COMPARISON BETWEEN CAPITAL MARKET IN THAILAND AND DIGITAL ASSET MARKETS

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MASTER OF SCIENCE
IN DIGITAL INNOVATION AND FINANCIAL TECHNOLOGY

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Kanyawut Ariya

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ผู้เขียน	นายกันยวุฒม์ อริยา	
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บทคัดย่อ

วิทยานิพนธ์นี้มีจุดมุ่งหมายในการเปรียบเทียบตลาดทุนในประเทศไทยกับตลาดสินทรัพย์ดิจิทัลที่กำลังเจริญขึ้น การศึกษานี้จะให้การวิเคราะห์อย่างละเอียดเกี่ยวกับสองตลาดรวมถึงกรอบกำหนดของการกำกับดูแลตลาด เทียบขนาดตลาด ความเหมาะสมในการลงทุน ปริมาณการซื้อขาย และโอกาสในการลงทุน การวิจัยพบว่า แม้ว่าตลาดทุนในประเทศไทยจะมีการกำกับดูแลอย่างเข้มงวด และมีกรอบกฎหมายที่เข้มแข็ง แต่ตลาดสินทรัพย์ดิจิทัลยังคงมีข้อจำกัดในการควบคุมดูแลทำธุรกรรม ตลาดทุนมีขนาดตลาดและปริมาณการซื้อขายที่ใหญ่กว่า และมีผลิตภัณฑ์การลงทุนที่หลากหลายกว่าตลาดสินทรัพย์ดิจิทัลที่ยังอยู่ในช่วงเริ่มต้นของการพัฒนาและมีผลิตภัณฑ์ในการลงทุนจำกัด การศึกษานี้เป็นการวิเคราะห์ข้อมูลประจำวัน ของสินทรัพย์ยอดนิยมในประเทศไทย คือ ราคาทองคำ ราคาน้ำมันดัชนี SET50 อัตราแลกเปลี่ยน THB/USD และสกุลเงินดิจิทัลต่างๆ คือ Bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB และ DOGE เพื่อหาความสัมพันธ์ระหว่างสินทรัพย์เหล่านี้ ใช้วิธีการเมทริกซ์โดย Pearson correlation coefficient และหาเส้นทางที่สั้นที่สุดระหว่างสินทรัพย์ด้วยวิธีโมเดล minimal spanning tree และทฤษฎี random matrix การศึกษายังแสดงให้เห็นว่าทั้งสองตลาดมีข้อดีและข้อเสียของตนเอง โดยที่ตลาดทุนมีโอกาสลงทุนที่มั่นคงและเชื่อถือได้ ในขณะที่ตลาดสินทรัพย์ดิจิทัลนั้นมีโอกาสที่จะได้รับผลตอบแทนสูงขึ้น แต่มาพร้อมกับความเสี่ยงที่สูงกว่า ข้อเสนอแนะจากการศึกษาพบว่าการลงทุนระหว่าง ดัชนี SET50 และ DOGE ในช่วงวิกฤตโคโรนาไวรัสสามารถนำมาเพิ่มโอกาสในการกระจายความเสี่ยงของพอร์ตการลงทุนได้

Thesis Title	Comparison Between Capital Market in Thailand and Digital Asset Markets	
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ABSTRACT

This thesis aims to compare the capital market in Thailand with the emerging digital asset markets. The study provides a comprehensive analysis of the two markets, including their regulatory frameworks, market size, liquidity, trading volume, and investment opportunities. The research finds that while the capital market in Thailand is highly regulated, with a well-established legal framework, the digital asset market operates in a relatively less regulated environment. The capital market has a larger market size and trading volume, with a more diverse range of investment products, while the digital asset market is still in its early stage of development, with limited investment products. The study analyzes the daily data of popular assets in Thailand such as gold, oil, the SET50 index, THB/USD exchange rate, and various cryptocurrencies including Bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE. To determine the correlations between these assets, a matrix approach is used with the Pearson correlation coefficient, and the shortest route between assets is determined with the help of a minimal spanning tree model and random matrix theory. The study also shows that both markets have their strengths and weaknesses. While the capital market provides stable and reliable investment opportunities, the digital asset market offers higher returns but comes with higher risks. Moreover, the liquidity of the two markets is also different, with the capital market having higher liquidity due to the involvement of institutional investors. The study also suggests that including alternatives to the SET50 and DOGE in an investment portfolio during the coronavirus period may offer opportunities for risk diversification.

