impact of Islamic infrastructure financing by Islamic banking in Malaysia's economic growth.

1.2 Problem Statement

Yaacob (2024) highlight the imbalance between transportation development and urbanization and economic growth in Klang Valley and Kuala Lumpur region and provide this as one of the reasons behind increasing traffic congestion. Furthermore,

the gaps in funding are the underlying reason why these programs are unable to be realized (Harumain et al, 2024). Realty Income Trusts are an interesting alternative. In contrast, the government's efforts such as the expansion of smart and green highways (Sazali and Firdaus, 2019) and REITs (Ishak et al., 2022) are a sign of commitment to alleviate these problems. The conflicting demands for developing infrastructure while ensuring high levels of sustainable development through innovative solutions and funding mechanisms are very much alive in Malaysia. Therefore, Islamic economic can be alternative fund, particularly for supporting the development of nation economic.

In Malaysia, there are quite a number of difficulties that have been attributed to the provision of ICT infrastructure. These include a lack of funding as well as the much pronounced urban and rural divide. The government of the country understand the importance of the ICT Revolution as one of the areas in which Malaysia could improve in its socio-economic setting. Nevertheless, it is noted, over 40% of the population lives in the regions which do not have the most basic communication infrastructure, including fixed telephones and internet access (Meng et al., 2013).

This has expanded the information divide between rural and urban areas, which the government is trying to close through initiatives like telecentres that allow rural populations to gain access to ICT resources (Meng et al., 2013). There are, however, certain anomalies in the implementation, quite a number of projects are still at the drawing board stage or have failed to take off (Meng et al., 2013).

Agricultural challenges in Malaysia encompass extreme weather conditions, poor soil fertility, and nutrient management issues. Farmers frequently exhibit a lack of awareness and knowledge, and there exists a reluctance towards genetically-modified planting materials. The inadequate deployment of technology further impedes agricultural productivity (Dorairaj & Govender, 2023). These issues indicate a necessity for enhanced infrastructure and funding for farmer education and technology adoption. In the forestry, Malaysia confronts challenges in balancing socio-economic needs with ecological functions. While agroforestry systems are recognized as viable options, their broader implementation is hindered by insufficient knowledge, limited institutional capacity, and inadequate funding (Paudel et al., 2021). This underscores the requirement for increased financial support and infrastructure development in the forestry sector.

In conclusion, Malaysia's agriculture, forestry, and fishing sectors necessitate substantial improvements in funding and infrastructure. These encompass investments in technology adoption, farmer education, smallholder support, and agroforestry implementation. Addressing these issues is crucial for enhancing the sustainability and productivity of these vital sectors in Malaysia's economy.

The relatively fast growth registered in the Malaysian economy has triggered an even greater increase in energy consumption, where final energy consumption is projected to increase at an annual rate of 7.8% within the years 2001 to 2005 (Jaafar et al., 2003). Development of this growth places strain on the already constructed systems and requires huge capital inflows into the energy markets. The fact that country was

transforming towards a net importer of fossil fuels such as oil gas and coal presented other issues with regards to energy security and supply of energy into the economy (Jaafar et al., 2003).

The electricity consumption in Malaysia is causally determined by economic growth and vice versa on the basis of a Granger Causality test which has been established by Tang & Tan in the year 2012. This emphasis the provision of sufficient electricity supply infrastructure in order for the economy to grow. But, due to the urgency for funding in renewable energy resources and energy efficiency measures, there is a funding gap that needs to be filled in (Jaafar et al., 2003; Tang & Tan, 2012).

Investment in education and health has a positive impact on Malaysia's economy as this develops human capital (Azam et al., 2017; Widarni & Wilantari, 2021). One such factor is the low amount of funds allocated by the government towards education, which is a serious issue as it restricts human capital growth which is crucial for development (Othman et al., 2024). In extreme cases of this type of underinvestment, we are likely to create skill gaps without productivity.

Malaysia's economic advancement certainly requires investment in health and education infrastructure, but the relationship is not simplistic. The government has to be careful of the distribution of expenditure over sectors with focus on enhancing returns. The challenge is how to manage public spending such that economic development goals are achieved while addressing public expenditure gaps on key sectors such as education and health infrastructure funding (Othman et al., 2024; Binti

Zawawi et al., 2024). New researches need to consider what is the right amount of investment in these sectors for the economic development of Malaysia in a sustainable manner.

1.3 Research Questions

This study objectives are to determine the impact of sustainable Islamic banking financing particularly in infrastructure projects between independent variables consist of economics sectors, social sectors, and environment sectors on dependent variable on Malaysia's economic growth (GDP). There is the research question by the discussion above:

i. To what extent does sustainable Islamic banking financing focus on economics infrastructure sectors (transportation) contribute to Malaysia Real GDP in long-run and short-run?

ii. To what extent does sustainable Islamic banking financing focus on economics infrastructure sectors (information and communication technology) contribute to Malaysia Real GDP in long-run and short-run?

iii. To what extent does sustainable Islamic banking financing focus on environmental infrastructure sectors (electric, gas and steam) contribute to Malaysia Real GDP in long-run and short-run?

iv. To what extent does sustainable Islamic banking financing focus on environmental infrastructure sectors (agriculture, forestry, and fishing) contribute to Malaysia Real GDP in long-run and short-run?

v. To what extent does sustainable Islamic banking financing focus on social infrastructure sectors (education) contribute to Malaysia Real GDP in long-run and short-run?

vi. To what extent does sustainable Islamic banking financing focus on social infrastructure sectors (human health and social works) contribute to Malaysia Real GDP in long-run and short-run?

1.4 Research Objectives

Primary Objective: To observe the impact of sustainable Islamic banking funding on Malaysia's economic development, particularly in relation to infrastructure projects.

Particular Aims:

i. To analyse the relationship of sustainable Islamic banking financing focus on economics infrastructure sectors (transportation and storages) contribute to Malaysia Real GDP in long-run and short-run.

ii. To analyse the relationship of sustainable Islamic banking financing focus on economics infrastructure sectors (information and communication technology) contribute to Malaysia Real GDP in long-run and short-run.

iii. To analyse the relationship of sustainable Islamic banking financing focus on environmental infrastructure sectors (agriculture, forestry, and fishing) contribute to Malaysia Real GDP in long-run and short-run.

iv. To analyse the relationship of sustainable Islamic banking financing focus on environmental infrastructure sectors (electric, gas and steam) contribute to Malaysia Real GDP in long-run and short-run.

v. To analyse the relationship of sustainable Islamic banking financing focus on social infrastructure sectors (education) contribute to Malaysia Real GDP in long-run and short-run.

vi. To analyse the relationship of sustainable Islamic banking financing focus on social infrastructure sectors (human health and social works) contribute to Malaysia Real GDP in long-run and short-run.

1.5 Significance of the Study

The research on infrastructure financing, particularly through Islamic financing, reveals a gap in the existing literature. Consequently, this study aims to address this gap by contributing to the theoretical, empirical, and practical dimensions of the field.

1.5.1 Theoretical and Empirical

This research addresses a notable gap in the existing literature by examining the complex interrelationship among Islamic finance, sustainability, and economic growth in Malaysia. By investigating the role of Islamic financing in promoting sustainable infrastructure, this study offers novel insights and establishes a foundation for further scholarly inquiry. The findings are expected to contribute valuable knowledge to the fields of Islamic finance, sustainability, and economic development, potentially informing policy decisions and industry practices in Malaysia and beyond.

The significance of infrastructure development in numerous countries can serve as a catalyst for economic growth. This assertion is supported by previous studies on infrastructure financing, physical infrastructure, and investment in relation to national economic growth (for example, Sojka and Pietrucha, 2024; Zeng and Ziang, 2023; Ranjan et al., 2019; Olayide, 2023; Arvin et al., 2021). Furthermore, research on Islamic financing, particularly from Islamic banking, remains limited in empirical studies.

According to the previous studies above the theoretical significance of the study lies in its integration of Islamic finance principles with sustainable development concepts, providing a unique perspective on how Shariahh-compliant financing can contribute to economic growth through infrastructure development. This approach enhances the understanding of potential synergies between Islamic financial practices and sustainability goals, offering a theoretical framework for future research in this area. Additionally, the research contributes to the broader discourse on alternative financing models for sustainable development, particularly in the context of emerging economies with significant Muslim populations.

Empirically, this study presents quantitative evidence regarding the influence of Islamic infrastructure financing on various sectors of the Malaysian economy. Utilizing advanced econometric methodologies, specifically the Autoregressive Distributed Lag (ARDL) model, the research yields robust empirical findings concerning both short-term and long-term relationships between Islamic financing and economic growth. These empirical results not only enhance the academic literature but

also provide practical insights for policymakers and financial institutions aiming to leverage Islamic finance for sustainable economic development.

1.5.2 Practical

The research offers significant insights for Islamic financial institutions, banks, and investors by presenting empirical evidence on the benefits and challenges associated with financing sustainable infrastructure projects. This framework aims to guide Islamic financial institutions in aligning their practices with national objectives related to sustainable development and economic growth. The findings can aid these institutions in developing more effective and targeted financing products, improving risk assessment methodologies for sustainable projects, and enhancing their overall contribution to the sustainable development agenda.

The outcomes of this investigation hold substantial significance for policymakers in Malaysia who are seeking to expand sustainable financing through Islamic banking for infrastructure development. The findings have the potential to inform regulatory bodies, such as Bank Negara Malaysia, in formulating policies that promote sustainable Islamic financing models. This may include the development of novel regulatory frameworks, incentive structures, or guidelines that encourage Islamic financial institutions to increase their participation in sustainable infrastructure projects.

The study provides comprehensive analyses of diverse infrastructure sectors, including transportation, ICT, energy, agriculture, education, and healthcare. These sector-specific insights can inform targeted policy interventions and investment strategies.

By identifying the unique challenges and opportunities within each sector, the research enables policymakers and investors to tailor their approaches accordingly. This granular understanding can facilitate more effective allocation of resources, prioritisation of projects, and development of sector-specific financing solutions that address the particular needs and characteristics of each infrastructure domain.

1.6 Scope of the Study

The study examines Islamic banking institutions operating in Malaysia, encompassing both domestic and international banks that provide Shariahh-compliant financing options. The geographical focus on Malaysia is strategically selected due to the country's significant role in Islamic finance and its government's strong commitment to sustainable infrastructure development. This choice facilitates an in-depth analysis of a mature Islamic financial market and its interaction with sustainability initiatives.

The temporal scope, extending from the first quarter of 2015 to the second quarter of 2024, offers a comprehensive perspective on recent and ongoing infrastructure projects, aligning with major national development initiatives during this period. This timeframe enables the research to capture evolving trends in Islamic finance and sustainable infrastructure, providing insights into both established practices and emerging innovations.

The thematic and institutional scopes further refine the study's focus. By concentrating on sustainable infrastructure projects across various sectors such as transport, ICT, energy, agriculture, education, and social health, the research aims to provide a holistic

view of how Islamic financing instruments are applied across different domains of sustainable development. The inclusion of both local and foreign Islamic banking institutions operating in Malaysia offers a diverse perspective on Shariahh-compliant financing options. This approach allows for a comparative analysis of different institutional practices and their effectiveness in supporting sustainable infrastructure projects, potentially revealing best practices and areas for improvement at the intersection of Islamic finance and sustainability.

1.7 Definition of Key Terms

1. Islamic Banking

   Islamic banking is a financial system that operates in accordance with Islamic law (Shariahh) and principles, offering interest-free banking arrangements that involve risk-sharing and cater to all sections of society (Nawaz, 2017).

2. Sustainable Financing

   Sustainable financing refers to the sufficient and predictable allocation and use of resources to support the achievement of long-term goals within the framework of overall health or economic financing (Saxenian et al., 2022).

3. Infrastructure Projects

   Infrastructure projects are large-scale public works initiatives aimed at developing and maintaining essential facilities and systems that support the functioning of society and the economy (Järvenpää et al., 2021).

4. Economic Growth

   Economic growth is generally defined as the increase in the overall production or output of an economy over a specific period, typically measured by the growth in

Gross Domestic Product (GDP). This concept is central to understanding a nation's economic performance and development (Upadhyaya et al., 2023).

5. Shariahh-compliant Financing

   Shariahh-compliant financing refers to financial practices and instruments that adhere to Islamic principles and laws (Gholipour & Meisamy, 2020).

1.8 Organisation of the Study

The research structure comprises five chapters. Chapter One introduces the study, covering its background, problem statement, research questions, objectives, significance, scope, and key terminology. Chapter Two reviews existing literature on Islamic banking, infrastructure financing, sustainability, and economic growth, analysing theoretical frameworks related to Islamic finance and its role in sustainable development. Chapter Three details the research methodology, including research design, data collection methods, data sources, and analytical techniques. Chapter Four presents the data analysis and discussion, examining the collected data in relation to the research objectives and comparing outcomes between Islamic and conventional financing. Finally, Chapter Five concludes the study by synthesizing the main findings, exploring contributions for Islamic banking and economic policy, and offering recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The concept of 'literature review' can be best understood as an exhaustive survey and analysis of the existing scholarly literature related to a particular topic or a research problem. This appears to have a number of uses in academic research (Ebidor and Ikhide, 2024). Consequently, this chapter will examine the previously mentioned studies concerning Islamic finance, Islamic banking's involvement in infrastructure development, the sectors of sustainable financing, and the determinants of economic growth, along with the theoretical constructs that guide the research effort.

2.2 Islamic Banking and Sustainable Financing

Islamic banks have incorporated the ESG verifying in their portfolio investment allocation strategies especially in the palm oil sector practices (Saratian and Arief, 2018). This practice underscores the application of sustainable finance principles in the operations of the Islamic banking system. Moreover, Islamic banks are also offering new products such as green sukuk to finance social environmentally sustainable energy projects (Kismawadi et al., 2024).

Al-Roubaie and Sarea (2019) argue that Islamic banks give concern and refrain from exerting threats to the environment as they pursue acceptable forms of investment that are oriented toward sustainable business or technology that will benefit the local

population. This concept is closely related to the purpose of *maqasid* Shariahh (goals of Islamic Shariahh), which stipulates inclusive human enhancement (Sunarya & Rusydiana, 2022). In addition, Islamic Shariahh embedded in the goods of the Islamic financial sector has also contributed a lot to the promotion of sustainable finance by encouraging the Islamised economy (Hartadinata et al., 2023).

Sustainable financing encompasses all the approaches, objectives and actions that will determine all financial decisions to be made in such a way that economic growth exists alongside environmental protection and social requirements (Budiasa, 2020; Martin, 2023). It has been seen that Sustainable Development Goals (SDGs) can be advanced and the promotion of ethical financial operations is possible using Islamic banking and finance (IBF). In this context, the Shariahh Supervisory Board (SSB) is important as it authenticates Islamic finance aspects. The characteristics of SSB indeed are able to influence the integrating of SDG finance in the research level (Umar, 2024).

Infrastructure Finance in Islamic banking perspective provides a collection of financial instruments to financing the infrastructure projects with Sukuk being one of them. Islamic bonds, known as sukuk, are financial instruments which constitute a form of legal ownership with respect to an underlying asset and are compliant with Islamic law (Khorshid, 2012). These assets have gained popularity in international markets and are being mobilized for development of sustainable financial architectural projects. Tariq (2012) has noted that there has been significant progression in the Islamic infrastructure investments in the Islamic Regions particularly within GCC region with Qatar alone intending to undertake More than seventy Billion US Dollars' worth of

infrastructural development activities through the year two thousand and thirty. As such if the possibilities in Islamic finance are clear, there are hurdles to clear in regard to development in infrastructure which have to be looked into in detail for instance innovative creating funding strategies like the Lives and Livelihoods Fund (LLF) which is already utilized by the Islamic Development Bank (World Bank Group, 2017; Pericoli, 2020).

2.3 Sustainable Financing Sectors

The concept of sustainable financing can be divided into three parts: the economic, the environmental and the social. These three categories are interrelated while being distinct crucial to the achievement of a sustainable development goal. Sustainable financing in economic perspective fosters initiatives aimed at the economic advancement of the society but also extends influence to the socio as well as the environmental realms.

Islamic financial institutions have expressed an interest in providing credit facilities to borrowers having a specified Environmental, Social, and Governance (ESG) focus in Eco-friendly construction works, sustainable farming, environment-friendly and other infrastructure development activities, forestry, clean energy, waste recycling, and energy efficiency practices (Hayati et al., 2020).

The financing of environment sectors is targeted towards protecting the natural resource and addressing global warming issues. Green bonds and further developments

of other financial instruments have been proposed as an effective means for financing sustainable energy programmes (Peng & Chen, 2023). These strategies have becoming more predominant in the endeavour of the environmental sector of the organization towards realizing its goals. Moreover, the effect of sustainable finance geared towards reduction of fossil fuels dependency advocates the use of renewable energy and energy-efficient technologies (Iordachi, 2024). The focus of sustainable finance in the social sector is to enhance the overall social wellbeing as well as to curb poverty. This has a role in financing quality education, poverty alleviation, and gender initiatives (Wuaten, 2022).

All things considered, for developing depth there exists a unique method of sustainable financing, in which economic, environmental and social dimensions are given a consideration. Investments that are consistent with the Paris Agreement on Climate Change and Sustainable Development Goals also determine the speed of the process of transformation in order to strengthen and ensure the sustainability of the global economy. This sinewy investment orientation, sometimes referred to as sustainable finance, is an engine of disruptive shifts in terms of the state of the economy, its features and structure (Budiasa, 2022).

2.4 The Role of Islamic Banking in Infrastructure Financing

As governments tend to engage the private sector for infrastructure works more than before, Islamic banks have come up with structures which are consistent with the Shariahh. With respect to Islamic banks as one of the sources, the Islamic Development Bank (IsDB) is considered to be a leader in the areas of development and humanitarian

assistance and implements programs among its member states (Pericoli, 2020). In regard to Islamic banks and their affiliates and partners, the Lives and Livelihoods Fund (LLF) provides assistance to health, agricultural as well as infrastructure initiatives with lower or more affordable risk adjusted returns with constructs that are attractive (Pericoli, 2020).

It has been recognized that Islamic finance is one of the alternative funding sources that can be used to fill the voids in the funding for Infrastructure projects in the Third World. For example, Indonesian authorities have developed a small hydropower plant based on Islamic financing scheme (Rarasati et al., 2019). While Islamic banks are making a sizeable contribution to these projects in the form of Shariah compliant financing, this method has its own obstacles to be addressed in the future, for wider adoption (Rarasati et al., 2019).

On the one hand, the role of an Islamic bank is seen as still a grey area due to the nature of the market and the gap that exists in both theory and practice but on the other hand, it is inarguable that Islamic finance is becoming more relevant in the Muslim world (Buana & Dali, 2023). As the funds collected from the various forms of debt are used, the Shariahh regulations on the business increase in significance. This is an opening for scholars to investigate a subject matter that seems to need more research and development. Also, the role of such finance is growing in sub-Saharan Africa and as such has implications in spurring growth of the small and medium-sized enterprises as well as microfinance industries (Gelbard et al., 2014).

In summary, Islamic finance may help in raising funds for implementing and financing infrastructure in waqf, sukuk, or microloans, as well as other new formats for projects that allow adherence to ethical investment and Shariahh rules, thereby focusing on sustainable economic development. The steps being taken by say the LLF and the efforts to blend Islamic finance with the Indonesian initiatives in infrastructure development show the promises. Still, more works and resources are required to fill the gap and increase the use of Islamic finance in relation to infrastructure financing and development.

2.5 Economics Growth and Infrastructure Sectors

2.5.1 Gross Domestic Product (GDP)

Gross Domestic Product (GDP) is a fundamental economic indicator that measures the total value of goods and services produced within a country's borders over a specified period. In contrast, Real GDP provides a more accurate representation of a nation's economic status by accounting for inflation and reflecting changes in prices over time (Liu, 2020). GDP can be evaluated at various scales, from national to regional levels, and can even be disaggregated into gridded datasets for more detailed local analysis (Ru et al., 2023). It encompasses multiple economic sectors, including agriculture, industry, and services. For instance, agricultural GDP is a critical metric for assessing the primary sector, which supports the livelihoods of over 2.5 billion individuals globally (Ru et al., 2023).

2.5.2 Transportation and Storage Infrastructure

Transportation encompasses the movement of goods from one location to another, utilizing various modalities such as trucks, ships, or airplanes. Within the domain of cold chain logistics, specialized refrigerated vehicles are utilized to maintain the requisite temperature throughout transit (Liu et al., 2021; Lorenc, 2023). Conversely, storage pertains to the temporary retention of goods in warehouses or distribution centres under controlled conditions. In the context of cold chain logistics, this typically involves refrigerated or frozen storage facilities with specific temperature settings tailored to different product types (Zheng et al., 2020).

Transportation and storage infrastructure is essential across various sectors, including energy, industry, agriculture, and logistics. Within the realm of hydrogen infrastructure, storage can be accomplished through physical methods, such as compressed gas, liquid, or supercritical states, as well as through material-based approaches, including liquid-organic hydrogen carriers, metal hydrides, or power fuels. Transportation options include land transport via trailers and pipelines, as well as overseas shipping (Yang et al., 2023)

2.5.3 Information and Communication Technology Infrastructure

Information and Communication Technology (ICT) encompasses a broad spectrum of digital technologies employed for communication, data processing, and information management. It is instrumental in the development of smart cities and communities on a global scale (Tcholtchev & Schieferdecker, 2021). ICT infrastructure pertains to the

fundamental technological systems and components that support ICT services across various sectors and communities. This infrastructure comprises hardware, software, networks, and facilities that facilitate the storage, processing, transmission, and exchange of digital data (Duan & Dinavahi, 2021; Tcholtchev & Schieferdecker, 2021).

2.5.4 Electric, Gas, and Steam Infrastructure

Electric, gas, and steam infrastructure comprises the interconnected systems responsible for the production, transmission, and distribution of electricity, natural gas, and steam to meet energy demands. The electric infrastructure includes power plants, transmission lines, and distribution networks that deliver electricity to consumers (Karimianfard et al., 2022). The natural gas infrastructure encompasses pipelines, storage facilities, and distribution systems for the transportation and delivery of natural gas (Hemmati et al., 2020). Steam infrastructure typically involves centralized steam generation facilities and distribution pipelines, which are commonly employed in industrial settings or district heating systems.

2.5.5 Agriculture, Forestry, and Fishing Infrastructure

The infrastructure underpinning agriculture, forestry, and fishing comprises a wide range of components, including equipment, facilities, and systems vital for production, processing, and distribution. In the agricultural sector, this infrastructure may include irrigation systems, agricultural machinery, and storage facilities. In forestry, it encompasses logging equipment, processing facilities, and transportation networks.

Within the fishing industry, it involves vessels, fishing gear, aquaculture installations, and processing facilities (Correa-Cano et al., 2023; St-Gelais et al., 2022).

2.5.6 Education Infrastructure

Education infrastructure comprises the physical and digital facilities, resources, and systems that support teaching and learning within educational environments. It encompasses various components essential for delivering high-quality education. Physical infrastructure includes school buildings, classrooms, laboratories, libraries, and other amenities that create a conducive learning environment (Fernández et al., 2023). Digital infrastructure encompasses technological tools such as computers, internet access, learning management systems, and virtual laboratories (Alda et al., 2020). Both types of infrastructure are crucial for providing effective education in the contemporary world.

2.5.7 Human Health and Social Work Infrastructure

The infrastructure underpinning human health and social work constitutes a complex system that integrates components ranging from natural environments to healthcare systems and social services. This infrastructure is crucial for the enhancement and maintenance of population health and well-being. A fundamental element of this infrastructure is the health literacy system's capacity, which is dedicated to developing personal skills and organizational frameworks that enable individuals to effectively access, understand, and utilize health information and services (Sørensen et al., 2021). Achieving this objective necessitates collaboration across various sectors, including

public health, healthcare, urban planning, and social services, to effectively address the social determinants of health and enhance population well-being (Lipshutz et al., 2021). The COVID-19 pandemic has highlighted the imperative of strengthening this infrastructure, particularly in areas such as leadership, governance, human resources, financing, information systems, and technology (El-Warrak et al., 2023).

2.6 Underpinning Theory

The term "underpinning theory" refers to the foundational concepts, frameworks, or models that establish the theoretical basis for understanding and explaining phenomena across various fields of study. In this research, endogenous growth theory serves as a foundational concept for elucidating the phenomena under investigation.

2.6.1 Endogenous Growth Theory

Endogenous factors are now the broad determinants of growth, current evidence points to the ‘endogenous growth theory’ as the one that best explains the role played by these different factors such as human capital, technology and innovation. In contrast to neo-classical growth models who considered this type of factors to be external influences (Nour, 2013; Sato et al., 1998). Citing, Renaissance of economic paradigms at the Endogenous level, it is argued that construction of transport systems and other essential components are instrumental in pushing the economic growth further. This creates knowledge and enhances creativity and productivity (Jiang et al., 2016; Sato et al., 1998).

Even more interesting, the relationship between economic growth and infrastructure is a bidirectional relationship. Economic development also provides room for further growth of infrastructural development as much as infrastructural development encourages economic development (Jiang et al., 2016). This kind of simultaneous interaction can be observed especially in the case of the built environment where investment in transport infrastructure can drive concentration of activities in specific pixels and thus external effects and enhance growth not only in the region of in question but also in region surrounding the focus point of investment (Jiang et al., 2016).

To summarize, the Endogenous Growth Theory offers a conceptual structure that enables us to comprehend how the development such as physical infrastructure leads to lasting economic transformations. Incorporating infrastructure more precisely into growth models enables researchers to investigate the more intricate relationships between investment, economic growth and factors such as human capital and technology upgrading (Grossmann & Steger, 2007; Sato et al., 1998). To this end, such an approach is very useful for policymakers to design infrastructure investment strategies that target long-term economic growth and development.

2.7 Previous Research on Infrastructure Projects Financing towards Economic Growth

Research examining the correlation between infrastructure project financing and economic growth demonstrates a variative association, with numerous analyses underscoring its significance across various countries and industries.

Horvat et al (2020) investigated the effects of infrastructure investments on economic growth in East African countries. Utilizing data from 1990 to 2018 across eight countries, the research adopted a mixed-methods approach, incorporating quantitative correlation analysis and qualitative expert interviews. The findings indicated that infrastructure investments generally exhibited a positive correlation with economic growth, with 10 out of 13 infrastructure characteristics demonstrating significant positive correlations. The study emphasized the importance of prioritizing transport infrastructure, particularly seaports and roads, to foster economic growth. Additionally, the research confirmed the significant impact of Foreign Direct Investment (FDI) on infrastructure development and economic growth, alongside a positive relationship between infrastructure growth and human development. However, it was noted that not all projects directly contributed to economic growth, as some were focused on enhancing quality of life or environmental sustainability.

Meka'a et al. (2024) investigates the influence of public investment in basic infrastructure on economic growth and private investment in Cameroon. Employing a simultaneous equation model with data spanning from 1983 to 2020, the authors utilized the generalized method of moments to analyze investments in road, energy, and telecommunications infrastructure. The results indicate that investments in energy infrastructure significantly enhance per capita GDP growth, whereas investments in road and telecommunications infrastructure exhibit positive but statistically insignificant effects. Furthermore, investments in road and energy infrastructure positively affect private investment, while telecommunications investments exert a

negative impact. A noted limitation of the study is the absence of data on existing infrastructure stock, which could have provided further insights. The authors suggest that analyzing infrastructures individually, rather than collectively, might have produced different outcomes.

Sirait et al. (2023) conducted a quantitative study examining the impact of digital innovation on economic growth, focusing on technology infrastructure, digital lending, and digital payments. The study utilized regression analysis on data from 2015-2020. The findings revealed that technological infrastructure significantly positively affected real per capita income and public health, while digital payments had a positive and significant impact on health and education levels. However, digital lending showed insignificant effects on the studied variables. The study's limitations included the use of secondary data, which may not have encompassed all necessary variables, and potential issues with data accuracy due to sourcing from related agencies rather than government sources. Additionally, the study's findings may not be generalizable beyond its specific context.

Kirui and Sang (2023) studied the impact of public infrastructure on sustainable socioeconomic development in Kenya. The methodology involved reviewing literature on public infrastructure's role in socioeconomic reforms globally. The study found that reliable, adequate, and quality infrastructure (transport, energy, water, and telecommunication) attract Foreign Direct Investments (FDIs), revitalizing economic progress. It also revealed that oil and wind exploitation infrastructures in Northern Kenya provide local communities with employment, water, electricity, and improved

transport. However, increased pollution near oil sites was noted as a negative impact. A limitation is the study's reliance on existing literature without primary data collection, which could have provided more current and context-specific insights into Kenya's infrastructure-development relationship.

Olayide et al, (2023) studied leveraging infrastructure development for economic growth in Nigeria. Published in the Journal of Economics, Finance and Management Studies, the research used Autoregressive Distributed Lag (ARDL) to analyze data from 1981 to 2020. The study found short-run positive impacts on real GDP from communication, electricity, education, and health infrastructures, while transport infrastructure had a negative impact. Long-term, communication, electricity, and education infrastructures positively influenced real GDP, while transport and health infrastructures had negative impacts. Electricity infrastructure was most impactful, positively influencing all GDP components in both short-run and long-run. A limitation was the focus on quantity rather than quality of infrastructure components, which could offer additional insights into their impact on Nigeria's economy.

Pradhan et al. (2021) investigated the interconnections between urbanization, transportation infrastructure, ICT infrastructure, and economic growth in G-20 countries over the period from 1961 to 2016. Employing a panel vector error-correction model, the researchers identified significant temporal causal relationships among these four variables in both the short and long term. The study's principal finding indicates that sustained economic growth in G-20 countries is contingent upon the co-development of policies that foster a dynamic urban ecosystem, facilitated by

intelligent transportation systems and supported by a robust ICT infrastructure plan. A noted limitation of the study is its exclusion of economic fundamentals, which could elucidate the general disparity in the direction of temporal causality among the variables in the short term.

Infrastructure development can significantly enhance the economic growth of agriculture, forestry, and fishing sectors. Enhanced transportation networks and logistics facilitate the movement of goods, reducing costs and increasing market access for agricultural and forestry products (Ma et al., 2023). This can result in increased production and exports, contributing to overall economic growth. Moreover, improved infrastructure can enhance the efficiency of resource utilization and promote technological innovation in these sectors, further driving economic growth (Ma et al., 2023; Zeng & Jiang, 2023).

However, infrastructure development can also have adverse effects on these sectors and consequently on economic growth. Extensive infrastructure projects may lead to deforestation and habitat destruction, negatively impacting biodiversity and ecosystem services (Marques et al., 2019). This can result in long-term economic losses, as biodiversity and ecosystem services are crucial for sustainable agriculture and forestry practices. Furthermore, the expansion of infrastructure may lead to land-use changes, potentially reducing the available area for agriculture, forestry, and fishing activities (Marques et al., 2019).

The findings from various studies on the impact of infrastructure development on economic growth present a complex and sometimes inconclusive picture. While some research indicates positive correlations between infrastructure investments and economic growth, others reveal mixed or insignificant results. For instance, the study by Meka'a et al., Fotso, and Guemdjo Kamdem (2024) found that energy infrastructure investments significantly boosted per capita GDP growth in Cameroon, but road and telecommunications investments had positive yet insignificant effects.

Similarly, Sirait et al. (2023) observed that technological infrastructure positively affected real per capita income, but digital lending showed insignificant effects on the studied variables. Olayide et al, (2023) research in Nigeria revealed contrasting short-term and long-term impacts of different infrastructure types on real GDP. These varied outcomes across different contexts and infrastructure types highlight the complexity of the relationship between infrastructure development and economic growth, suggesting that the impact may depend on specific conditions, implementation strategies, and other contextual factors.

2.8 Research Framework

A research framework serves as a structured approach to guide and organize a study, providing a foundation for understanding complex phenomena and relationships within a research context. It typically comprises key concepts, theories, and variables that are relevant to the research question (Guntur, 2019). The conceptual framework by the Figure 2.1 for this research illustrates the connection between the infrastructure financing project utilizing Islamic banking as sustainable financing, which

encompasses three main sectors: economic, environmental, and social, in relation to economic growth in Malaysia.

This research employs three categories of independent variables: firstly, economic infrastructure financing sectors (transportation & storage, and information & communications); secondly, environmental infrastructure financing sectors (agriculture, forestry, fishing and electricity, gas, steams); and lastly, social infrastructure financing sectors (education, human health & social work). The dependent variable utilized in this study is Malaysia's Real GDP.

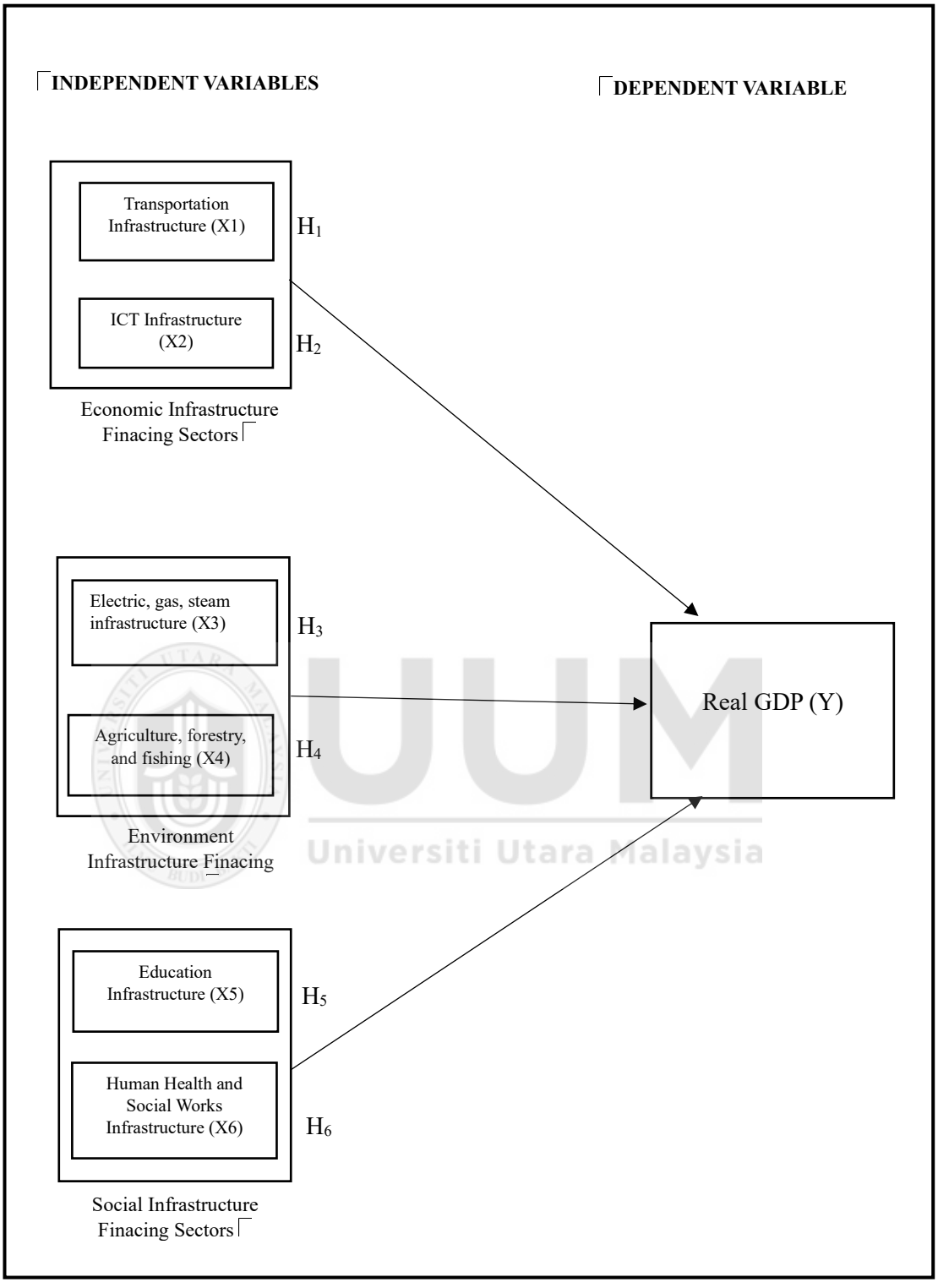

Figure 2.1
Research Framework

2.9 Hypothesis Development

According to (Alger, 2019; Mohareb, 2012), a hypothesis is a precise predictive statement or a speculative explanation for an observable phenomenon that can be tested and potentially disproven. It serves as a blueprint and summary of an investigation, describing in concrete terms what researchers expect will happen in their study (Mohareb, 2012). From Figure 2.1 about research frameworks, the variables and their relationships have been identified. Moreover, the test regarding these relationships and whether they have been theorized to hold true is significant. Furthermore, several hypotheses related to the study objectives were formulated:

2.9.1 Islamic infrastructure sustainable financing Transportation and Storage toward Malaysia's Economic Growth

The construction industry, which includes transportation infrastructure, is integral to global economic development (Alaloul et al., 2021). In Malaysia, the integration of this sector with other industries significantly enhances the economy and contributes to the Gross Domestic Product (GDP). Research indicates that sectors such as agriculture and services are closely interconnected with construction, suggesting their capacity to generate substantial income even during economic downturns (Alaloul et al., 2021).

Notably, while economic growth and urbanization have negatively impacted environmental quality in Malaysia, evidenced by rising CO2 emissions alongside GDP and urbanization (Ridzuan et al., 2023), Islamic financing methods offer viable solutions. Islamic social finance instruments, including Zakat, Waqf, Sadaqat, and Qard-hasan, can facilitate the achievement of Sustainable Development Goals (SDGs)

by promoting economic, social, and environmental sustainability (Dirie et al., 2023). These instruments can address 11 out of the 17 SDGs, with Islamic commercial finance potentially addressing the remaining goals.

Thus, based on the discussion above findings from the past studies, the hypothesized for these relations is:

H_1: *There a positively relationship between Islamic infrastructure sustainable financing in the transportation and storage sector towards Malaysia's economic growth (Real GDP) in the long-run and short-run.*

2.9.2 Islamic infrastructure sustainable financing Information and Communication Technology toward Malaysia's Economic Growth

ICT has been recognized as a significant driver of economic growth and environmental sustainability in various countries, including Malaysia. The adoption of ICT can lead to increased productivity, improved communication, and enhanced efficiency in economic operations (Hashemizadeh et al., 2023). In the case of Malaysia, studies have shown that ICT has a substantial impact on the country's economic growth and environmental sustainability.

Thus, based on the discussion above and findings from the past studies, the hypothesized for these relations is:

H_2: *There a positively relationship between Islamic infrastructure sustainable financing in the information and communication technology sector towards Malaysia's economic growth (Real GDP) in the long-run and short-run.*

2.9.3 Islamic infrastructure sustainable financing Electric, Gas, Steam toward Malaysia's Economic Growth

The implementation of Shariahh-compliant financing has demonstrated beneficial effects in reducing unemployment and promoting economic growth in Muslim-majority countries (Yuli & Rofik, 2023). In the context of Malaysia, this financial approach could prove particularly effective in funding sustainable energy infrastructure projects. Natural gas consumption has been identified as playing a crucial role in enhancing economic growth in both the short and long term in Malaysia, while contributing less to CO2 emissions compared to other non-renewable energy sources (Majekodunmi et al., 2023). This indicates that Islamic financing for gas infrastructure could support economic growth while aligning with environmental objectives.

Thus, based on the discussion above and findings from the past studies, the hypothesized for these relations is:

H_3: *There a positively relationship between Islamic infrastructure sustainable financing in the electric, gas, and steam sectors towards Malaysia's economic growth (Real GDP) in the long-run and short-run.*

2.9.4 Islamic infrastructure sustainable financing Agriculture, Forestry, and Fishing toward Malaysia's Economic Growth

Sustainable energy solutions, encompassing renewable and low-carbon sources, have the potential to foster economic growth while mitigating environmental impacts (Arvanitidis et al., 2023). The integration of electric vehicles into public transportation systems has demonstrated economic benefits and garnered substantial public acceptance, resulting in decreased air pollution and greenhouse gas emissions (Agaton et al., 2020). This evidence indicates that investments in sustainable infrastructure within the electric sector can have a positive influence on economic growth.