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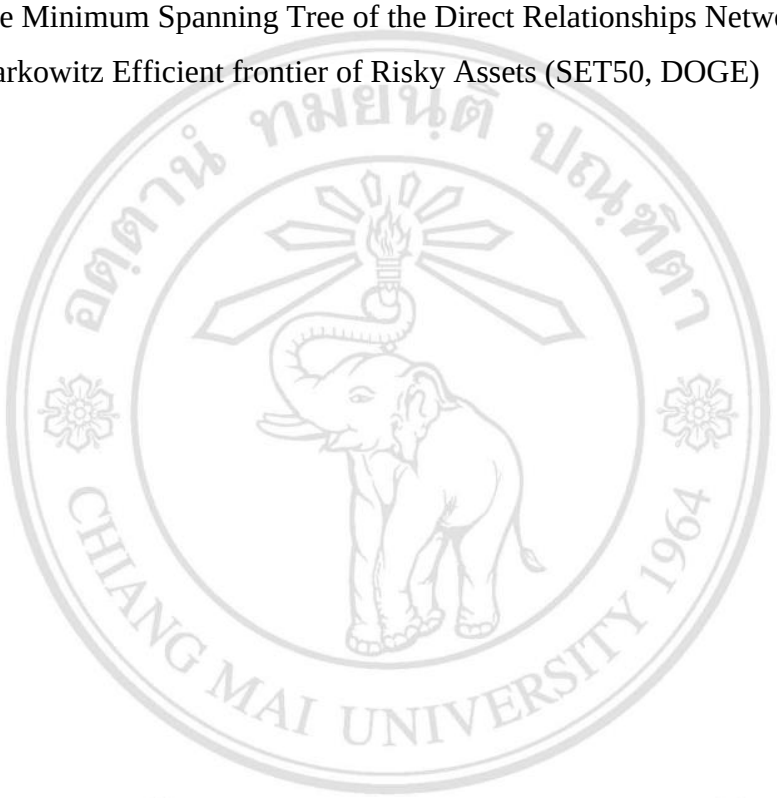


LIST OF ABBREVIATIONS

CBDC	Central Bank Digital Currency
SEC	Securities and Exchange Commission
SET	Stock Exchange of Thailand
MAI	Market for Alternative Investment
IPO	Initial Public Offering
DeFi	Decentralized Finance
RMT	Random Matrix Theory
MST	Minimum Spanning Tree
UTAUT	Unified Theory of Acceptance and Use of Technology
NFT	Non-Fungible Token
FOREX	Foreign Exchange
VAR	Vector Autoregression

LIST OF SYMBOLS

λ Lamda, The Noisy Eigenva

CHAPTER 1

Introduction

1.1 Research Background

Financial systems pertain to a diverse range of establishments, markets, and tools that facilitate the transfer of funds within an economy [1]. These systems hold a pivotal function in empowering individuals and organizations to obtain, provide, and invest funds, rendering them a crucial element of the worldwide economy [2].

Financial intermediaries such as banks, insurance companies, and investment businesses play an important role in easing the movement of cash between savers and borrowers in modern financial systems. Financial intermediaries accept deposits from savers and lend the cash to borrowers, such as individuals or corporations, who require finance for a variety of reasons [3].

Financial markets are another important component of financial systems. The buying and selling of financial assets including stocks, bonds, and derivatives take place on financial markets, where both people and institutions can transact [4]. The flow of money between savers and borrowers is made possible by financial markets, which also give investors a way to diversify their holdings and control risk.

Financial systems have undergone significant changes in recent decades due to advances in technology and the globalization of financial markets. The use of electronic systems and the internet has made it easier to conduct financial transactions and access financial services, and the growth of international trade and investment has increased the interconnectedness of financial systems around the world [5].

The financial system in Thailand is made up of various institutions and markets that facilitate the exchange of funds within the country. It includes banks, insurance companies, and investment firms that provide financial services, as well as financial

markets where individuals and institutions can buy and sell financial instruments [6]. The Bank of Thailand is the central bank of the country and plays a key role in the financial system. It is responsible for implementing monetary policy, regulating the banking system, and maintaining financial stability [7].

The Thai banking system is composed of commercial banks, state-owned banks, and foreign banks. Commercial banks, which include both local and foreign banks, provide a range of financial services, including deposits, loans, and investment products. State-owned banks, which are owned by the Thai government, also provide financial services, but they often focus on serving specific sectors or regions of the country [8].