Thus, based on the discussion above and findings from the past studies, the hypothesized for these relations is:

H_4: *There a positively relationship between Islamic infrastructure sustainable financing in the agriculture, forestry, fishing sectors towards Malaysia's economic growth (Real GDP) in the long-run and short-run.*

2.9.5 Islamic infrastructure sustainable financing Education toward Malaysia's Economic Growth

Islamic finance and sustainable infrastructure financing in the education sector can significantly contribute to economic growth. The introduction of sustainable development goals has prioritized sustainability for many nations, leading to increased investment in educational systems. Institutional investors play a significant role in financing clean energy infrastructure, entrepreneurial development, and poverty reduction (Khan et al., 2022). The proposed Institutional Investor & Sustainable University Funding Governance Code offers a roadmap for creating alternative sustainable funding for higher education, potentially easing the government's burden and creating market opportunities.

Thus, based on the discussion above and findings from the past studies, the hypothesized for these relations is:

H_5: *There a positively relationship between Islamic infrastructure sustainable financing in the education sector towards Malaysia's economic growth (Real GDP) in the long-run and short-run.*

2.9.6 Islamic infrastructure sustainable financing Human Health and Social Work toward Malaysia's Economic Growth

Islamic finance holds considerable potential to contribute to sustainable development goals, particularly in the domains of human health, social welfare, and economic growth. The integration of Islamic financial instruments with sustainable development objectives can generate a powerful synergy for addressing societal challenges. Islamic social finance instruments, such as zakat, waqf, sadaqat, and qard-hasan, have been identified as effective tools for achieving sustainable development goals (Dirie et al., 2023). These mechanisms possess the capacity to address numerous social issues and enhance welfare conditions by ensuring economic, social, and environmental sustainability. Notably, Islamic social funding has the potential to achieve 11 out of the 17 SDGs, with Islamic commercial finance addressing the remaining goals (Dirie et al., 2023).

Thus, based on the discussion above and findings from the past studies, the hypothesized for these relations is:

H_6: *There a positively relationship between Islamic infrastructure sustainable financing in the human health and social work sectors towards Malaysia's economic growth (Real GDP) in both the long-run and short-run.*

2.10 Chapter Summary

The literature review investigates the interconnections among Islamic finance, infrastructure development, sustainable financing sectors, and economic growth. It scrutinizes various infrastructure sectors, including transportation, information and communication technology (ICT), energy, agriculture, education, and healthcare. The review underscores the potential of Islamic banking and finance instruments, such as sukuk, in funding infrastructure projects and promoting sustainable development.

Although Islamic finance demonstrates promise in supporting infrastructure and economic growth, particularly in Muslim-majority countries, its impacts may vary across different financial instruments and contexts. The chapter also addresses sustainable financing approaches across economic, environmental, and social sectors. Overall, the literature suggests complex relationships between Islamic infrastructure financing and economic growth that merit further investigation, especially as Islamic finance continues to evolve as an alternative funding source for development projects. The conceptual framework and hypotheses presented offer a structure for empirically examining these relationships within the Malaysian context.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the general approach which has been used in this study. In this chapter, the researcher will estimate the study parameters. This chapter also provides a description of the relevant theoretical economic framework, and the econometric techniques applied in this research. Also, this chapter explains how decisions were made and how the data was gathered. Moreover, it illustrates the relationships between dependent and independent variables in this study and detail approach used in the analysis of economic growth factors in Malaysia.

3.2 Research Design

The structure of research design is an integral part of the scientific research in the studies and writing of manuscripts because it provides a logical basis for the methodologies and procedures used to make observations as well as interpret the data. There came a time when it was only concerned about the explaining the taking of the data and the trend has changed to include the analysing of the data as well (Knight, 2010). This research seeks to find out how sustainable Islamic banks financing infrastructure projects affects economic growth in Malaysia. It is postulated this effect has relation by the Islamic banking sectors such as economic, environmental, and social financing.

The methodology of this study hinges on quantitative approach accompanied by econometric methods, which quantitative approach is a studies form a logical and orderly way of experimenting with numerous occurrences with the help of statistics. It uses tools and econometrics is defined to mean statistical techniques applied to economic data and to the modelling of economic relationships (Watson, 2015; Jorgenson, 2000). For this research will use the analytical tool namely Eviews 13 application and the research data have been accessed from secondary sources.

3.3 Data Sources

The significance of collecting data from reliable and accurate sources is crucial for conducting effective research. Failure to meet this criterion may render the research ineligible for continuation. In this study, the primary source of data is derived from secondary sources. Table 3.1 below provides a detailed description of the data information utilized in this research.

Table 3.1
Data Sources

Category	Time Period	Source
Real Gross Domestic Product (2015 Based year)	2015Q1 – 2024Q2	DOSM
Transportation Financing Sector (X1)	2015Q1 – 2024Q2	PSIFIs IFSB
Information and Communication Financing Sector (X2)	2015Q1 – 2024Q2	PSIFIs IFSB
Electric, Gas, and Steam Financing Sector (X3)	2015Q1 – 2024Q2	PSIFIs IFSB
Agriculture, Forestry, and Fishing sector (X4)	2015Q1 – 2024Q2	PSIFIs IFSB
Education Financing Sectors (X5)	2015Q1 – 2024Q2	PSIFIs IFSB
Human Health and Social Work Sectors (X6)	2015Q1 – 2024Q2	PSIFIs IFSB

Source: Author Construction (2024)

3.4 Model Specification

The dependent variable in this study is Real Gross Domestic Product (GDP) while the independent variables fall under three distinct groups each classified into two variables per sector. Firstly, the sectors concerning economic infrastructure include transportation financing (X1) and information and communication technology financing (X2) respectively. Secondly, the sectors that relate to environment infrastructure include electricity, gas and steam financing (X3) and agriculture, forestry, and fishing financing (X4). Thirdly, the sectors dealing with social infrastructure consist of education financing (X5) and financing of human health and social work (X6).

As Paul Romer explained in 1994, the theory of the economy system must be drawn from the internal development aspects of the economy system. Discussed in detail it brings in the role of human capital, innovation and knowledge as the engine of growth. An equation for a linear function in general is stated as:

$$Yt = At + \alpha Ht + \beta Kt + \gamma Lt + \epsilon t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.1)$$

Symbol		**Description**
Yt	:	(GDP) at time *t*
At	:	The technology or knowledge stock at time t (innovation factor)
Ht	:	Human capital at time
Kt	:	Physical capital at time t (investment in infrastructure, machinery)
Lt	:	Labour input at time t (size of the workforce or hours worked)
ϵt	:	The error term (unexplained variations or shocks).

From equation (1.1), the researcher utilised real GDP Constant as a proxy for GDP Growth rate. In this research, Islamic infrastructure financing serves as a representative for physical capital and is related to human capital and innovation. This may be expressed as a model:

$$Y_{tm} = \beta + \beta_1 X1_{tm} + \beta_2 X2_{tm} + \beta_2 X3_{tm} + \beta_3 X4_{tm} + \beta_4 X5_{tm} + \beta_5 X6_{tm} + \epsilon t \quad \ldots\ldots\ldots\ldots \quad (1.2)$$

Symbol		Description
Y_{tm}	:	Real GDP constant at time t
$X1_{tm}$	:	Infrastructure transportation financing at time t
$X2_{tm}$	:	Infrastructure ICT financing at time t
$X3_{tm}$	:	Electricity, gas, and steam infrastructure financing at time t
$X4_{tm}$	:	Agriculture, forestry, and fishing infrastructure financing at time t
$X5_{tm}$	:	Education infrastructure financing at time t
$X6_{tm}$	:	Human health and social work infrastructure financing at time t
β1, β2, β3, β4, β5, and β6	:	the effect of positive or negative on Real GDP
ϵt	:	The error term

3.5 Autoregressive Distributed Lag (ARDL)

The researcher using Autoregressive Distributed Lag for regression in this research. The Autoregressive Distributed Lag (ARDL) model is a versatile econometric tool used for analysing time series data and capturing dynamic relationships between variables. It has evolved from its origins in analysing autocorrelated trend stationary processes to applications in cointegrated non-stationary time series (Cho et al., 2021).

The ARDL model incorporates both autoregressive components and distributed lag effects, allowing for the examination of short-run and long-run relationships between variables. Recent extensions of the ARDL model have expanded its capabilities and

applications. These include asymmetric and non-linear generalizations, quantile ARDL models, pooled mean group dynamic panel data models, and spatio-temporal ARDL models (Cho et al., 2021).

3.5.1 The Advantages of Autoregressive Distributed Lag (ARDL)

The ARDL model has a number of advantages in econometric modelling. It enables the estimation of the interrelationship among the variables in both the short-run and the long-run pale at the same time which makes it a flexible method for analysing time series data (Shen et al, 2013). One benefit is the ability to use variables of various integration orders without doing unit root pre-testing (Murthy & Okunade, 2016). This, in turn, makes the use of ARDL applicable for a broad class of economic cases.

One of the most importance aspects of ARDL is its ability to model non-linear functions. The combination of the two classes of models, known as ARDL and smooth transition autoregressive (STAR) models, is referred to as STAR distributed lag or STARDL models because it allows for nonlinearity in short-run and long-run parameters as well (Bildirici & Ersin, 2017). This progress offers fresh perspectives on intricate economic phenomena, including the asymmetric long-run and short-run relationships between greenhouse gas emissions and gross domestic product.

In conclusion, the scope of activities where ARDL is implemented ranges from evaluating the competitive position of ports (Shen et al., 2013) to identifying the factors which influence health spending (Murthy & Okunade, 2016). The OD (Ordered

Data) test could not be employed because the dependent variable does not have to be I(1). However, it still provides a straightforward answer regarding whether or not there is a need of cointegration (Sam et al., 2018). These benefits, in addition to all the required critical and p-values being available for easier use (Kripfganz & Schneider, 2023), suggest that ARDL is an impressive and easy to use technique for economists in a wide spectrum of economic sub-fields.

3.5.2 The Steps and requirements to do the ARDL Co-integration Approach

The ARDL co-integration approach involves several key steps:

1. The typical first step to determine the order of integration of the variables is unit root testing. Although applying ARDL does not depend on whether the variables are I(0) or I(1), it is however important that none is I(2) (Maundu et al, 2023). Augmented Dickey-Fuller (ADF) test is the most widely used test for this purpose.

2. It is very important to specify the model correctly and choose the lag length. A particular feature of ARDL model is that it is designed to accommodate both short-run dynamics as well as long-run relationships. For instance, AIC or SBC is used to select optimal lag lengths (Hamid & Shabri, 2017; Shen et al., 2013).

3. Co-integrating bounds test is one of the major steps. This involves estimation of the ARDL model and conducting an F-test on the lagged level variables to ascertain if a long-run relationship exists (Phong et al., 2017; Sam et al., 2018). The obtained F-statistic is compared with the computed critical value bounds.

4. In cases where a long-run relationship is established, values of long-run and short-run coefficients are computed. The long-run ARDL model is useful in understanding

equilibrium relationships while the ARDL derived ECM captures the short-run dynamics and the speed of adjustment (Ogundunmade, 2024; Phong et al, 2017).

5. The last activity is model diagnostic tests to make sure that the model under study is valid.

The aforementioned consist of tendency tests for serial correlation, heteroscedasticity, and stability checks involving the CUSUM and CUSUMSQ tests (Ditta et al., 2020). Terms such as 'non-spurious' co-integration were convincingly conditioned in the augmented ARDL bounds test by further H_0 on lagged independent variables wherein more convincing conclusion regarding co-integration status is arrived at (Sam et al., 2018).

3.6 Methodological Framework

3.6.1 Unit Root Test (Stationer)

The researcher using secondary data on macroeconomic time series which unit root test is important. It tests play a crucial role in time series analysis, serving as a fundamental tool for determining the stationarity of data. These tests are essential for several reasons:

1. A crucial characteristic of time series is stationarity, which allows unit root tests to be a point of departure for analysis (Zuo, 2019). They assist researchers in determining whether a series is stationary or has a unit root, crucial for modelling strategy selection and avoiding spurious multiple correlations. Unit root tests constitute an important

aspect of every time series analysis and allow practitioners to ascertain the characteristics of the data (Smeekes & Wilms, 2020).

2. But interestingly, each of the unit root tests has its own merit and demerits some of which are well documented. The most common methods include the DF, ADF, PP, KPSS, and Breitung nonparametric unit root test (Zuo, 2019). Other improvements include the development of panel unit root tests that analyse a set of time series data in one go (Coakley & Fuertes, 1997). Also, tests allowing for asymmetric adjustment and smooth transition between deterministic linear trends have also become available (Sollis, 2004).

3. The function of unit root tests is not only limited to academic research but spans a wide range of uses including econometrics and finance.

For example, they have been employed for real exchange rates analysis (Coakley & Fuertes, 1997), industrial production estimation (Sollis, 2004), and even environmental economics, for instance, CO2 emissions (Saliminezhad & Bahramian, 2020). Nevertheless, it is essential to understand that these tests are sensitive to sample size, model specification and structural breaks (Herwartz et al., 2022; Montañes & Olloqui, 1999). Therefore, a choosing of relevant test strictly matching a data set and a research question becomes critical, and in many cases, multiple tests are conducted for the purpose of reaching more adequate conclusions.

3.6.2 Pesaran's ARDL Approach for Co-Integration Test

Due to its flexibility and its benefits over the standard approaches, the Pesaran's Autoregressive Distributed Lag (ARDL) approach for cointegration testing has grown in popularity in the contexts of economic studies.

According to the works of Murthy and Okunade (2016), ARDL bounds testing developed by Pesaran (2001) has various econometric advantages over some of the conventional methods of testing for the existence of cointegration. The key one is its capacity to bypass the requirement of unit root tests in the estimation of long-run economic relationships which means it can be applied to I(0) and I(1) variables (Bentzen & Engsted, 2002; Ozdemir, 2019). This flexibility also comes in handy when handling economic variables that are likely to be non-stationary.

It is worth noting that although some scholars have ignored the ARDL model for non-stationary variables, Pesaran and Shin (1997) showed its applicability when the variables are cointegrated (Bentzen & Engsted, 2002). This result is essential for modelling relationships in energy demand and in other economic evaluations. Furthermore, the augmented ARDL bounds test has the additional lagged levels of independent variables (F-test) and this helps to determine the cointegration status and does not make it a prerequisite that the dependent variable be I(1) (Sam et al., 2018).

Finally, for ARDL equation for this research according to the independent variable and dependent variables, as follows:

$$\Delta \text{RealGDP}_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta \text{RealGDP}_{t-i} + \sum_{j=0}^{q} \gamma_j \Delta X1_{t-j} + \sum_{k=0}^{r} \delta_k \Delta X2_{t-k} + \sum_{l=0}^{s} \eta_l \Delta X3_{t-l}$$

$$+ \sum_{m=0}^{u} \theta_m \Delta X4_{t-m} + \sum_{n=0}^{v} \psi_n \Delta X5_{t-n} + \sum_{o=0}^{w} \xi_o \Delta X6_{t-o} + \phi_1 \text{RealGDP}_{t-1}$$

$$+\phi_2 X1_{t-1} + \phi_3 X2_{t-1} + \phi_4 X3_{t-1} + \phi_5 X4_{t-1} + \phi_6 X5_{t-1} + \phi_7 X6_{t-1} + \epsilon_t$$

Symbol		**Description**
ΔRealGDPt	:	Growth of real GDP at time t
ΔX1t	:	Change in transportation infrastructure financing
ΔX2t	:	Change in Infrastructure ICT financing
ΔX3t	:	Change in electricity, gas, and steam
ΔX4t	:	Change in Agriculture, forestry, and fishing infrastructure financing
ΔX5t	:	Change in education infrastructure financing
ΔX6t	:	Change in Human health and social work infrastructure financing
βi, γ,δ, etc.	:	The short-run impact of past changes
ϕ1,ϕ2,…,ϕ7:	:	The long-run effects of the respective lagged variables (Xt−1) on RealGDPt−1
ϵt	:	Residual or unexplained component of the model

Figure 3.1
ARDL Equation

If a long-run relationship (cointegration) is established, the ARDL model can be reformulated as an ECM to incorporate the adjustment toward equilibrium:

$$\Delta \text{RealGDP}_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta \text{RealGDP}_{t-i} + \sum_{j=0}^{q} \gamma_j \Delta X1_{t-j} + \ldots + \sum_{o=0}^{w} \xi_o \Delta X6_{t-o}$$

$$+\lambda \cdot \text{ECT}_{t-1} + \epsilon_t$$

Figure 3.2
Error Correction Term Equation

From Figure 3.2 ECT_{t-1} is Error correction term derived from the long-run equilibrium.

3.7 Robustness Analysis Model

In various economic studies, the Autoregressive Distributed Lag model is said to frequently use the Fully Modified Ordinary Least Squares, Dynamic Least Squares, and Canonical Cointegration Regression methods for robustness checks (Belloumi & Alshehry, 2018; Elfaki et al., 2021; Idroes et al., 2023; Priyankara, 2018). These techniques are exercised to complement the ARDL estimations in order to prove the long-run association and consistency of the findings. In this research, to robustness result from ARDL estimations. Researcher performing robustness analysis through all of the above.

3.7.1 Fully Modified Ordinary Least Squares (FMOLS)

The FMOLS estimation technique is widely applied as a robustness test for ARDL models in the field of economics and the environment. FMOLS is also used with the purpose of cross-checking the long run estimates of ARDL models in terms of the long run reliability of the results.

The use of FMOLS estimation is particularly relevant when there is a possibility of endogeneity and/or serial correlation in the explanatory variables. As a result, it is also suitable for verification of the results of ARDL regressions (Belloumi & Alshehry, 2018; Idroes et al., 2023; Okoye et al., 2022). It aids in solving the problem of endogeneity and serial correlation, also allowing for nearly unrestricted long run parameter estimates, thus it is significant in establishing the long run solutions offered by the ARDL models (Elfaki et al., 2021; Gul et al., 2022; Priyankara, 2018).

3.7.2 Dynamic Ordinary Least Squares (DOLS)

The Ordinary Least Squares of the Dynamic Model is often used as a robustness test for the Autoregressive Distributed Lag approach in econometrics. This association is noted across numerous studies investigating different aspects of the economy.

In many different works DOLS is used as part of a robustness test for ARDL. For example, it was applied in analysing the relation between foreign trade and intellectual property rights in Egypt (Ali, 2024), exploring causal relationships among investment and economic growth in Saudi Arabia (Belloumi & Alshehry, 2018) and estimating Canada's import demand in Fiji's economy (Narayan & Narayan, 2004). The sustained usage of such application in various economic situations enhances the robustness and the complementary role of DOLS and ARDL models in economics analyses.

3.7.3 Conical Cointegration Regression (CCR)

The adoption of the Canonical cointegrating regression (CCR) serves as an advanced technique which aids in the examination of the long run relationship within the framework of the ARDL model. It serves as a great tool in the robustness test alongside other integration methods.

Each of the aforementioned models' results are combined with other models ensuring the results of the ARDL models are robust using CCR. For example, Priyankara (2018) cited the use of CCR in the situation where the impact of services exports on total factor productivity growth was analysed in Sri Lanka with the use of Johansen

Cointegration Test, ARDL, FMOLS, and DOLS approaches. An example is Chandio et al. (2019) where the authors analysed the effect of FDI in the agriculture sector on the economic growth of Pakistan and used CCR, ARDL, DOLS, and FMOLS to translate the various long run relationships.

3.8 Chapter Summary

This chapter provides a comprehensive analysis of the research methodology employed in this study, which investigates the impact of Islamic banks' infrastructure financing on economic growth in Malaysia. It details the quantitative approach, utilizing econometric techniques, specifically the Autoregressive Distributed Lag (ARDL) model, to examine the relationships between various economic, environmental, and social financing sectors and GDP growth. The chapter elaborates on the data sources, model specification, and the procedures involved in the ARDL co-integration method, including unit root testing, model specification, bounds testing, and diagnostic checks. Additionally, it underscores the advantages of the ARDL model and introduces robustness analysis methods such as Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Cointegration Regression (CCR) to validate the ARDL findings. This methodological framework establishes a solid foundation for analysing the complex relationships between Islamic banking financing and economic growth in Malaysia, ensuring the study's findings are both reliable and valid.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Introduction

This chapter examines and interprets the outcomes and discoveries of research grounded in hypotheses formulated from research objectives. The focus of this investigation is the influence of Sustainable Islamic Infrastructure Project Financing on the economic development of Malaysia. The investigative methodology initiates with a descriptive examination, progresses to unit root assessment, and employs the Autoregressive Distributed Lag (ARDL) framework with cointegration analysis to investigate enduring associations between the dependent variable and each predictor. This is followed by the execution of long-term and short-term evaluations, culminating in a series of robustness checks to validate the findings.

4.2 Descriptive Analysis

Table 4.1
Descriptive Analysis

	LOG_GDP	LOG_X1	LOG_X2	LOG_X3	LOG_X4	LOG_X5	LOG_X6
Mean	12.74521	9.357227	8.535455	8.320957	9.609758	8.882041	7.708512
Median	12.74927	9.416233	8.519618	8.343508	9.650045	9.093328	7.804396
Maximum	12.92468	9.562799	9.242497	9.309999	9.897323	9.290367	8.038267
Minimum	12.55057	8.866564	7.989810	7.675227	8.907331	8.111903	7.144742
Std. Dev.	0.100504	0.173548	0.391015	0.528512	0.227876	0.336155	0.266771
Skewness	-0.173829	-1.383294	0.233795	0.450866	-1.144798	-0.705862	-0.761032
Kurtosis	2.151554	3.840059	1.826218	1.913483	4.129573	2.047846	2.185765
Jarque-Bera	1.331151	13.23620	2.527642	3.156596	10.32047	4.590973	4.717795
Probability	0.513978	0.001336	0.282572	0.206326	0.005740	0.100712	0.094524
Sum	484.3180	355.5746	324.3473	316.1964	365.1708	337.5175	292.9234
Sum Sq. Dev.	0.373741	1.114402	5.657031	10.33504	1.921317	4.181019	2.633180
Observations	38	38	38	38	38	38	38

Table 4.1 presents descriptive statistics for **Log_GDP$_{tm}$**, representing Malaysia's Real GDP in 2015 base year, indicating stable economic performance over 38 observations. The mean (12.74521) approximates the median (12.74927), suggesting minimal skewness (-0.173829). The maximum (12.92468) and minimum (12.55057) values reflect a narrow range, indicating consistent economic output. The low standard deviation (0.100504) corroborates this stability. The distribution is slightly platykurtic (kurtosis: 2.151554), indicating light tails and fewer outliers.

An examination of the descriptive statistics for **Log_X1$_{tm}$**, which denotes Islamic banking financing for transport and storage infrastructure, reveals a fairly consistent pattern across 38 observations. The average value stands at 9.357227, with the median slightly higher at 9.416233, pointing to a mild negative skewness (-1.383294). The span from 8.866564 to 9.562799 is comparatively narrow, implying limited fluctuation in infrastructure funding levels. A standard deviation of 0.173548 indicates some year-to-year variation. The kurtosis value of 3.840059 suggests a leptokurtic distribution with tails heavier than a normal curve.

The statistical analysis of **Log_X2$_{tm}$**, which denotes Islamic banking funding for ICT infrastructure, reveals moderate fluctuations. With an average of 8.535455 and a median of 8.519618, the distribution appears nearly symmetrical. Financing levels vary between 7.989810 and 9.242497, whilst the standard deviation of 0.391015 indicates moderate spread around the mean. A slight positive skew of 0.233795 suggests a marginally higher occurrence of lower values. The kurtosis value of

1.826218 points to a platykurtic distribution, implying fewer outliers compared to a normal distribution.

The analysis of **Log_X3$_{tm}$**, which denotes Islamic banking financing for electricity, gas, and steam infrastructure, shows moderate fluctuations over the observed period. With an average of 8.320957 and a slightly higher median of 8.343508, the distribution appears relatively balanced. The financing levels exhibit notable variation, spanning from 7.675227 to 9.309999. A standard deviation of 0.528512 indicates moderate spread in the data. The distribution is characterised by a mild positive skew (0.450866), suggesting a tendency towards lower values. The kurtosis value of 1.913483 points to a platykurtic distribution, implying fewer outliers compared to a normal curve.

The descriptive statistics for **Log_X4$_{tm}$**, representing Islamic banking financing for agriculture, forestry, and fishing infrastructure, highlight a consistent investment level with some variability. The mean value is 9.609758, and the median is 9.650045, indicating a symmetric distribution. Values range from 8.907331 to 9.897323, reflecting narrower variation compared to other variables. The standard deviation of 0.227876 shows low dispersion around the mean. The skewness value of -1.144798 indicates a negative skew, with more frequent higher values and fewer extremely low values. The kurtosis of 4.129573 suggests a leptokurtic distribution, indicating more extreme values than a normal distribution.

The statistical analysis of **Log_X5$_{tm}$**, which denotes Islamic banking's financial support for educational infrastructure, reveals moderate fluctuations and a well-

balanced distribution. With an average of 8.882041 and a slightly higher median of 9.093328, the data exhibits a minor tilt towards lower figures. The span from 8.111903 to 9.290367 underscores variations in funding levels. A standard deviation of 0.336155 indicates moderate spread. The skewness value of -0.705862 suggests a slight negative asymmetry, with a tendency towards higher values. The kurtosis measure of 2.047846 implies a near-normal distribution, albeit somewhat platykurtic.

The descriptive statistics for **Log_X6$_{tm}$**, representing Islamic banking financing for human health and social work infrastructure, show moderate variability with a slightly left-skewed distribution. The mean is 7.708512, while the median is slightly higher at 7.804396, indicating a skew toward lower values. The minimum value is 7.144742, and the maximum is 8.038267, showing a relatively narrow range. The standard deviation of 0.266771 reflects moderate dispersion. The skewness of -0.761032 indicates a mild negative skew, suggesting data concentration around higher values. The kurtosis of 2.185765 suggests a relatively normal distribution, leaning slightly platykurtic.

4.3 Unit Roots Test

This research employs two conventional methodologies for unit root testing: the Augmented Dickey-Fuller (ADF) Test and the Phillips-Perron Test, applied to seven variables. The outcomes of these tests consistently suggest that all variables demonstrate stationarity upon first differencing. A comprehensive presentation of the findings is provided in Table 4.2 below:

Table 4.2

Augmented Dickey Fuller (ADF) Test and Phillips-Perron Test

Augmented Dickey Fuller (ADF) Test				
	Level		**First Difference**	
Variables	**Intercept**	**With Trend**	**Intercept**	**With Trend**
Log_GDP_{tm}	-0.650222	-4.503919**	-6.843913***	-6.723495***
	[0.8459]	[0.0050]	[0.0000]	[0.0000]
Log_X1_{tm}	-3.144241**	-2.774577	-5.815714***	-5.924704***
	[0.0318]	[0.2151]	[0.0000]	[0.0001]
Log_X2_{tm}	-0.423431	-3.535208**	-5.332936***	-4.275594**
	[0.8947]	[0.0506]	[0.0001]	[0.0108]
Log_X3_{tm}	-0.752416	-2.530304	-5.30285***	-5.177500***
	[0.82064]	[0.31267]	[0.0001]	[0.0000]
Log_X4_{tm}	-3.69755**	-4.68266**	-4.165976**	-4.68266**
	[0.0083]	[0.0031]	[0.00237]	[0.0031]
Log_X5_{tm}	-1.05625	-2.9400	-4.941411***	-4.870376**
	[0.7225]	[0.16265]	[0.0002]	[0.00196]
Log_X6_{tm}	-1.762255	-1.963836	-6.561243***	-6.751942***
	[0.39232]	[0.60121]	[0.0000]	[0.0000]

Sources: Author's Construction (2025)

Notes: P-values are in the brackets. *** Significant at 1%. ** Significant at 5%, * Significant at 10%. Null hypothesis under ADF or Phillips-Perron is that the series is a unit root. All the variables are in log condition.

Phillips-Perron Test				
	Level		**First Difference**	
Variables	**Intercept**	**With Trend**	**Intercept**	**With Trend**
Log_GDP_{tm}	-1.837549	-4.43553**	-12.9811***	-12.86664***
	[0.3572]	[0.0059]	[0.0000]	[0.0000]
Log_X1_{tm}	-3.507388**	-2.653150	-6.106951***	-7.050357***
	[0.0133]	[0.2607]	[0.0000]	[0.0000]
Log_X2_{tm}	-0.248232	-3.026257	-5.848928***	-5.688386**
	[0.92396]	[0.13903]	[0.0000]	[0.00021]
Log_X3_{tm}	-0.804009	-2.515379	-5.261879***	-5.119145***
	[0.80624]	[0.31936]	[0.0001]	[0.00010]
Log_X4_{tm}	-3.69755**	-4.68266**	-4.165976**	-4.68266**
	[0.0083]	[0.0031]	[0.00237]	[0.0031]
Log_X5_{tm}	-1.05625	-2.450420	-4.901582***	-4.826801**
	[0.72251]	[0.34934]	[0.00031]	[0.00220]
Log_X6_{tm}	-1.194659	-1.727220	-6.963640***	-13.53323***

[0.6646]	[0.71882]	[0.0000]	[0.0000]

Sources: Author's Construction (2025)

Notes: P-values are in the brackets. *** Significant at 1%. ** Significant at 5%, * Significant at 10%. Null hypothesis under ADF or Phillips-Perron is that the series is a unit root. All the variables are in log condition.

4.4 ARDL Approach for Co-integration and Causality

4.4.1 ARDL Co-integration test

The Unit Root Test findings revealed that all variables examined were non-stationary at the I (2) level, permitting to move forward with ARDL analysis. The next phase involves executing the bounds test to determine the presence of cointegration relationships among the variables under study. The evaluation methodology employs F-statistics, which are derived with critical thresholds for each variable under examination. Preceding the computation of F-statistics, it is imperative to ascertain the optimal lag based on the Akaike Information Criterion (AIC) for the variables encompassed in this investigation. Table 4.3 delineates the outcomes of the ARDL Cointegration analysis.

Table 4.3
ARDL Co-Integration Test

Bounds Testing to Cointegration

Dependent Variable	**Estimated Models**			**F-Statistics**		
Log_GDP_{tm}	(GDP/X1,X2,X3,X4,X5,X6)			11.2414***		
	10%		**5%**		**1%**	
Sample Size	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
			F-Statistic			
30	2.457	3.797	2.970	4.499	4.270	6.211
35	2.387	3.671	2.864	4.324	4.016	5.797
Asymptotic	2.120	3.230	2.450	3.610	3.150	4.430

Sources: Author Construction (2025)

Notes: (***)- 1% significant, (**)- 5% significant, (*)- 1% significant. No cointegration among the variables existed if null hypothesis under bound testing. All the variables are in log condition.

From the table 4.3, the Bounds Testing to Cointegration table examines the existence of a long-run equilibrium relationship among the variables, with Log_GDP_{tm} as the dependent variable and Log_X1_{tm} (transportation and storage infrastructure financing), Log_X2_{tm} (information and communication technology infrastructure financing), Log_X3_{tm} (electric, gas, and steam infrastructure financing), Log_X4_{tm} (agriculture, forestry, and fishing infrastructure financing), Log_X5_{tm} (education infrastructure financing), and Log_X6_{tm} (human health and social work infrastructure financing) as independent variables.

The computed F-statistic of 11.2414 surpasses the upper critical bound I(1) values across all significance thresholds (10%, 5%, and 1%). Given 35 observations, the critical values at the 1% level are 4.016 (I(0)) and 5.797 (I(1)), demonstrating that the null hypothesis of no cointegration is refuted even at the most rigorous significance

level, thus substantiating a long-term relationship. Accordingly, the F-statistic findings offer compelling support for the existence of cointegration.

The aforementioned analysis indicates the presence of long-term and short-term relationships between Log_GDP_{tm}, Log_X1_{tm}, Log_X2_{tm}, Log_X3_{tm}, Log_X4_{tm}, Log_X5_{tm}, and Log_X6_{tm} in this regression, due to the existence of a cointegration relationship among the seven variables. Consequently, the error correction form can be regressed to estimate the adjustment equilibrium in the short run toward the long-run effect of the participating independent variables in this study. The estimation is presented in Table 4.4.

4.4.2 ARDL Long-Run Analyses

This section will examine the interpretation of coefficients, t-statistics, and p-values in ARDL long-run analyses across three groups of variables in this study.

Table 4.4
ARDL Long-Run Coefficients

Long Run Coefficients			
Variables	**Coefficient**	**T-Statistic**	**P-Value**
Log_X1(-1)	0.040355	0.469616	0.6421
Log_X2 (-1)	0.121508	1.459525	0.1552
Log_X3 (-1)	0.025696	0.680530	0.5016
Log_X4 (-1)	-0.079576	-0.432835	0.6683
Log_X5 (-1)	0.038980*	1.665385	0.1066
Log_X6 (-1)	0.195470*	1.899330	0.0675
Constant	22.78043***	5.250203	0.0005
$R^2 = 0.96$	R^2. Adjustment = 0.86		

Sources: Author Construction (2025)

Notes: (***)- 1% significant, (**)- 5% significant, (*)- 1% significant. Estimates derived using the error correction model with ΔLog_GDP a as the dependent variable. All the variables are in log condition.

This section will present the statement of hypothesis development for each two group of variables on economic, environment, and social infrastructure financing sectors. accompanied by detailed explanations:

H_1: There a positively relationship between Islamic infrastructure sustainable financing in the transportation and storage sector towards Malaysia's economic growth (Real GDP) in the long run.

H_2: There a positively relationship between Islamic infrastructure sustainable financing in the information and communication sector towards Malaysia's economic growth (Real GDP) in the long run.

From Table 4.4, in analysing the long-run coefficients representing the first group variables of economic Islamic infrastructure financing sector, the following observations can be made. Firstly, the variable Log_$X1_{tm}$, representing transportation and storage infrastructure financing, the variable Log_$X2_{tm}$, which represents information and communication technology (ICT) infrastructure financing, is the second factor under consideration. An examination of the long-run coefficients and hypothesis tests reveals that the null hypotheses for both H_1 and H_2 cannot be rejected at conventional significance levels.

Specifically, for H_1, the coefficient for Log_X1(-1) is 0.040355, with a corresponding p-value of 0.6421. This statistical evidence suggests the absence of a significant long-term relationship between Islamic infrastructure sustainable financing in the ICT sector and Malaysia's economic growth, as measured by Real GDP. Similarly, for H_2, the coefficient for Log_X2(-1) is 0.121508, with a p-value of 0.1552, which also shows no significant long-run relationship. This suggests that a 1% increase in transportation and storage Islamic infrastructure financing from banking is associated with a 0.043 % enhancement in economic growth, ceteris paribus. Similarly, a 1% increase in information and communication technology (ICT) Islamic infrastructure financing from banking is associated with a 0.121 % enhancement in economic growth, ceteris paribus.

H_3: There a positively relationship between Islamic infrastructure sustainable financing in the electric, gas, steam, and air-conditioning supply sectors towards Malaysia's economic growth (Real GDP) in the long run.

H_4: There a positively relationship between Islamic infrastructure sustainable financing in the agriculture, forestry, fishing sectors towards Malaysia's economic growth (Real GDP) in the long run.

With reference to Table 4.4, two variables represent environmental Islamic infrastructure financing. First, the variable Log_X3_{tm}, representing financing for electric, gas, and steam infrastructure, Second, the variable Log_X4_{tm}, representing financing for agriculture, forestry, and fishing infrastructure. Based on the long-run

coefficients and hypothesis tests, the null hypotheses for both H_3 and H_4 cannot be rejected at conventional significance levels.

For H_3, the coefficient for Log_X3(-1) (electric, gas, steams, and air-conditioning financing) is 0.025696, with a p-value of 0.5016, indicating no statistically significant long-run relationship between Islamic infrastructure sustainable financing in this sector and Malaysia's economic growth (Real GDP). Similarly, for H_4, the coefficient for Log_X4(-1) (agriculture, forestry, fishing financing) is -0.079576, with a p-value of 0.6683, which also shows no significant long-run relationship. These findings suggest that a 1% increase in electric, gas, and steam Islamic infrastructure financing from banking is associated with a 0.0256 % increase in economic growth, ceteris paribus. Conversely, a 1% increase in agriculture, forestry, and fishing Islamic infrastructure financing is associated with a 0.079 % decrease in economic growth, ceteris paribus.

H_5: There a positively relationship between Islamic infrastructure sustainable financing in the education sector towards Malaysia's economic growth (Real GDP) in the long run.

H_6: There a positively relationship between Islamic infrastructure sustainable financing in the human health and social work sectors towards Malaysia's economic growth (Real GDP) in both the long run.

The variable representing social Islamic infrastructure financing comprises two components. First, the variable Log_X5_{tm}, representing education infrastructure financing, Second, the variable Log_X6_{tm}, representing human health and social work infrastructure financing. Based on the long-run coefficients and hypothesis tests, the null hypotheses for both H_5 and H_6 can be rejected at conventional at 10% significance levels.

For H_5, the coefficient for Log_X5(-1) (education infrastructure financing) is 0.038980, with a p-value of 0.5016 and t-statistic 1.6653, indicating statistically significant long-run relationship between Islamic infrastructure sustainable financing in this sector and Malaysia's economic growth (Real GDP). The analysis of H_6 reveals a coefficient of 0.195470 for Log_X6(-1), representing human health and social works financing, with a p-value of 0.0675 and t-statistic of 1.899. These figures indicate a substantial long-term correlation. The findings suggest that a 1% rise in Islamic banking's infrastructure financing for education corresponds to a 0.038% boost in long-term economic growth, all other factors remaining constant. Moreover, when Islamic banking increases its infrastructure financing for human health and social work by 1%, it leads to a 0.195% uptick in economic growth, ceteris paribus.

The constant value of 22.78043, which is statistically significant at the 1% level (p-value = 0.0005), represents the baseline level of Real GDP (Log_GDP_{tm}) when all independent variables are equal to zero. While this is predominantly theoretical due to the logarithmic transformation, it underscores the substantial contribution of other unobserved factors in the model. The R^2 value of 0.96 indicates that 96% of the

variation in Real GDP is explained by the independent variables (Log_X1_{tm}, Log_X2_{tm}, Log_X3_{tm}, Log_X4_{tm}, Log_X5_{tm}, and Log_X6_{tm}), demonstrating the model's robust explanatory power. The adjusted R^2, at 0.86, marginally reduces this figure by accounting for the number of predictors and sample size, suggesting that 86% of GDP variation is explained after adjustments.

4.4.3 ARDL Short-Run Analyses

This chapter will examine the interpretation of coefficient, t-statistic, p-value, and the hypothesis result for each variable in this study.

Table 4.5
ARDL Short-Run Coefficients

Short Run Coefficients			
Variable	**Coefficient**	**T-Statistic**	**P-Value**
ECT	-2.266667***	-11.45207	0.0000
ΔLog_GDP(-1)	-0.560768**	-2.749411	0.0225
ΔLog_GDP(-2)	-0.437028	-1.818281	0.1024
ΔLog_GDP(-3)	-0.268871	-1.037863	0.3264
ΔLog_X1	-0.146648	-1.381666	0.2004
ΔLog_X1(-1)	0.016573	0.091072	0.9294
ΔLog_X1(-2)	0.476807***	3.720380	0.0048
ΔLog_X1(-3)	-0.255261	-1.015257	0.3365
ΔLog_X2	0.301149***	3.933565	0.0034
ΔLog_X2(-1)	-0.247970**	-2.793819	0.0209
ΔLog_X2(-2)	0.222238	1.479357	0.1732
ΔLog_X3	0.118051**	2.793819	0.0209
ΔLog_X3(-1)	-0.131382**	-2.735581	0.0230
ΔLog_X3(-2)	0.324973***	4.683909	0.0011
ΔLog_X3(-3)	-0.253398***	-3.966162	0.0033
ΔLog_X4	0.225536	1.011247	0.3383
ΔLog_X4(-1)	-0.405974*	-1.996235	0.0770
ΔLog_X5	-0.054074	-1.197684	0.2616
ΔLog_X5(-1)	0.014699	0.206462	0.8410
ΔLog_X5(-2)	0.224878**	2.783617	0.0213
ΔLog_X5(-3)	-0.097149	-1.527063	0.1611
ΔLog_X6	0.349366	1.711142	0.1212
ΔLog_X6(-1)	-0.814913***	-3.985615	0.0032
ΔLog_X6(-2)	0.748435**	2.448762	0.0368
ΔLog_X6(-3)	0.160177*	1.887708	0.0917
Dummy_Covid19	-0.192283***	-7.264753	0.0000
$R^2 = 0.98$	R^2. Adjustment = 0.94		

Sources: Author Construction (2025)

Notes: (***)- 1% significant, (**)- 5% significant, (*)- 1% significant. Estimates derived using the error correction model with ΔLog_$GDPt$ a as the dependent variable. All the variables are in log condition.