Thailand's financial markets include the stock exchange, the bond market, and the derivatives market. The Stock Exchange of Thailand is the main stock exchange in the country, and it provides a platform for companies to raise capital by issuing stocks and for investors to buy and sell stocks [9]. The bond market allows companies and governments to raise funds by issuing bonds, and the derivatives market provides a way for investors to manage risk using financial instruments such as futures and options.

In Thailand, investors can be either Thai nationals or foreign investors. Thai investors may include individual investors, who invest their own money in financial assets or businesses, as well as institutional investors, such as pension funds, insurance companies, and mutual funds, which invest on behalf of their clients. Thai investors have a range of investment options available to them, including stocks, bonds, mutual funds, real estate, and other financial instruments [10]. They can also invest in businesses by providing capital in exchange for equity or through loans.

Foreign investment in Thailand refers to the investment made by individuals, companies, or governments from one country into Thailand. It has been increasing steadily over the past few decades due to Thailand's strategic location, low labor costs, well-developed infrastructure, and favorable investment climate. Foreign investment has played a significant role in Thailand's economic development, contributing to economic growth, employment opportunities, and technology transfer [11]. However, foreign

investment has also been associated with environmental degradation, social and labor issues, and inequality. Thailand needs to manage foreign investment in a way that maximizes its benefits and minimizes its costs by balancing investment incentives with environmental and social regulations, promoting technology transfer and skill development, and ensuring that local communities and workers are not left behind [12].

Cryptography is used to secure cryptocurrencies, which are digital or virtual currencies that are not backed by any central bank or government [13]. Cryptocurrencies are decentralized systems that allow for the creation, transfer, and verification of transactions through a network of computers on the internet, rather than through a central authority such as a bank or government [14].

In 2009, the cryptocurrency known as Bitcoin was developed. Since then, numerous additional cryptocurrencies have been developed, each with distinct qualities and features [15]. Some common features of cryptocurrencies include the use of decentralized control, anonymity, and a secure, encrypted method of conducting transactions. Cryptocurrencies are often used as a store of value, a means of exchange, and a unit of account. They can be bought and sold on cryptocurrency exchanges, and they can also be used to purchase goods and services online and in some physical stores [16].

Cryptocurrencies have attracted a lot of attention in recent years due to their potential to disrupt traditional financial systems and their highly volatile prices. While they have the potential to revolutionize the way we think about money and financial transactions, they also carry significant risks, including the potential for fraud and the lack of regulation and oversight. It is important for individuals to thoroughly research and carefully consider the risks before investing in cryptocurrencies [17].

In Thailand, the use of cryptocurrency is not yet widespread, but it has gained some traction in recent years. The Bank of Thailand, the country's central bank, has issued warnings about the risks associated with investing in cryptocurrency, but it has also taken steps to support the development of the technology [18]. In 2018, the Bank of Thailand launched a pilot program to test the use of a central bank digital currency (CBDC) using

a blockchain platform. The pilot was aimed at exploring the potential benefits and risks of using a CBDC, and it was conducted in partnership with eight commercial banks [19]. While the use of cryptocurrency in Thailand is still in the early stages, several exchanges and platforms allow individuals to buy and sell cryptocurrency. It is important for individuals to carefully consider the risks associated with investing in cryptocurrency, as the market is highly volatile and there is a risk of fraud or other illicit activities [20].

1.2 Problem Statement

Investing is always risky. Because there is no guarantee that the investment will generate good returns. Different investments carry different levels of risk. And investors need to understand the risks associated with each type of investment. In Thailand, investors face a range of risks that can impact the value of their investments, including economic, political, and market risks [21]. One key risk for investors in Thailand is an economic risk. This refers to the risk that economic conditions, such as changes in gross domestic product growth, inflation, or employment levels, could affect the performance of investment [22]. Economic risks can be difficult to predict and may be influenced by a variety of factors, such as changes in government policies, natural disasters, or global economic trends.

Political risk is another concern for investors in Thailand. This refers to the risk that changes in government policies or political instability could affect the performance of an investment. For example, if there is a change in government policies that is unfavorable to businesses, it could negatively impact the performance of companies operating in Thailand, and this could in turn affect the value of an investment in those companies [23]. Market risk is another common risk faced by investors. This refers to the risk that changes in market conditions, such as changes in interest rates or exchange rates, could affect the value of investment [24]. For example, if interest rates rise, it could affect the value of bonds, and if the value of the Thai baht falls relative to other currencies, it could affect the value of investments denominated in foreign currencies.