As evidenced in Table 4.5, the Error Correction Term (ECT) coefficient of -2.266667 demonstrates statistical significance at the 1% level (p-value = 0.0000), indicating a robust adjustment mechanism toward long-run equilibrium in the model. The negative sign of the ECT is essential, as it confirms that deviations from the long-run equilibrium are rectified in subsequent periods. Specifically, the magnitude of -2.266667 suggests that approximately 226.67% of the disequilibrium in Real GDP (Log_GDP_{tm}) is corrected in each period. The statistically significant ECT coefficient provides substantial evidence of cointegration among the variables (Log_X1_{tm}, Log_X2_{tm}, Log_X3_{tm}, Log_X4_{tm}, Log_X5_{tm}, Log_X6_{tm}), affirming the existence of a long-run equilibrium relationship between Real GDP and the selected infrastructure financing components.

H_1: There a positively relationship between Islamic infrastructure sustainable financing in the transportation and storage sector towards Malaysia's economic growth (Real GDP) in the short run.

The short-run coefficients for ΔLog_X1_{tm} and its lags elucidate the temporal impact of transportation and storage infrastructure financing on Real GDP. The immediate effect (ΔLog_X1_{tm}) is minimal, negative, and statistically insignificant (-0.1466, p = 0.2004), it means increasing 1 % of transportation and storage infrastructure financing decreasing economic growth by 0.1466 %, ceteris paribus. indicating an absence of immediate economic returns. The one-quarter lag (ΔLog_X1_{tm} (-1)) demonstrates a negligible and insignificant positive impact (0.0166, p = 0.9294), suggesting minimal short-term effects. However, the two-quarters lag (ΔLog_X1_{tm} (-2)) exhibits a

significant and positive impact (0.4768, p = 0.0048), highlighting that infrastructure financing typically requires two quarters to generate substantial economic benefits. The three-quarters lag (ΔLog_X1_{tm} (-3)) reveals a negative but insignificant impact (-0.2553, p = 0.3365), potentially attributable to diminishing returns or external factors.

These findings underscore the delayed nature of infrastructure projects, with the most pronounced economic impact manifesting after a two-quarter period. Therefore, based on the short run coefficients and hypothesis tests, the null hypotheses for H_1 variative results in short run. It means in ΔLog_X1_{tm} and $\Delta Log\_X1_{tm}(-3)$, H_1 cannot be rejected at conventional significance levels. But in ΔLog_X1_{tm} (-2) the null hypothesis for H_1 can be rejected at 1% conventional significance levels.

H_2: There a positively relationship between Islamic infrastructure sustainable financing in the information and communication sector towards Malaysia's economic growth (Real GDP) in the short run.

The immediate and lagged short-run coefficients for ΔLog_X2_{tm} illustrate the influence of ICT infrastructure financing on Real GDP. The contemporaneous effect (ΔLog_X2_{tm}) is both statistically significant and positive (0.3011, p = 0.0034), suggesting that a 1% rise in ICT infrastructure financing is associated with a 0.3011% increase in GDP, possibly due to swift technological progress. The first-quarter lag (ΔLog_X2_{tm} (-1)) shows a considerable negative impact (-0.2480, p = 0.0209), indicating potential adaptation costs or inefficiencies. The second-quarter lag (ΔLog_X2_{tm} (-2)) displays a positive but statistically insignificant effect (0.2222, p =

0.1732), hinting that earlier investments might contribute to GDP growth, albeit with reduced impact.

These results highlight the diverse short-term effects of ICT financing, characterised by initial benefits followed by possible disruptions or inefficiencies. Consequently, based on the short-run coefficients and hypothesis tests, the null hypotheses for H_2 yield varied outcomes in the short run. This implies that for ΔLog_X2_{tm} (-2), H_2 cannot be rejected at conventional significance levels. However, for ΔLog_X2_{tm} and ΔLog_X2_{tm} (-1), the null hypothesis for H_2 can be rejected at 1% conventional significance levels.

H_3: There a positively relationship between Islamic infrastructure sustainable financing in the electric, gas, steam, and air-conditioning supply sectors towards Malaysia's economic growth (Real GDP) in the short run.

The short-run coefficients for ΔLog_X3_{tm} and its lags elucidate the effects of financing for electric, gas, and steam infrastructure on Real GDP. The immediate impact (ΔLog_X3_{tm}) is positive and statistically significant (0.1181, p = 0.0209), indicating that a 1% increase in current-quarter infrastructure financing corresponds to a 0.1181% rise in GDP, reflecting rapid productivity gains from enhanced energy availability. The one-quarter lag (ΔLog_X3_{tm} (-1)) demonstrates a negative significant effect (-0.1314, p = 0.0230), suggesting that earlier investments may strain economic resources. The two-quarter lag (ΔLog_X3_{tm} (-2)) exhibits a strong positive impact (0.3250, p =

0.0011), highlighting substantial delayed benefits as projects become operational. The three-quarter lag (ΔLog_X3_{tm} (-3)) reveals a significant negative effect (-0.2534, p = 0.0033), potentially indicating diminishing returns or maintenance costs.

These findings suggest a complex short-term relationship wherein immediate and delayed benefits are offset by temporary inefficiencies or long-term adjustments. Therefore, based on the short run coefficients and hypothesis tests, the null hypotheses for H_3 results in short run can be rejected at 1% conventional significance levels for all lags.

H_4: There a positively relationship between Islamic infrastructure sustainable financing in the agriculture, forestry, fishing sectors towards Malaysia's economic growth (Real GDP) in the short run.

The immediate and lagged short-term coefficients for ΔLog_X4_{tm} provide insights into the impact of agricultural, forestry, and fishing infrastructure financing on Real GDP. The current period effect (ΔLog_X4_{tm}) is positive but statistically insignificant (0.2255, p = 0.3383), implying that a 1% increase in present funding corresponds to a 0.2255% rise in GDP, though this relationship is not statistically robust. The one-quarter lag (ΔLog_X4_{tm} (-1)) exhibits a negative and marginally significant effect at the 10% level (-0.4060, p = 0.0770), suggesting that a 1% boost in infrastructure financing from the previous quarter is associated with a 0.406% decline in GDP.

This phenomenon may be attributed to inefficiencies, delays, or adjustment costs in utilising infrastructure investments within agriculture-related sectors. These findings underscore the limited and inconclusive short-term effects of such investments on economic performance. As a result, the short-run coefficients and hypothesis tests for H_4 yield mixed outcomes. For ΔLog_X4_{tm}, H_4 cannot be rejected at conventional significance levels, whilst for ΔLog_X4_{tm} (-1), the null hypothesis for H_4 can be rejected at 10% conventional significance levels.

H_5: There a positively relationship between Islamic infrastructure sustainable financing in the education sector towards Malaysia's economic growth (Real GDP) in the short run.

The short-run coefficients for ΔLog_X5_{tm} and its lags provide insight into education infrastructure financing effects on Real GDP. The immediate impact (ΔLog_X5_{tm}) is negative but statistically insignificant (-0.0541, p = 0.2616), suggesting that a 1% increase in current-quarter education financing is associated with a 0.0541% reduction in GDP, although this effect is not statistically meaningful in the short term. The first-quarter lag (ΔLog_X5_{tm} (-1)) demonstrates a negligible positive but statistically insignificant effect (0.0147, p = 0.8410), indicating no substantial contribution from investments made one period prior. However, the second-quarter lag (ΔLog_X5_{tm} (-2)) reveals a positive and statistically significant impact (0.2249, p = 0.0213), implying that a 1% increase in financing from two quarters prior results in a 0.2249% rise in GDP, reflecting a delayed positive effect as investments begin to yield returns. The

third-quarter lag (ΔLog_X5_{tm} (-3)) is negative and statistically insignificant (-0.0971, p = 0.1611), suggesting diminishing effects of investments made three quarter priors.

In aggregate, education infrastructure financing exhibits a delayed but statistically significant short-run positive impact on GDP, particularly after two quarters. Therefore, based on the short run coefficients and hypothesis tests, the null hypotheses for H_5 variative results in short run. It means in ΔLog_X5_{tm}, ΔLog_X5_{tm} (-1), and ΔLog_X5_{tm} (-3), H_5 cannot be rejected at conventional significance levels. But in ΔLog_X5_{tm} (-2) the null hypothesis for H_4 can be rejected at 5% conventional significance levels.

H_6: There a positively relationship between Islamic infrastructure sustainable financing in the human health and social work sectors towards Malaysia's economic growth (Real GDP) in both the long run.

The short-run coefficients for ΔLog_X6_{tm} and its lags highlight the dynamic effects of human health and social work infrastructure financing on Real GDP. The immediate impact (ΔLog_X6_{tm}) is positive but statistically insignificant (0.3494, p = 0.1212), suggesting a 1% increase in current-period financing raises GDP by 0.3494%. The first-quarter lag (ΔLog_X6_{tm} (-1)) shows a significant negative impact (-0.8149, p = 0.0032), indicating a 1% increase in financing one quarter ago reduces GDP by 0.8149%, potentially reflecting short-term disruptions in implementing health-related projects. The second-quarter lag (ΔLog_X6_{tm} (-2)) exhibits a positive and statistically significant effect (0.7484, p = 0.0368), meaning a 1% increase in financing two-quarter

ago leads to a 0.7484% rise in GDP, as benefits of investments in health infrastructure materialize. The third-quarter lag (ΔLog_X6_{tm} (-3)) shows a positive but statistically insignificant effect (0.1602, p = 0.0917), indicating a smaller delayed contribution.

Overall, while there are short-term fluctuations, health infrastructure financing demonstrates a delayed but meaningful positive impact on GDP after two periods. Therefore, based on the short-run coefficients and hypothesis tests, the null hypotheses for H_6 yield variable results in the short run. Specifically, for ΔLog_X6_{tm}, H_5 cannot be rejected at conventional significance levels. However, for ΔLog_X6_{tm} (-1), ΔLog_X6_{tm} (-2), and ΔLog_X6_{tm} (-3), the null hypothesis for H_5 can be rejected at 1%, 5%, and 10% conventional significance levels, respectively.

The Dummy_Covid19 variable quantifies the short-term impact of COVID-19 on Real GDP. Its coefficient of -0.192283 is statistically significant at the 1% level (p = 0.0000), indicating a mean GDP decrease of 19.23% during the pandemic period relative to non-COVID-19 periods. This finding underscores the substantial economic disruptions precipitated by the pandemic, including reduced economic activity, supply chain perturbations, and lockdown measures. The high R^2 value of 0.98 suggests that 98% of the variation in Real GDP is accounted for by the model, indicating a strong goodness of fit. The adjusted R^2 of 0.94, which takes into account the number of predictors, corroborates that 94% of GDP variation is explained by the independent variables. These values underscore the model's robustness in capturing short-term GDP dynamics, including the severe economic ramifications of COVID-19.

4.4.4 Diagnostic Statistics Test

Table 4.6
Diagnostic Statistics Test

Diagnostic Statistics		
	F-Statistics	P-Value
Serial	1.549779	0.2960
ARCH	0.454580	0.9421
RAMSEY	0.622073	0.4530
CUSUM	STABLE	
CUSUMQ	STABLE	

Sources: Author Construction (2025)

Notes: (***)- 1% significant, (**)- 5% significant, (*)- 1% significant. Estimates derived using the error correction model with ΔLog_GDP a as the dependent variable. All the variables are in log condition.

The diagnostic statistics evaluate the robustness and reliability of the error correction model (ECM) used, with **ΔLog_GDP$_{tm}$** as the dependent variable. The **Serial Correlation** test (F-statistic = 1.5498, p = 0.2960) indicates no significant serial correlation in the residuals, suggesting the model is well-specified. The **ARCH test** (F-statistic = 0.4546, p = 0.9421) confirms the absence of heteroskedasticity, meaning that the variance of errors is stable over time. The **Ramsey RESET test** (F-statistic = 0.6221, p = 0.4530) indicates no functional form misspecification, validating the adequacy of the model structure. Both the **CUSUM** and **CUSUMQ** tests show stability, further supporting the reliability of the model over the sample period. Overall, these diagnostics confirm that the ECM is statistically sound, robust, and suitable for analysing the short-run and long-run dynamics of Real GDP (Log_GDP$_{tm}$) and its determinants.

4.5 Robustness Model

This study will employ robust econometric models, specifically Fully Modified Ordinary Least Square (FMOLS), Dynamic Ordinary Least Squares (DOLS), Canonical Cointegration Regression (CCR), and Granger Causality (GC).

4.5.1 Fully Modified Ordinary Least Squares (FMOLS)

Table 4.7
Fully Modified Ordinary Least Square result

FMOLS Coefficients			
Variable	**Coefficient**	**T-Statistic**	**P-Value**
Log_X1	0.101805*	1.785000	0.0847
Log_X2	0.023045	0.520935	0.6064
Log_X3	0.035523	1.475385	0.1509
Log_X4	0.135187	1.636689	0.1125
Log_X5	-0.030926	-1.153592	0.2581
Log_X6	0.070516	1.324119	0.1958
Constant	9.744651***	16.16703	0.0000
Dummy_Covid19	-0.057874***	-4.824873	0.0000
R2	0.820574		
Adj. R2	0.777265		

Sources: Author Construction (2025)

Notes: (***)- 1% significant, (**)- 5% significant, (*)- 1% significant. Estimates derived using the error correction model with ΔLog_GDP a as the dependent variable. All the variables are in log condition.

The FMOLS (Fully Modified Ordinary Least Squares) results reveal the long-run relationships between Real GDP (Log_GDP_{tm}) and its explanatory variables. The coefficient for Log_X1_{tm} (transportation and storage infrastructure financing) is positive and statistically significant at the 10% level (p = 0.0847), suggesting that a 1% increase in transportation and storage financing contributes to a 0.1018% increase

in Real GDP. This finding highlights the importance of investments in infrastructure for boosting economic performance over the long term. Other variables, such as Log_X2_{tm} (ICT financing), Log_X3_{tm} (electric, gas, and steam financing), Log_X4_{tm} (agriculture, forestry, and fishing financing), Log_X5_{tm} (education financing), and Log_X6_{tm} (human health and social work financing), exhibit positive coefficients except for Log_X5_{tm}, but none are statistically significant at conventional levels.

The dummy variable for Covid-19 is highly significant ($p = 0.0000$) and negatively associated with Real GDP, with a coefficient of -0.0579. This reflects the substantial adverse economic impact of the pandemic, which led to disruptions across multiple sectors. The constant term is also highly significant ($p = 0.0000$), capturing the baseline level of Real GDP not explained by the explanatory variables.

The model's R-squared (0.8206) and adjusted R-squared (0.7773) indicate that approximately 78% of the variation in Real GDP is explained by the model, demonstrating a good fit. However, the relatively low significance of most variables suggests that other factors, possibly structural or macroeconomic variables, may also play a role in influencing GDP over the long run. The results of this study's FMOLS model are not free from plausible estimation error and hence cannot be utilised to make policy decisions.

4.5.2 Dynamic Ordinary Least Square (DOLS)

Table 4.8
Dynamic Ordinary Least Square Result

DOLS Coefficients			
Variable	**Coefficient**	**T-Statistic**	**P-Value**
Log_X1	0.448812	1.269680	0.2360
Log_X2	-0.076184	-0.471193	0.6064
Log_X3	0.142825	1.441359	0.1834
Log_X4	-0.184257	-0.502990	0.6270
Log_X5	-0.016491	-0.226437	0.8259
Log_X6	0.010210	0.040231	0.9688
Constant	9.850680***	4.530260	0.0014
Dummy_covid19	-0.035156	-0.657913	0.5271
R2	0.820574		
Adj. R2	0.777265		

Sources: Author Construction (2025)

Notes: (***)- 1% significant, (**)- 5% significant, (*)- 1% significant. Estimates derived using the error correction model with ΔLog_GDP a as the dependent variable. All the variables are in log condition.

The DOLS (Dynamic Ordinary Least Squares) results provide insights into the long-run relationship between Real GDP (Log_GDP_{tm}) and the explanatory variables. The coefficient for Log_X1_{tm} (transportation and storage infrastructure financing) is positive but statistically insignificant ($p = 0.2360$), indicating that a 1% increase in this type of financing could theoretically lead to a 0.4488% increase in Real GDP, but the effect cannot be confirmed with confidence.

Similarly, the coefficients for Log_X3_{tm} (electric, gas, and steam financing) and Log_X6_{tm} (human health and social work financing) are positive but not statistically

significant, implying their potential long-run contributions to GDP are inconclusive. In contrast, the coefficient for Log_X2_{tm} (ICT financing) is negative and insignificant ($p = 0.6064$), suggesting no robust long-run relationship with GDP, while Log_X4_{tm} (agriculture, forestry, and fishing financing) and Log_X5_{tm} (education financing) also show negative but statistically insignificant impacts.

The constant term is highly significant ($p = 0.0014$) with a coefficient of 9.8507, indicating a strong baseline level of Real GDP not captured by the explanatory variables. The Covid-19 dummy variable demonstrates a negative coefficient (-0.0352) but fails to achieve statistical significance ($p = 0.5271$), suggesting its limited explanatory capacity for long-term GDP fluctuations within this model. With an R-squared of 0.8206 and an adjusted R-squared of 0.7773, the model accounts for approximately 78% of Real GDP variation, indicating a robust fit.

Nevertheless, the lack of significance across most variables highlights the uncertainty surrounding their long-term impact on GDP, possibly stemming from data constraints or the influence of unmeasured factors. It is important to note that the results obtained from this study's DOLS model are susceptible to potential estimation errors and should not be employed as a basis for policy decisions.

4.5.3 Conical Cointegration Regression (CCR)

Table 4.9
Conical Cointegration Regression (CCR)

CCR Coefficients			
Variable	**Coefficient**	**T-Statistic**	**P-Value**
Log_X1	0.085049	1.130746	0.2674
Log_X2	0.020910	0.412714	0.6829
Log_X3	0.030923	1.103532	0.2789
Log_X4	0.147009*	2.030391	0.0516
Log_X5	-0.033170	-1.181477	0.2470
Log_X6	0.084740	1.411074	0.1689
Constant	9.754595***	19.98550	0.0000
Dummy_covid19	-0.059444***	-4.295983	0.0002
R2	0.819102		
Adj. R2	0.775437		

Sources: Author Construction (2025)

Notes: (***)- 1% significant, (**)- 5% significant, (*)- 1% significant. Estimates derived using the error correction model with ΔLog_GDP a as the dependent variable. All the variables are in log condition.

The CCR (Canonical Cointegration Regression) results offer insights into the long-run relationship between Real GDP (Log_GDP_{tm}) and the explanatory variables. The coefficient for Log_X1_{tm} (transportation and storage infrastructure financing) is positive (0.0850), but its impact is statistically insignificant (p = 0.2674), suggesting no conclusive evidence of its long-run influence on Real GDP. Similarly, Log_X2_{tm} (ICT financing) and Log_X3 (electric, gas, and steam financing) have positive coefficients (0.0209 and 0.0309, respectively), but their effects are also statistically insignificant (p > 0.05), indicating their limited explanatory power for GDP in the long run.

In contrast, Log_X4_{tm} (agriculture, forestry, and fishing infrastructure financing) shows a positive coefficient (0.1470) and is marginally significant ($p = 0.0516$), suggesting a potential long-run contribution to GDP, likely reflecting the sector's role in economic stability and rural development. Both Log_X5_{tm} (education financing) and Log_X6_{tm} (human health and social work financing) show insignificant results, with Log_X5_{tm} having a negative coefficient (-0.0332), while Log_X6_{tm} positive coefficient (0.0847) remains inconclusive in terms of statistical significance.

The constant term is highly significant ($p < 0.01$) with a coefficient of 9.7546, representing a strong baseline level of Real GDP that remains unexplained by the explanatory variables. The dummy variable for Covid-19 has a significant negative coefficient (-0.0594, $p = 0.0002$), highlighting a measurable adverse effect of the pandemic on GDP in the long run. The model demonstrates a high level of explanatory power, with an R-squared of 0.8191 and an adjusted R-squared of 0.7754, suggesting that approximately 78% of the variation in Real GDP is explained by the included variables. However, the limited significance of most variables indicates that other factors or dynamics might play a stronger role in determining GDP outcomes in the long run. The results of this study's CCR model are not free from plausible estimation error and hence cannot be utilised to make policy decisions.

4.5.4 Granger Causality

The results of the Granger causality test presented in the table examine whether one variable can statistically predict another in the short run, based on lagged information. The null hypothesis for each pair posits that one variable does not Granger-cause the other. Rejection of the null hypothesis, indicated by a low p-value (typically below

0.05), would imply that the independent variable significantly predicts changes in the dependent variable. In this test, six variables (D_LNX1 through D_LNX6) and Real GDP growth (D_LNGDP) are analysed for pairwise relationships over two lags.

The results reveal no statistically significant Granger causality between D_LNGDP and any of the explanatory variables (D_LNX1 to D_LNX6) in either direction. For instance, the p-values for the null hypotheses that D_LNX1 does not Granger-cause D_LNGDP (0.9290) and D_LNGDP does not Granger-cause D_LNX1 (0.5846) are both well above 0.05, suggesting no evidence of a predictive relationship. This pattern is consistent across all pairs involving D_LNGDP, indicating that none of the infrastructure or sectoral financing variables have a short-run predictive influence on GDP growth, nor does GDP growth predict changes in these variables.

Examining interactions among the explanatory variables themselves, there are few instances where significant Granger causality is detected. For example, D_LNX1 appears to Granger-cause D_LNX4 ($p = 0.0406$), suggesting that changes in transportation and storage financing have a predictive relationship with agricultural financing. Similarly, D_LNX6 Granger-causes D_LNX1 ($p = 0.0141$), indicating a predictive link from health and social work financing to transportation infrastructure.

Overall, these results suggest limited short-run interdependence among the variables, with most relationships failing to exhibit statistical significance. This lack of Granger causality could indicate delays in the effects of financing decisions on GDP and other

sectors, consistent with the longer time horizons typically associated with infrastructure investments.

Pairwise Granger Causality Tests
Date: 01/16/25 Time: 14:44
Sample: 2015Q1 2024Q2
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
D_LNX1 does not Granger Cause D_LNGDP	35	0.07385	0.9290
D_LNGDP does not Granger Cause D_LNX1		0.54656	0.5846
D_LNX2 does not Granger Cause D_LNGDP	35	0.65225	0.5281
D_LNGDP does not Granger Cause D_LNX2		0.01699	0.9832
D_LNX3 does not Granger Cause D_LNGDP	35	0.01660	0.9835
D_LNGDP does not Granger Cause D_LNX3		0.57002	0.5715
D_LNX4 does not Granger Cause D_LNGDP	35	0.00103	0.9990
D_LNGDP does not Granger Cause D_LNX4		0.25270	0.7783
D_LNX5 does not Granger Cause D_LNGDP	35	0.11484	0.8919
D_LNGDP does not Granger Cause D_LNX5		0.25454	0.7769
D_LNX6 does not Granger Cause D_LNGDP	35	1.29025	0.2900
D_LNGDP does not Granger Cause D_LNX6		2.41987	0.1061
D_LNX2 does not Granger Cause D_LNX1	35	0.08117	0.9222
D_LNX1 does not Granger Cause D_LNX2		0.62589	0.5416
D_LNX3 does not Granger Cause D_LNX1	35	0.65264	0.5279
D_LNX1 does not Granger Cause D_LNX3		0.22428	0.8004
D_LNX4 does not Granger Cause D_LNX1	35	0.52778	0.5953
D_LNX1 does not Granger Cause D_LNX4		3.54950	0.0413
D_LNX5 does not Granger Cause D_LNX1	35	0.04948	0.9518
D_LNX1 does not Granger Cause D_LNX5		2.05934	0.1452
D_LNX6 does not Granger Cause D_LNX1	35	2.93029	0.0688
D_LNX1 does not Granger Cause D_LNX6		4.93023	0.0141
D_LNX3 does not Granger Cause D_LNX2	35	0.65690	0.5258
D_LNX2 does not Granger Cause D_LNX3		0.25972	0.7730
D_LNX4 does not Granger Cause D_LNX2	35	0.11265	0.8938
D_LNX2 does not Granger Cause D_LNX4		1.09446	0.3477
D_LNX5 does not Granger Cause D_LNX2	35	0.83462	0.4439
D_LNX2 does not Granger Cause D_LNX5		0.52875	0.5947
D_LNX6 does not Granger Cause D_LNX2	35	0.76388	0.4747
D_LNX2 does not Granger Cause D_LNX6		0.11540	0.8914
D_LNX4 does not Granger Cause D_LNX3	35	0.41910	0.6614
D_LNX3 does not Granger Cause D_LNX4		2.87757	0.0719
D_LNX5 does not Granger Cause D_LNX3	35	1.20189	0.3147
D_LNX3 does not Granger Cause D_LNX5		0.28306	0.7555
D_LNX6 does not Granger Cause D_LNX3	35	0.29960	0.7433
D_LNX3 does not Granger Cause D_LNX6		0.09807	0.9069
D_LNX5 does not Granger Cause D_LNX4	35	1.09962	0.3460
D_LNX4 does not Granger Cause D_LNX5		2.10546	0.1394
D_LNX6 does not Granger Cause D_LNX4	35	1.02161	0.3722
D_LNX4 does not Granger Cause D_LNX6		0.96246	0.3934
D_LNX6 does not Granger Cause D_LNX5	35	2.38767	0.1091
D_LNX5 does not Granger Cause D_LNX6		5.90516	0.0069

Figure 4.1
Granger Causality Test

4.6 The Summary Findings

The primary objectives of this study are to examine the impact of sustainable Islamic banking financing on Malaysia's economic growth, with a particular focus on infrastructure projects. For the details summary findings presented on table 4.10.

Table 4.10
The Summary Findings

Type of Equilibrium						Granger Causality
Short run	**Hypothesis**	**Result**	**Long run**	**Hypothesis**	**Result**	
Yes			Yes			Five unidirectional causality relationship
Log_X1: -ve & insigni	H_1	Unsupported	Log_X1: +ve & insigni	H_1	Unsupported	
Log_X1(-1): +ve & insigni	H_1	Unsupported	Log_X2: +ve & insigni	H_2	Unsupported	
Log_X1(-2): +ve & signi	H_1	Supported	Log_X3: +ve & insigni	H_3	Unsupported	
Log_X1(-3): -ve & insigni	H_1	Unsupported	Log_X4: -ve & insigni	H_4	Unsupported	
Log_X2: +ve & signi	H_1	Supported	Log_X5: +ve & signi	H_5	Supported	
Log_X2(-1): -ve & signi	H_2	Supported	Log_X6: +ve & signi	H_6	Supported	
Log_X2(-2):+ve & insigni	H_2	Unsupported				
Log_X3: +ve & signi	H_3	Supported				
Log_X3(-1): -ve & signi	H_3	Unsupported				
Log_X3(-2): +ve & signi	H_3	Supported				
Log_X3(-3): -ve & signi	H_3	Unsupported				
Log_X4: +ve & insigni	H_4	Unsupported				
Log_X4(-1): -ve & signi	H_4	Unsupported				
Log_X5: -ve & insigni	H_5	Unsupported				
Log_X5(-1): +ve & insigni	H_5	Unsupported				

Log_X5(-2): +ve & signi	H_5	Supported
Log_X5(-3): -ve & insigni	H_5	Unsupported
Log_X6: +ve & insigni	H_6	Unsupported
Log_X6(-1): -ve & signi	H_6	Unsupported
Log_X6(-2): +ve & signi	H_6	Supported
Log_X6(-3): +ve & signi	H_6	Supported

4.7 Discussion on Findings

The results are predicated on both long-term and short-term analyses. Mainly supporting by the Commercial Cooperation of the Organisation of Islamic Cooperation (COMCEC) research (2019) regarding the Islamic infrastructure financing in Organisation of Islamic Cooperation (OIC), that Islamic infrastructure financing demonstrates minimal impact on long-term outcomes across all variables examined in this study. Potential explanations for the limited contribution of infrastructure investment from Islamic banking include the majority of assets being allocated to deposits, which are short-term in nature, or restrictions on long-term investments. Furthermore, the Basel III standards for long-term financing investments necessitate higher capital requirements, which may serve as a disincentive for investments in infrastructure sectors. Conversely, Islamic banks contribute to the infrastructure sectors indirectly through the capital market (sukuk holdings), which constitute approximately 13.3% of their assets.

4.7.1 RO1: Transportation and Storage Islamic Infrastructure Financing to Malaysia Economic Growth

The primary research objective of this study is to analyse the relationship between sustainable Islamic banking financing, focusing on Economic Infrastructure Sectors (transportation and storage), and its contribution to Malaysia's Real GDP in the long-run and short-run. The findings of this study regarding long-run equilibrium, as presented in table 4.10, indicate that transportation and storage Islamic infrastructure financing by Islamic Banking has a positive but statistically insignificant effect on

Malaysia's economic growth. Conversely, based on table 4.10, the short-run analyses yield varying results for different lags.

The research demonstrated that infrastructure investment in roads has a positive effect on GDP per capita growth, with a 1% increase in road infrastructure investment resulting in a 0.41% increase in GDP per capita growth after a three-year lag (Ibrahimov et al., 2023). Evidence indicates that the short-term effects of roads and railways on GDP can be negative (Timilsina et al., 2023). This seemingly paradoxical finding may be attributed to the initial disruption and costs associated with large infrastructure projects prior to the realization of their long-term benefits. Furthermore, the impact of transport infrastructure on economic growth appears to diminish over time, particularly in more economically advanced nations. In conclusion, while evidence suggests a positive relationship between transportation and storage infrastructure financing and economic growth, the impact is often statistically insignificant or delayed stated Afonso and Rodrigues (2023).

The findings of Islamic Infrastructure Financing for Transportation and Storage (X1) is congruent with Malaysia's real economic landscape, wherein Islamic banks actively participate in infrastructure development financing, particularly through Sukuk (Islamic bonds), which have been instrumental in funding critical transport projects such as highways, MRT expansions, and port developments. The short-term volatility indicates that transportation and storage financing may have delayed economic effects, potentially due to the extended gestation period of infrastructure projects before yielding productivity gains. Furthermore, Malaysia's robust government support for Islamic banking, through institutions such as Bank Negara Malaysia and Khazanah

Nasional, ensures that Shariahh-compliant financing remains a cornerstone for sustainable infrastructure growth, which is reflected in its long-term economic significance. The negative yet statistically insignificant long-run coefficient suggests that other macroeconomic factors, including regulatory shifts, global economic conditions, or inefficiencies in project execution, may moderate the direct benefits of such financing on economic growth.

4.7.2 RO2: Information and communication technology (ICT) Infrastructure Financing to Malaysia Economic Growth

This study second research objective examines the impact of sustainable Islamic banking financing, specifically in economic infrastructure sectors (information and communication technology), on Malaysia's Real GDP in both long-term and short-term contexts. The findings from the long-run analysis, presented in table 4.10, indicate that Islamic Banking's financing of information and communication technology infrastructure exhibits a positive but statistically insignificant effect on Malaysia's economic growth on long-run. Conversely, the short-run analysis results from table 4.10 also demonstrate varying outcomes across different time lags.

It has been reported that an increase in telecommunications infrastructure yields substantial, long-term positive effects on GDP, although short-term effects are less pronounced. Furthermore, the study indicates that the impact of communication infrastructure is comparatively higher in developing economies than in industrialized economies (Timilsina et al., 2023). Furthermore, research conducted in Nigeria

concerning the impact of ICT infrastructure on economic growth indicated a positive but statistically insignificant effect (Olaye, 2023).

In contrast, Ziky and El-Abdellaoui (2023) present a contradictory finding regarding renewable energy, which is frequently associated with ICT advancements. Their study demonstrates a negative impact of renewable energy on Morocco's economic growth, which may be attributed to high initial costs, structural changes in the industry, and the necessity of establishing infrastructure for production. This suggests that ICT-related investments in certain sectors might have short-term negative effects on GDP (Ziky & El-Abdellaoui, 2023).

The findings on Islamic Infrastructure Financing for ICT Infrastructure reflect Malaysia's current economic landscape, wherein Islamic financial institutions have been actively engaged in funding ICT infrastructure projects, such as the expansion of fibre optic networks, digital payment platforms, and 5G technology, utilising Shariahh-compliant financial instruments like Sukuk and Ijarah financing. The significant negative short-term lag (ΔLog_X2(-1), $p = 0.0209$) suggests that excessive ICT funding in a given period may result in a temporary economic growth deceleration, potentially due to overinvestment, delays in implementation, or initial inefficiencies prior to the full operationalisation of the digital infrastructure. However, the Malaysian government's commitment to digital transformation, as outlined in the MyDIGITAL blueprint, coupled with the growth of Islamic fintech solutions, ensures that Shariahh-compliant financing will remain a crucial factor in driving ICT infrastructure development, aligning with the observed short-term economic impact.

4.7.3 RO3: Electric, Gas, and Steams Infrastructure Financing to Malaysia Economic Growth

The third research objective of this study is to analyse the relationship between sustainable Islamic banking financing, focusing on environment infrastructure sectors (electric, gas, and steam), and its contribution to Malaysia's Real GDP in the long-run and short-run. The conclusion of this study in long-run analyses, based on table 4.10, indicates that electric, gas, and steam infrastructure financing by Islamic banking has a positive but insignificant effect on Malaysia's economic growth. Conversely, based on table 4.10, the short-run analyses yield different results for different lags.

The funding for electric, gas, and steam infrastructure positively influences economic growth. This effect is particularly pronounced in the long run and within developing economies. However, a negative impact of renewable energy on Morocco's economic growth was identified, which may be attributed to high initial costs, structural changes in the industry, and the necessity of establishing infrastructure for production (Alkasasbeh et al., 2023; Timilsina et al., 2023). Nevertheless, the short-term effects may be less significant or even negative due to substantial initial costs and structural changes (Ziky & El-Abdellaoui, 2023). The impact can vary depending on the specific sector and country context.

The findings indicate that Islamic infrastructure financing for electricity, gas, and steam (X3) suggests that while short-term investments in energy infrastructure

enhance economic activity, their long-term impact is less stable. This aligns with Malaysia's energy sector dynamics, where Islamic banks have been financing large-scale renewable energy projects, power plant expansions, and sustainable energy transitions through sukuk issuances and Shariahh-compliant project financing. The negative and significant coefficient at the third lag (ΔLog_X3(-3), p = 0.0033) may indicate that delays in project implementation, regulatory hurdles, or inefficiencies in energy distribution might temporarily impede economic benefits. However, Malaysia's commitment to the National Energy Transition Roadmap (NETR) and its promotion of Islamic green financing solutions reinforce the crucial role of Islamic banking in enhancing energy security and economic resilience, aligning with the observed short-term growth impact.

4.7.4 RO4: Agriculture, Forestry, and Fishing Infrastructure Financing to Malaysia Economic Growth

The fourth research objective of this study is to analyse the relationship between sustainable Islamic banking financing, focusing on environment infrastructure sectors (agriculture, forestry, and fishing), and its contribution to Malaysia's Real GDP in the long-run and short-run. The conclusion of this study, based on long-run analyses presented in table 4.10, indicates that agriculture, forestry, and fishing infrastructure financing by Islamic banking has a negative but insignificant impact on Malaysia's economic growth. Conversely, the short-run analyses in table 4.10 demonstrate varying results for different lags.

From the previous research on AFF (Agriculture, Forestry, and Fishing) infrastructure, there are potential trade-offs between economic development and environmental sustainability. Excessive emphasis on AFF infrastructure financing without adequate environmental considerations may result in increased ecological footprints and environmental degradation (Geng et al., 2024). For instance, in certain regions, the impact of industrial structure on forestry eco-efficiency has been observed to be significantly negative (Tan et al., 2023).

However, the extant literature on AFF infrastructure financing demonstrates a significant potential to promote economic growth through enhanced productivity and efficiency in these sectors. Improved infrastructure facilitates increased production, enhanced market access, and elevated incomes for agricultural and fishery workers (Rani et al., 2023; Xu et al., 2023). For instance, investment in fish trading infrastructure and essential facilities such as social networks, education, and technology can augment the livelihood income of fishermen and mitigate poverty (Xu et al., 2023). Furthermore, the forestry industry, as a low-carbon green sector, exhibits substantial development potential and can contribute to sustainable economic growth (Ma et al., 2023).

The findings suggest that Islamic infrastructure financing for agriculture, forestry, and fishing (X4) may incur short-term adjustment costs or exhibit delayed benefits, potentially attributable to prior investments in agricultural infrastructure. This observation aligns with the current situation in Malaysia, where Islamic financial institutions have utilised Shariahh-compliant instruments such as Sukuk and *Ijarah* to

finance rural development projects, irrigation systems, and Halal food supply chains. The limited statistical significance could be attributed to various factors, including land use restrictions, climate-related risks, and the gradual implementation of modern Islamic financing methods in the agricultural sector. Nonetheless, Malaysia's initiatives to promote Islamic green financing in agriculture and the incorporation of Sustainable and Responsible Investment (SRI) Sukuk for agri-infrastructure development indicate potential long-term advantages, despite current empirical data demonstrating limited impact.

4.7.5 RO5: Education Infrastructure Financing to Malaysia Economic Growth

The fifth research objective in this study is to analyse the relationship between sustainable Islamic banking financing, focusing on social infrastructure sectors (education), and its contribution to Malaysia's Real GDP in the long-run and short-run. The conclusion of this study in long-run analyses, based on table 4.10, indicates that education infrastructure financing by Islamic banking has a positive and statistically significant effect at the 10% level on Malaysia's economic growth. Conversely, based on table 4.10, the short-run analyses yield varying results for different lags.

The extant literature on this subject indicates that in the short term, education infrastructure investment appears to have a limited or potentially negative impact on economic growth. Ibrahimov et al. (2023) posit that infrastructure investments generally exhibit a delayed effect on GDP growth, with the most significant influence manifesting after a three-year lag. Conversely, in the long term, the impact of education

sector infrastructure financing and investment on economic growth is predominantly positive. Shah et al. (2023). Additional literature regarding the impact of this sector on long-term economic growth in Nigeria demonstrated a positive but statistically insignificant relationship. The insignificance of this result indicates that the infrastructure conditions in this sector remain substantially below the desired level (Olaye, 2023).

The results indicate that Islamic infrastructure financing for education (X5) suggests that previous investments in educational infrastructure through Islamic banking can yield economic benefits with a temporal lag. However, the current period and other lagged coefficients remain statistically insignificant, implying that the impact of Islamic education financing is not immediate. This observation aligns with the prevailing conditions in Malaysia, where Islamic banks have increasingly supported higher education institutions, university campuses, and vocational training centres utilising Shariahh-compliant instruments such as Sukuk *Wakalah* and *Ijarah* financing. While the government has promoted Islamic finance in the education sector, challenges including high capital requirements, regulatory constraints, and extended gestation periods for educational returns may elucidate the delayed economic impact. Nevertheless, given Malaysia's strong commitment to Islamic finance and human capital development, the role of Islamic education infrastructure financing is anticipated to strengthen over time, particularly in enhancing workforce productivity and innovation-driven growth.

4.7.6 RO6: Human Health and Social works Infrastructure Financing to Malaysia Economic Growth

The sixth research objective of this study is to analyse the relationship between sustainable Islamic banking financing, focusing on social infrastructure sectors (human health and social works), and its contribution to Malaysia's Real GDP in the long-run and short-run. The conclusion of this study, based on long-run analyses that human health and social works infrastructure financing by Islamic banking has a positive and significant impact at the 10% level on Malaysia's economic growth. Conversely, based on table 4.10, the short-run analyses yield varying results for different lags.

According to research from Jiang and Wang (2023), Private health expenditure demonstrates a significant positive effect on GDP per capita, with a 1-unit increase resulting in a 3.51 % rise in short-term GDP and a 1.31 coefficient for long-term growth. Social service expenditure exhibits a strong positive correlation with economic growth, with a 1-unit increase leading to a 5.97 % rise in short-term GDP per capita and a 5.76 coefficient for long-term growth (Jiang & Wang, 2023).

Nevertheless, negative impacts and contradictions warrant consideration. Government health expenditure yields mixed results, with a negative long-term coefficient (-4.33) for positive changes, suggesting that increased government health spending may not consistently lead to economic growth (Jiang & Wang, 2023). The impact of health and social infrastructure investments may vary between advanced and emerging economies. For instance, public investment exerts more positive effects on GDP

growth and private investment in emerging economies compared to advanced economies (Afonso & Rodrigues, 2023).

The research indicates that Islamic infrastructure financing for human health and social works (X6) exerts a significant influence on Malaysia's economic growth. This suggests that while an initial increase in Islamic funding for health and social infrastructure may temporarily destabilise the economy (due to substantial capital outflows), it subsequently yields positive outcomes as these investments begin to generate returns. This phenomenon aligns with the current situation in Malaysia, where Islamic financial institutions are increasingly participating in the funding of healthcare facilities, aged-care centres, and social welfare establishments utilising Shariahh-compliant financial instruments such as Sukuk *Ijarah* and *Musharakah Mutanaqisah*.

As Malaysia endeavours to establish itself as a regional centre for Islamic healthcare financing, concepts such as hospital waqf funding and Islamic endowments for medical research have gained prominence. The varied short-term impact suggests that initial capital-intensive investments may necessitate financial adjustments before the benefits are fully realised. Nevertheless, in the long term, improved healthcare infrastructure enhances productivity, life expectancy, and workforce efficiency, ultimately contributing to Malaysia's sustainable economic growth through enhanced human capital development.

4.8 Chapter Summary

In conclusion, this chapter has provided a thorough analysis of the impact of sustainable Islamic infrastructure project financing on Malaysia's economic development. The study utilized a range of econometric techniques, including descriptive analysis, unit root tests, ARDL cointegration, and robustness checks employing FMOLS, DOLS, CCR, and Granger causality. The findings indicated varied results across different infrastructure financing sectors and temporal scopes. While certain sectors exhibited significant associations with economic growth in either the short or long term, others displayed limited or inconclusive effects. The COVID-19 pandemic was identified as having a considerable negative impact on the economy. Overall, the analysis highlights the intricate nature of the relationship between Islamic infrastructure financing and economic growth, emphasizing the necessity for nuanced policy approaches and further research to comprehensively understand these dynamics.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This section elucidates the conclusions derived from the results and findings delineated in the preceding chapter. It then synthesizes these findings and compares them with the study's objectives. Furthermore, this segment explores the study's implications, acknowledges its limitations, and proposes avenues for future research endeavours.

5.2 Recapitulation of the Study

The primary objective of this research is to examine the influence of sustainable Islamic banking funding on Malaysia's economic development, with a particular focus on infrastructure projects. In summarizing this study, it successfully achieved all the research objectives, thereby addressing the research questions;

i. To what extent does sustainable Islamic banking financing focus on economics infrastructure sectors (transportation) contribute to Malaysia Real GDP?
ii. To what extent does sustainable Islamic banking financing focus on economics infrastructure sectors (information and communication technology) contribute to Malaysia Real GDP?

iii. To what extent does sustainable Islamic banking financing focus on environmental infrastructure sectors (electric, gas and steam) contribute to Malaysia Real GDP?

iv. To what extent does sustainable Islamic banking financing focus on environmental infrastructure sectors (agriculture, forestry, and fishing) contribute to Malaysia Real GDP?

v. To what extent does sustainable Islamic banking financing focus on social infrastructure sectors (education) contribute to Malaysia Real GDP?

vi. To what extent does sustainable Islamic banking financing focus on social infrastructure sectors (human health and social works) contribute to Malaysia Real GDP?

The questions were also utilized to formulate the hypotheses that were tested. The analytical method employed the Autoregressive Distributed Lag (ARDL) model. Overall, the findings, as discussed in the previous chapter, indicate that in the long run, only hypotheses five and six are supported, while in the short run, the support varies across different lags.

5.2 Contribution of the Study

5.2.1 Theoretical Contributions

The present research offers substantial theoretical contributions by investigating the intricate relationship between Islamic finance, sustainability, and economic growth in Malaysia. Through an examination of the ways in which Islamic financial practices

facilitate sustainable infrastructure development, the study presents a novel perspective on the role of faith-based financial systems in advancing environmental and social responsibility. This innovative approach not only addresses a gap in the existing literature but also establishes a foundation for future scholarly inquiries into the intersection of religious principles, financial practices, and sustainable development.

Regarding the underpinning theory which used in this study. Endogenous growth theory offers a comprehensive framework for understanding the intrinsic drivers of economic growth, emphasizing the significance of human capital, innovation, and technological advancement. Unlike neoclassical models that treat these elements as external, endogenous growth theory integrates them directly into the growth process. This perspective highlights the critical role of infrastructure—particularly transport systems and other foundational components—in stimulating economic activity by enhancing knowledge diffusion, creativity, and productivity. The theory also introduces a bidirectional relationship between infrastructure and economic growth, where infrastructure development promotes economic expansion, and in turn, economic growth creates the capacity and demand for further infrastructure investment.

By incorporating infrastructure into the core of growth models, endogenous growth theory allows for a nuanced analysis of the interplay between investment, human capital, and technological progress. This approach is particularly useful for policymakers seeking to design infrastructure investment strategies that support

sustainable, long-term economic development. It provides a conceptual structure to understand how physical infrastructure contributes not only to immediate economic gains but also to lasting structural transformations. Consequently, the theory serves as a valuable tool in aligning infrastructure planning with broader economic objectives.

5.2.2 Practical Contributions

The research provides substantive insights for Islamic financial institutions, banks, and investors by presenting empirical evidence regarding the advantages and challenges associated with financing sustainable infrastructure projects. This framework will guide Islamic financial institutions in aligning their practices with national objectives pertaining to sustainable development and economic growth. The findings can assist these institutions in developing more efficacious and targeted financing products, improving risk assessment methodologies for sustainable projects, and enhancing their overall contribution to the sustainable development agenda. Moreover, the research may facilitate the identification of potential areas for innovation in Islamic financial instruments that specifically address sustainable infrastructure requirements.

The outcomes of this investigation will be of substantial significance for policymakers in Malaysia seeking to expand sustainable financing through Islamic banking for infrastructure development. The findings have the potential to inform regulatory bodies such as Bank Negara Malaysia in formulating policies that promote sustainable Islamic financing models. This may encompass the development of novel regulatory frameworks, incentive structures, or guidelines that encourage Islamic financial institutions to increase their participation in sustainable infrastructure projects.

Furthermore, the research could influence the integration of sustainability criteria into existing Islamic finance regulations and standards, thereby fostering a more comprehensive approach to sustainable development within the Islamic finance sector.

The study provides comprehensive analyses of diverse infrastructure sectors, including transportation, ICT, energy, agriculture, education, and healthcare. These sector-specific insights can inform targeted policy interventions and investment strategies. By identifying the unique challenges and opportunities within each sector, the research enables policymakers and investors to tailor their approaches accordingly. This granular understanding can facilitate more effective allocation of resources, prioritisation of projects, and development of sector-specific financing solutions that address the particular needs and characteristics of each infrastructure domain.

The research delineates between long-term and short-term effects of Islamic infrastructure financing on economic growth, providing a nuanced understanding of the temporal dynamics of such investments. This temporal perspective is crucial for policymakers and investors in formulating informed decisions regarding resource allocation and project prioritisation. It facilitates a more comprehensive evaluation of the potential impacts of sustainable infrastructure investments, considering both immediate economic benefits and long-term sustainability outcomes. This distinction can aid in developing more balanced and sustainable economic growth strategies that consider both short-term economic gains and long-term environmental and social benefits.

5.3 Limitations and Recommendations

The research is confined to Malaysia, potentially limiting its generalisability to other countries or regions. While Malaysia is a significant participant in Islamic finance, the distinctive characteristics of its economic, political, and regulatory environment may not be representative of other Islamic finance markets. This geographical constraint may restrict the applicability of the findings to other countries with differing levels of Islamic finance development, economic structures, or regulatory frameworks.

It is recommended to conduct analogous studies in diverse countries or regions to facilitate cross-country comparisons and enhance generalisability. This approach could entail selecting a heterogeneous range of countries with varying levels of Islamic finance development, economic structures, and regulatory environments. Such comparative analysis would aid in identifying common patterns and unique factors influencing the relationship between Islamic infrastructure financing and economic growth across different contexts. Furthermore, it could contribute to the development of a more universal framework for comprehending the role of Islamic finance in economic development.

Future research could benefit from incorporating primary data sources, such as surveys or interviews with industry experts, to complement secondary data analysis. This mixed-method approach would yield more comprehensive and nuanced insights into the mechanisms through which Islamic infrastructure financing influences economic growth. Primary data collection could encompass structured interviews with Islamic finance practitioners, policymakers, and economists, as well as surveys of businesses

and consumers engaged in Islamic finance transactions. This methodology would facilitate the capture of qualitative aspects of the relationship that may not be discernible in quantitative data alone.

Conduct in-depth studies on individual sectors to gain more nuanced insights into their specific impacts on economic growth. This could involve focusing on key infrastructure sectors such as transportation, energy, telecommunications, and water supply. By examining each sector separately, researchers could identify unique challenges, opportunities, and impact pathways specific to Islamic financing in these areas. This granular approach would allow for more targeted policy recommendations and a better understanding of how different sectors contribute to overall economic growth through Islamic financing mechanisms.

This chapter offers a thorough analysis of the influence of sustainable Islamic banking financing on Malaysia's economic growth, with a particular emphasis on various infrastructure sectors. The findings indicate a complex relationship between Islamic infrastructure financing and economic development, exhibiting diverse effects across different sectors and temporal frameworks. While certain sectors, such as education and human health, demonstrate positive long-term impacts, others exhibit limited or negligible effects. The study underscores the significance of considering both short-term and long-term implications of Islamic infrastructure financing, as well as the necessity for sector-specific strategies. These insights enhance the understanding of Islamic finance's role in sustainable development and provide valuable guidance for policymakers, financial institutions, and investors in aligning Islamic banking practices with national economic objectives. The research also acknowledges

limitations in geographical scope and data sources, suggesting avenues for future research to improve the generalizability and depth of findings in this critical area of sustainable economic growth.

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APPENDICES

A. Descriptive Statistics

	LOG_GDP	LOG_X1	LOG_X2	LOG_X3	LOG_X4	LOG_X5	LOG_X6
Mean	12.74521	9.357227	8.535455	8.320957	9.609758	8.882041	7.708512
Median	12.74927	9.416233	8.519618	8.343508	9.650045	9.093328	7.804396
Maximum	12.92468	9.562799	9.242497	9.309999	9.897323	9.290367	8.038267
Minimum	12.55057	8.866564	7.989810	7.675227	8.907331	8.111903	7.144742
Std. Dev.	0.100504	0.173548	0.391015	0.528512	0.227876	0.336155	0.266771
Skewness	-0.173829	-1.383294	0.233795	0.450866	-1.144798	-0.705862	-0.761032
Kurtosis	2.151554	3.840059	1.826218	1.913483	4.129573	2.047846	2.185765
Jarque-Bera	1.331151	13.23620	2.527642	3.156596	10.32047	4.590973	4.717795
Probability	0.513978	0.001336	0.282572	0.206326	0.005740	0.100712	0.094524
Sum	484.3180	355.5746	324.3473	316.1964	365.1708	337.5175	292.9234
Sum Sq. Dev.	0.373741	1.114402	5.657031	10.33504	1.921317	4.181019	2.633180
Observations	38	38	38	38	38	38	38

B. Bounce Test

Null hypothesis: No levels relationship
Number of cointegrating variables: 6
Trend type: Unrest. constant (Case 3)
Sample size: 35

Test Statistic	Value
F-statistic	11.241421
t-statistic	-3.559148

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
			F-Statistic			
30	2.457	3.797	2.970	4.499	4.270	6.211
35	2.387	3.671	2.864	4.324	4.016	5.797
Asymptotic	2.120	3.230	2.450	3.610	3.150	4.430
			t-Statistic			
Asymptotic	-2.570	-4.040	-2.860	-4.380	-3.430	-4.990

* I(0) and I(1) are respectively the stationary and non-stationary bounds.

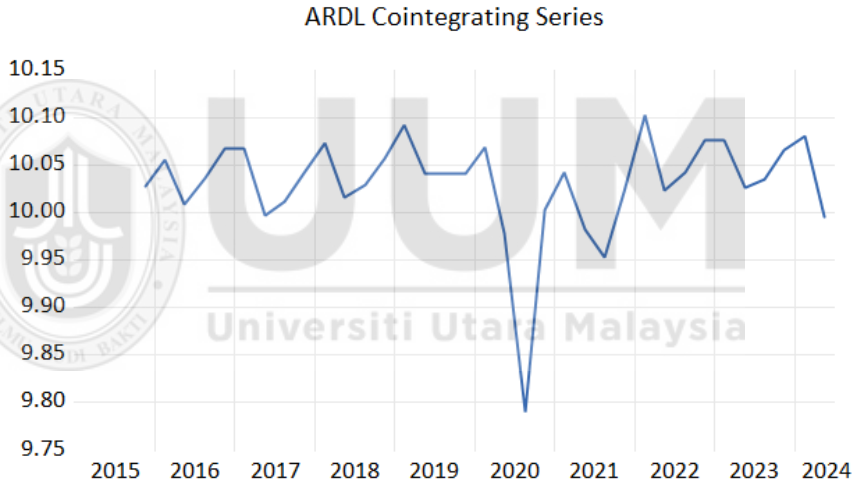
C. Cointegration

Deterministics: Unrest. constant (Case 3)

CE = LOG_GDP(-1) - (0.040355*LOG_X1(-1) + 0.121508*LOG_X2(-1) + 0.025696*LOG_X3(-1) - 0.079576*LOG_X4(-1) + 0.038980*LOG_X5(-1) + 0.195470*LOG_X6(-1))

Variable *	Coefficient	Std. Error	t-Statistic	Prob.
LOG_X1(-1)	0.040355	0.085932	0.469616	0.6421
LOG_X2(-1)	0.121508	0.083251	1.459525	0.1552
LOG_X3(-1)	0.025696	0.037759	0.680530	0.5016
LOG_X4(-1)	-0.079576	0.183848	-0.432835	0.6683
LOG_X5(-1)	0.038980	0.023406	1.665385	0.1066
LOG_X6(-1)	0.195470	0.102915	1.899330	0.0675

Note: * Coefficients derived from the CEC regression.



D. Stationary Test

a. GDP

(i) ADF

Null Hypothesis: LOG_GDP has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.650222	0.8459
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_GDP has a unit root
Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.503919	0.0050
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_GDP) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.843913	0.0000
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

Null Hypothesis: D(LOG_GDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.723495	0.0000
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

ii. PP

Null Hypothesis: LOG_GDP has a unit root
Exogenous: Constant
Bandwidth: 12 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.837549	0.3572
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_GDP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.435530...	0.00590...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

Null Hypothesis: D(LOG_GDP) has a unit root
Exogenous: Constant
Bandwidth: 14 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.98118	0.0000
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_GDP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 14 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.86684	0.0000
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

*MacKinnon (1996) one-sided p-values.

b. Variable X1

i. ADF

Null Hypothesis: LOG_X1 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.144241	0.0318
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

Null Hypothesis: LOG_X1 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.774577	0.2151
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X1) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.815714	0.0000
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

Null Hypothesis: D(LOG_X1) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.924704	0.0001
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

*MacKinnon (1996) one-sided p-values.

ii. PP

Null Hypothesis: LOG_X1 has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.507388	0.0133
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_X1 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.653150	0.2607
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X1) has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.106951	0.0000
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

Null Hypothesis: D(LOG_X1) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 11 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.050357	0.0000
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

*MacKinnon (1996) one-sided p-values.

c. Variable X2

i. ADF

Null Hypothesis: LOG_X2 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.423431	0.8947
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

Null Hypothesis: LOG_X2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.535208	0.0506
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	

Null Hypothesis: D(LOG_X2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.332936	0.0001
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 7 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.275594	0.0108
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

*MacKinnon (1996) one-sided p-values.

ii. PP

Null Hypothesis: LOG_X2 has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.248233	0.9231
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_X2 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.026258	0.1390
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X2) has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.848928	0.0000
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X2) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.688386	0.0002
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

*MacKinnon (1996) one-sided p-values.

d. Variable X3

i. ADF

Null Hypothesis: LOG_X3 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.752416...	0.82064...
Test critical values:	1% level	-3.621022970921404	
	5% level	-2.943426737878374	
	10% level	-2.610263477402139	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_X3 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.530304...	0.31267...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X3) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.308581	0.0001
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X3) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.177500...	0.00086...
Test critical values:	1% level	-4.234972303363573	
	5% level	-3.540328054586965	
	10% level	-3.202445365931776	

*MacKinnon (1996) one-sided p-values.

ii. PP

Null Hypothesis: LOG_X3 has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.804009...	0.80624...
Test critical values:	1% level	-3.621022970921404	
	5% level	-2.943426737878374	
	10% level	-2.610263477402139	

*MacKinnon (1996) one-sided p-values.
Null Hypothesis: LOG_X3 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.515379...	0.31936...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X3) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.261879...	0.0001
Test critical values:	1% level	-3.626783579953108	
	5% level	-2.945842297613319	
	10% level	-2.61153098100415	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X3) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.119145...	0.00101...
Test critical values:	1% level	-4.234972303363573	
	5% level	-3.540328054586965	
	10% level	-3.202445365931776	

*MacKinnon (1996) one-sided p-values.

e. Variable X4

i. ADF

Null Hypothesis: LOG_X4 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.697553...	0.00822...
Test critical values:	1% level	-3.621022970921404	
	5% level	-2.943426737878374	
	10% level	-2.610263477402139	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_X4 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.682666...	0.00311...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_X4 has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.165976...	0.00237...
Test critical values:	1% level	-3.621022970921404	
	5% level	-2.943426737878374	
	10% level	-2.610263477402139	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_X4 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.682666...	0.00311...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

*MacKinnon (1996) one-sided p-values.

f. Variable X5

i. ADF

Null Hypothesis: LOG_X5 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.056254...	0.72251...
Test critical values:	1% level	-3.621022970921404	
	5% level	-2.943426737878374	
	10% level	-2.610263477402139	

*MacKinnon (1996) one-sided p-values.
Null Hypothesis: LOG_X5 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.940042...	0.16265...
Test critical values:	1% level	-4.234972303363573	
	5% level	-3.540328054586965	
	10% level	-3.202445365931776	

*MacKinnon (1996) one-sided p-values.
Null Hypothesis: D(LOG_X5) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.941411...	0.00027...
Test critical values:	1% level	-3.626783579953108	
	5% level	-2.945842297613319	
	10% level	-2.61153098100415	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X5) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.870376...	0.00196...
Test critical values:	1% level	-4.234972303363573	
	5% level	-3.540328054586965	
	10% level	-3.202445365931776	

*MacKinnon (1996) one-sided p-values.

ii. PP

Null Hypothesis: LOG_X5 has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.056254...	0.72251...
Test critical values:	1% level	-3.621022970921404	
	5% level	-2.943426737878374	
	10% level	-2.610263477402139	

*MacKinnon (1996) one-sided p-values.
Null Hypothesis: LOG_X5 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.450420...	0.34934...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

*MacKinnon (1996) one-sided p-values.
Null Hypothesis: D(LOG_X5) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.901582...	0.00031...
Test critical values:	1% level	-3.626783579953108	
	5% level	-2.945842297613319	
	10% level	-2.61153098100415	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X5) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.826801...	0.00220...
Test critical values:	1% level	-4.234972303363573	
	5% level	-3.540328054586965	
	10% level	-3.202445365931776	

*MacKinnon (1996) one-sided p-values.

g. Variable X6

ADF

Null Hypothesis: LOG_X6 has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.762255...	0.39232...
Test critical values:	1% level	-3.632900372759561	
	5% level	-2.948403904980925	
	10% level	-2.612874301840857	

*MacKinnon (1996) one-sided p-values.
Null Hypothesis: LOG_X6 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.963836...	0.60121...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X6) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.561243	0.0000
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X6) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.751942	0.0000
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

ii. PP

Null Hypothesis: LOG_X6 has a unit root
Exogenous: Constant
Bandwidth: 17 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.194659...	0.66646...
Test critical values:	1% level	-3.621022970921404	
	5% level	-2.943426737878374	
	10% level	-2.610263477402139	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_X6 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.727220...	0.71882...
Test critical values:	1% level	-4.226814758569573	
	5% level	-3.536601078028856	
	10% level	-3.200319736406595	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X6) has a unit root
Exogenous: Constant
Bandwidth: 12 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.963640	0.0000
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOG_X6) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 35 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.53292	0.0000
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

*MacKinnon (1996) one-sided p-values.

E. Short-Run analysis

Dependent Variable: LOG_GDP
Method: ARDL
Date: 01/16/25 Time: 22:18
Sample: 2015Q4 2024Q2
Included observations: 35
Dependent lags: 3 (Automatic)
Automatic-lag linear regressors (3 max. lags): LOG_X1 LOG_X2 LOG_X3 LOG_X4 LOG_X5 LOG_X6
Static regressors: DUMMY_COVID19
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 12288
Selected model: ARDL(3,3,2,3,1,3,3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG_GDP(-1)	-0.560768	0.203959	-2.749411	0.0225
LOG_GDP(-2)	-0.437028	0.240353	-1.818281	0.1024
LOG_GDP(-3)	-0.268871	0.259062	-1.037863	0.3264
LOG_X1	-0.146648	0.106138	-1.381666	0.2004
LOG_X1(-1)	0.016573	0.181975	0.091072	0.9294
LOG_X1(-2)	0.476807	0.128161	3.720380	0.0048
LOG_X1(-3)	-0.255261	0.251425	-1.015257	0.3365
LOG_X2	0.301149	0.076559	3.933565	0.0034
LOG_X2(-1)	-0.247970	0.094952	-2.611532	0.0282
LOG_X2(-2)	0.222238	0.150226	1.479357	0.1732
LOG_X3	0.118051	0.042254	2.793819	0.0209
LOG_X3(-1)	-0.131382	0.048027	-2.735581	0.0230
LOG_X3(-2)	0.324973	0.069381	4.683909	0.0011
LOG_X3(-3)	-0.253398	0.063890	-3.966162	0.0033
LOG_X4	0.225536	0.223027	1.011247	0.3383
LOG_X4(-1)	-0.405907	0.203336	-1.996235	0.0770
LOG_X5	-0.054074	0.045149	-1.197684	0.2616
LOG_X5(-1)	0.014699	0.071196	0.206462	0.8410
LOG_X5(-2)	0.224878	0.080786	2.783617	0.0213
LOG_X5(-3)	-0.097149	0.063618	-1.527063	0.1611
LOG_X6	0.349366	0.204171	1.711142	0.1212
LOG_X6(-1)	-0.814913	0.204464	-3.985615	0.0032
LOG_X6(-2)	0.748435	0.305638	2.448762	0.0368
LOG_X6(-3)	0.160177	0.084853	1.887708	0.0917
DUMMY_COVID19	-0.192283	0.026468	-7.264753	0.0000
C	22.78043	4.338962	5.250203	0.0005

R-squared	0.984693	Mean dependent var	12.75967
Adjusted R-squared	0.942174	S.D. dependent var	0.090670
S.E. of regression	0.021804	Akaike info criterion	-4.685892
Sum squared resid	0.004279	Schwarz criterion	-3.530490
Log likelihood	108.0031	Hannan-Quinn criter.	-4.287047
F-statistic	23.15872	Durbin-Watson stat	2.425340
Prob(F-statistic)	0.000017		

*Note: p-values and any subsequent test results do not account for model selection.

F. Long-Run Analysis

Dependent Variable: D(LOG_GDP)
Method: ARDL
Date: 01/16/25 Time: 22:18
Sample: 2015Q4 2024Q2
Included observations: 35
Dependent lags: 3 (Automatic)
Automatic-lag linear regressors (3 max. lags): LOG_X1 LOG_X2 LOG_X3 LOG_X4 LOG_X5 LOG_X6
Static regressors: DUMMY_COVID19
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 12288
Selected model: ARDL(3,3,2,3,1,3,3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_GDP(-1)*	-2.266667	0.636857	-3.559148	0.0061
LOG_X1(-1)	0.091472	0.208560	0.438587	0.6713
LOG_X2(-1)	0.275417	0.125710	2.190897	0.0562
LOG_X3(-1)	0.058244	0.099511	0.585301	0.5727
LOG_X4(-1)	-0.180371	0.372779	-0.483856	0.6400
LOG_X5(-1)	0.088354	0.062609	1.411211	0.1918
LOG_X6(-1)	0.443065	0.148718	2.979225	0.0155
D(LOG_GDP(-1))	0.705900	0.466901	1.511885	0.1649
D(LOG_GDP(-2))	0.268871	0.259062	1.037863	0.3264
D(LOG_X1)	-0.146648	0.106138	-1.381666	0.2004
D(LOG_X1(-1))	-0.221547	0.270316	-0.819584	0.4336
D(LOG_X1(-2))	0.255261	0.251425	1.015257	0.3365
D(LOG_X2)	0.301149	0.076559	3.933565	0.0034
D(LOG_X2(-1))	-0.222238	0.150226	-1.479357	0.1732
D(LOG_X3)	0.118051	0.042254	2.793819	0.0209
D(LOG_X3(-1))	-0.071575	0.088252	-0.811027	0.4383
D(LOG_X3(-2))	0.253398	0.063890	3.966162	0.0033
D(LOG_X4)	0.225536	0.223027	1.011247	0.3383
D(LOG_X5)	-0.054074	0.045149	-1.197684	0.2616
D(LOG_X5(-1))	-0.127729	0.077551	-1.647037	0.1340
D(LOG_X5(-2))	0.097149	0.063618	1.527063	0.1611
D(LOG_X6)	0.349366	0.204171	1.711142	0.1212
D(LOG_X6(-1))	-0.908612	0.336451	-2.700577	0.0244
D(LOG_X6(-2))	-0.160177	0.084853	-1.887708	0.0917
DUMMY_COVID19	-0.192283	0.026468	-7.264753	0.0000
C	22.78043	4.338962	5.250203	0.0005

R-squared	0.963723	Mean dependent var	0.008466
Adjusted R-squared	0.862954	S.D. dependent var	0.058897
S.E. of regression	0.021804	Akaike info criterion	-4.685892
Sum squared resid	0.004279	Schwarz criterion	-3.530490
Log likelihood	108.0031	Hannan-Quinn criter.	-4.287047
F-statistic	9.563672	Durbin-Watson stat	2.425340
Prob(F-statistic)	0.000683		

* p-values are incompatible with t-bounds distribution.

G. ARDL Error Correction Model

Dependent Variable: D(LOG_GDP)
Method: ARDL
Date: 01/16/25 Time: 22:18
Sample: 2015Q4 2024Q2
Included observations: 35
Dependent lags: 3 (Automatic)
Automatic-lag linear regressors (3 max. lags): LOG_X1 LOG_X2 LOG_X3 LOG_X4 LOG_X5 LOG_X6
Static regressors: DUMMY_COVID19
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 12288
Selected model: ARDL(3,3,2,3,1,3,3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-2.266667	0.197926	-11.45207	0.0000
D(LOG_GDP(-1))	0.705900	0.138901	5.082017	0.0001
D(LOG_GDP(-2))	0.268871	0.099998	2.688777	0.0168
D(LOG_X1)	-0.146648	0.053805	-2.725541	0.0156
D(LOG_X1(-1))	-0.221547	0.063477	-3.490176	0.0033
D(LOG_X1(-2))	0.255261	0.062744	4.068313	0.0010
D(LOG_X2)	0.301149	0.056412	5.338383	0.0001
D(LOG_X2(-1))	-0.222238	0.044666	-4.975585	0.0002
D(LOG_X3)	0.118051	0.024210	4.876182	0.0002
D(LOG_X3(-1))	-0.071575	0.024730	-2.894220	0.0111
D(LOG_X3(-2))	0.253398	0.031339	8.085668	0.0000
D(LOG_X4)	0.225536	0.073178	3.082024	0.0076
D(LOG_X5)	-0.054074	0.029202	-1.851729	0.0839
D(LOG_X5(-1))	-0.127729	0.037451	-3.410527	0.0039
D(LOG_X5(-2))	0.097149	0.032266	3.010893	0.0088
D(LOG_X6)	0.349366	0.096068	3.636662	0.0024
D(LOG_X6(-1))	-0.908612	0.095301	-9.534114	0.0000
D(LOG_X6(-2))	-0.160177	0.051879	-3.087500	0.0075
DUMMY_COVID19	-0.192283	0.013932	-13.80157	0.0000
C	22.78043	1.983938	11.48243	0.0000

R-squared	0.963723	Mean dependent var	0.008466
Adjusted R-squared	0.917772	S.D. dependent var	0.058897
S.E. of regression	0.016889	Akaike info criterion	-5.028749
Sum squared resid	0.004279	Schwarz criterion	-4.139979
Log likelihood	108.0031	Hannan-Quinn criter.	-4.721945
F-statistic	20.97297	Durbin-Watson stat	2.425340
Prob(F-statistic)	0.000000		

* p-values are incompatible with t-Bounds distribution.

H. Robustness Analysis

a. FMOLS

Dependent Variable: LOG_GDP
Method: Fully Modified Least Squares (FMOLS)
Date: 01/19/25 Time: 23:15
Sample (adjusted): 2015Q2 2024Q2
Included observations: 37 after adjustments
Cointegrating equation deterministics: C DUMMY_COVID19
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_X1	0.101805	0.057034	1.785000	0.0847
LOG_X2	0.023045	0.044237	0.520935	0.6064
LOG_X3	0.035523	0.024077	1.475385	0.1509
LOG_X4	0.135187	0.082598	1.636689	0.1125
LOG_X5	-0.030926	0.026809	-1.153592	0.2581
LOG_X6	0.070516	0.053255	1.324119	0.1958
C	9.744651	0.602748	16.16703	0.0000
DUMMY_COVID19	-0.057874	0.011995	-4.824873	0.0000

R-squared	0.820574	Mean dependent var	12.75047
Adjusted R-squared	0.777265	S.D. dependent var	0.096441
S.E. of regression	0.045515	Sum squared resid	0.060077
Long-run variance	0.000697		

b. DOLS

Dependent Variable: LOG_GDP
Method: Dynamic Least Squares (DOLS)
Date: 01/15/25 Time: 23:05
Sample (adjusted): 2015Q3 2024Q1
Included observations: 35 after adjustments
Cointegrating equation deterministics: C DUMMY_COVID19
Fixed leads and lags specification (lead=1, lag=1)
Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_X1	0.448812	0.353484	1.269680	0.2360
LOG_X2	-0.076184	0.161684	-0.471193	0.6487
LOG_X3	0.142825	0.099091	1.441359	0.1834
LOG_X4	-0.184257	0.366323	-0.502990	0.6270
LOG_X5	-0.016491	0.072830	-0.226437	0.8259
LOG_X6	0.010210	0.253790	0.040231	0.9688
C	9.850680	2.174418	4.530260	0.0014
DUMMY_COVID19	-0.035156	0.053435	-0.657913	0.5271

R-squared	0.906202	Mean dependent var	12.75121
Adjusted R-squared	0.645654	S.D. dependent var	0.090915
S.E. of regression	0.054119	Sum squared resid	0.026360
Long-run variance	0.001150		

c. CCR

Dependent Variable: LOG_GDP
Method: Canonical Cointegrating Regression (CCR)
Date: 01/15/25 Time: 23:07
Sample (adjusted): 2015Q2 2024Q2
Included observations: 37 after adjustments
Cointegrating equation deterministics: C DUMMY_COVID19
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_X1	0.085049	0.075215	1.130746	0.2674
LOG_X2	0.020910	0.050666	0.412714	0.6829
LOG_X3	0.030923	0.028022	1.103532	0.2789
LOG_X4	0.147009	0.072404	2.030391	0.0516
LOG_X5	-0.033170	0.028075	-1.181477	0.2470
LOG_X6	0.084740	0.060053	1.411074	0.1689
C	9.754595	0.488083	19.98550	0.0000
DUMMY_COVID19	-0.059444	0.013837	-4.295983	0.0002

R-squared	0.819102	Mean dependent var	12.75047
Adjusted R-squared	0.775437	S.D. dependent var	0.096441
S.E. of regression	0.045702	Sum squared resid	0.060570
Long-run variance	0.000697		

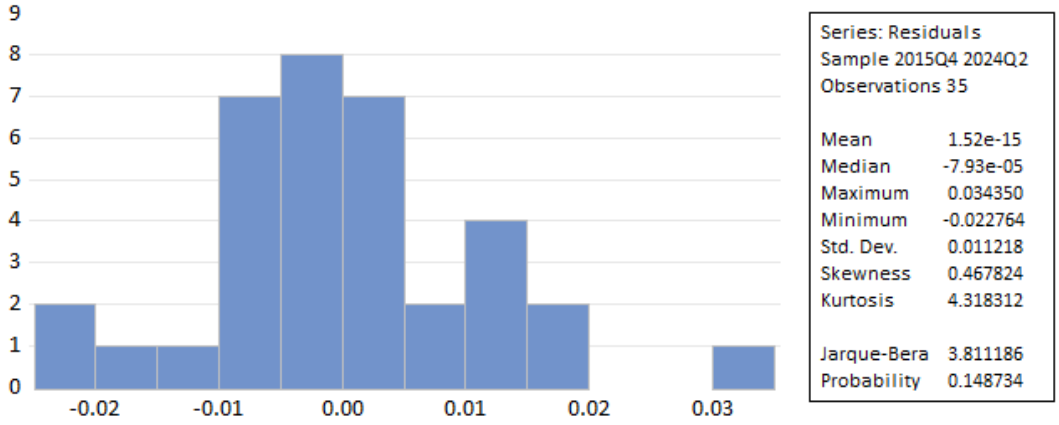
d. **Granger Causality**

Pairwise Granger Causality Tests
Date: 01/16/25 Time: 14:44
Sample: 2015Q1 2024Q2
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
D_LNX1 does not Granger Cause D_LNGDP	35	0.07385	0.9290
D_LNGDP does not Granger Cause D_LNX1		0.54656	0.5846
D_LNX2 does not Granger Cause D_LNGDP	35	0.65225	0.5281
D_LNGDP does not Granger Cause D_LNX2		0.01699	0.9832
D_LNX3 does not Granger Cause D_LNGDP	35	0.01660	0.9835
D_LNGDP does not Granger Cause D_LNX3		0.57002	0.5715
D_LNX4 does not Granger Cause D_LNGDP	35	0.00103	0.9990
D_LNGDP does not Granger Cause D_LNX4		0.25270	0.7783
D_LNX5 does not Granger Cause D_LNGDP	35	0.11484	0.8919
D_LNGDP does not Granger Cause D_LNX5		0.25454	0.7769
D_LNX6 does not Granger Cause D_LNGDP	35	1.29025	0.2900
D_LNGDP does not Granger Cause D_LNX6		2.41987	0.1061
D_LNX2 does not Granger Cause D_LNX1	35	0.08117	0.9222
D_LNX1 does not Granger Cause D_LNX2		0.62589	0.5416
D_LNX3 does not Granger Cause D_LNX1	35	0.65264	0.5279
D_LNX1 does not Granger Cause D_LNX3		0.22428	0.8004
D_LNX4 does not Granger Cause D_LNX1	35	0.52778	0.5953
D_LNX1 does not Granger Cause D_LNX4		3.54950	0.0413
D_LNX5 does not Granger Cause D_LNX1	35	0.04948	0.9518
D_LNX1 does not Granger Cause D_LNX5		2.05934	0.1452
D_LNX6 does not Granger Cause D_LNX1	35	2.93029	0.0688
D_LNX1 does not Granger Cause D_LNX6		4.93023	0.0141
D_LNX3 does not Granger Cause D_LNX2	35	0.65690	0.5258
D_LNX2 does not Granger Cause D_LNX3		0.25972	0.7730
D_LNX4 does not Granger Cause D_LNX2	35	0.11265	0.8938
D_LNX2 does not Granger Cause D_LNX4		1.09446	0.3477
D_LNX5 does not Granger Cause D_LNX2	35	0.83462	0.4439
D_LNX2 does not Granger Cause D_LNX5		0.52875	0.5947
D_LNX6 does not Granger Cause D_LNX2	35	0.76388	0.4747
D_LNX2 does not Granger Cause D_LNX6		0.11540	0.8914
D_LNX4 does not Granger Cause D_LNX3	35	0.41910	0.6614
D_LNX3 does not Granger Cause D_LNX4		2.87757	0.0719
D_LNX5 does not Granger Cause D_LNX3	35	1.20189	0.3147
D_LNX3 does not Granger Cause D_LNX5		0.28306	0.7555
D_LNX6 does not Granger Cause D_LNX3	35	0.29960	0.7433
D_LNX3 does not Granger Cause D_LNX6		0.09807	0.9069
D_LNX5 does not Granger Cause D_LNX4	35	1.09962	0.3460
D_LNX4 does not Granger Cause D_LNX5		2.10546	0.1394
D_LNX6 does not Granger Cause D_LNX4	35	1.02161	0.3722
D_LNX4 does not Granger Cause D_LNX6		0.96246	0.3934
D_LNX6 does not Granger Cause D_LNX5	35	2.38767	0.1091
D_LNX5 does not Granger Cause D_LNX6		5.90516	0.0069

I. Diagnostic Test

a. Normality Test



b. Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 3 lags

F-statistic	1.549779	Prob. F(3,6)	0.2960
Obs*R-squared	15.28046	Prob. Chi-Square(3)	0.0016

c. ARCH

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

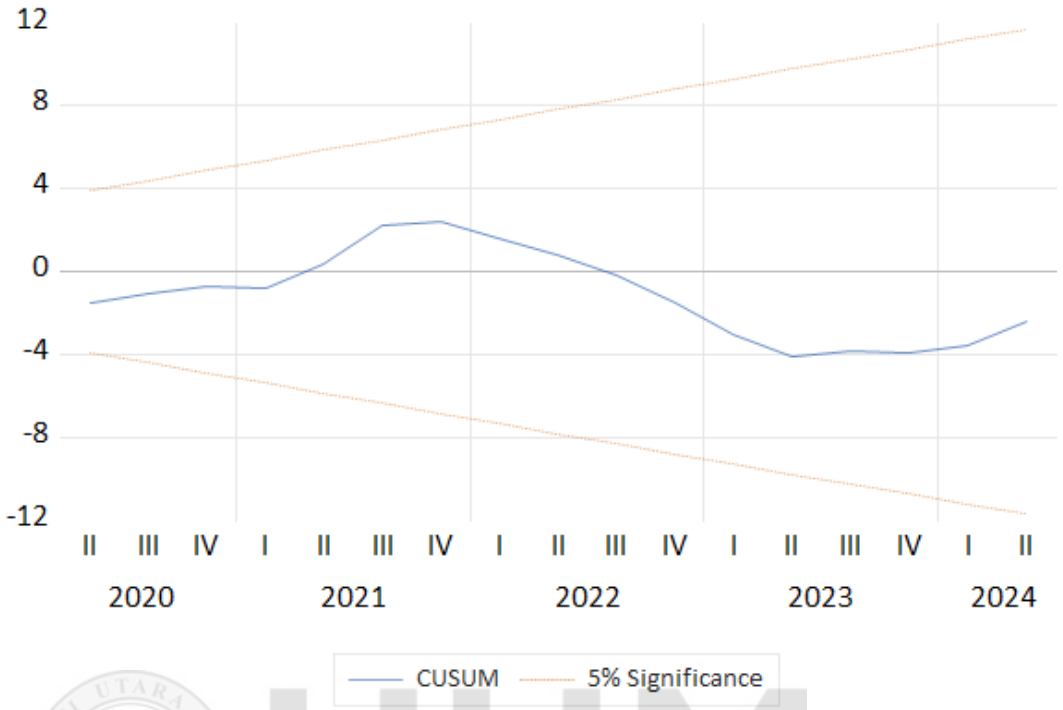
F-statistic	0.454580	Prob. F(25,9)	0.9421
Obs*R-squared	19.53190	Prob. Chi-Square(25)	0.7709
Scaled explained SS	2.142795	Prob. Chi-Square(25)	1.0000

d. RAMSEY

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: LOG_GDP LOG_GDP(-1) LOG_GDP(-2) LOG_GDP(-3) LOG_X1 LOG_X1(-1) LOG_X1(-2) LOG_X1(-3) LOG_X2 LOG_X2(-1) LOG_X2(-2) LOG_X3 LOG_X3(-1) LOG_X3(-2) LOG_X3(-3) LOG_X4 LOG_X4(-1) LOG_X5 LOG_X5(-1) LOG_X5(-2) LOG_X5(-3) LOG_X6 LOG_X6(-1) LOG_X6(-2) LOG_X6(-3) DUMMY_COVID19 C

	Value	df	Probability
t-statistic	0.788716	8	0.4530
F-statistic	0.622073	(1, 8)	0.4530
Likelihood ratio	2.620941	1	0.1055

e. CUSUM



f. CUSUMQ