Investing in cryptocurrency carries a high level of risk, and this is especially true in Thailand, where the use of cryptocurrency is not yet widespread and there is little regulation of the market. Some specific risks associated with investing in cryptocurrency in Thailand include price volatility, security risks, limited acceptance, and technical complexity. It is important for investors to carefully consider these risks and to thoroughly research any investment before committing funds. It may also be helpful to seek professional advice from a financial advisor or investment professional. The correlation between traditional assets, such as stocks and bonds, and cryptocurrency can vary over time. In general, traditional assets and cryptocurrency tend to have a low or negative correlation, which means that they do not tend to move in the same direction. However, it is important to note that correlations can change over time, and the correlation between traditional assets and cryptocurrency can become positive or negative at different points in time.

In Thailand, the correlation between traditional assets and cryptocurrency may be influenced by a variety of factors, including economic conditions, government policies, and global market trends. It is important for investors to carefully consider the correlation between different types of assets and to diversify their portfolios to help manage risk. It may also be helpful to seek professional advice from a financial advisor or investment professional. Lack of clarity and consistency in regulatory frameworks governing digital asset markets globally can make it difficult to compare the regulatory landscape in Thailand with other countries. Limited availability of data and information on digital asset markets can make it difficult to conduct a comprehensive and accurate analysis of the market structure, investor base, and other key features.

Rapidly changing market dynamics in digital asset markets, including new technologies, products, and market participants, which can make it challenging to keep up with and analyze the latest trends and developments. Limited understanding and awareness of digital asset markets among traditional capital market participants, can lead to misconceptions and biases that may impact the analysis and interpretation of data. Differences in the level of institutionalization and investor sophistication between the capital market in Thailand and digital asset markets may require different analytical

approaches and methodologies. Differences in the underlying technology and infrastructure of digital asset markets, such as blockchain and decentralized exchanges, which may require specialized knowledge and expertise to fully understand and analyze. The rapidly evolving nature of digital asset markets, which may require frequent updates to research findings and methodologies. The complex and decentralized nature of digital asset markets, which may make it difficult to accurately capture market dynamics and trends. Potential language barriers and cultural differences that may make it challenging to access and interpret information and data from both the capital market in Thailand and digital asset markets. Limited understanding and expertise among researchers and analysts in digital asset markets, which may require specialized knowledge and training.

1.3 Research Question and Motivation

The research question aims to explore the correlation between cryptocurrency and the capital market in Thailand, specifically traditional assets such as the SET50 index, gold price, oil price, and THB-USD exchange rate. This research question is important as it can provide valuable insights into the potential benefits of including digital assets in investment portfolios and can help investors to create well-diversified portfolios that are better able to weather market fluctuations and reduce overall portfolio risk. The research question also examines the dynamic nature of correlation over time, which can provide insights into the underlying factors that drive changes in correlation, such as changes in market conditions or investor sentiment.

The research question is relevant given the growing interest in digital assets, including cryptocurrency, in Thailand and the region. Policymakers have recognized the potential of digital assets to contribute to economic growth and have taken steps to promote the development of the digital asset market. However, there is limited empirical research on the relationship between cryptocurrency and the capital market in Thailand, and the research question aims to fill this gap by providing a comprehensive analysis of the correlation between these assets. By examining the relationship between cryptocurrency and the capital market in Thailand, the research question can provide

valuable insights for investors and policymakers that can be used to guide investment decisions and the development of policies and regulations that promote the growth of the digital asset market in Thailand.

The motivation behind the research question is to provide a deeper understanding of the correlation between cryptocurrency and the capital market in Thailand. The growing interest in digital assets, including cryptocurrency, in Thailand and the region, has highlighted the need for empirical research to understand the relationship between these assets and traditional assets. One of the main motivations for this research is to provide insights into the potential benefits of including digital assets in investment portfolios. By examining the correlation between digital assets and traditional assets, the research can provide insights into the potential diversification benefits of including digital assets in investment portfolios. This can help investors to create well- diversified portfolios that are better able to weather market fluctuations and reduce overall portfolio risk.

Another motivation for the research is to provide insights for policymakers on the relationship between cryptocurrency and the capital market in Thailand. The findings of the research can be used to develop policies and regulations that promote the growth of the digital asset market in Thailand. By providing a comprehensive analysis of the correlation between cryptocurrency and traditional assets, the research can provide valuable insights that can be used to guide the development of policies and regulations that are supportive of the growth of the digital asset market.

How do distinctions between the capital markets in Thailand and those for digital assets in terms of trading instruments, trading processes, and liquidity?

How do the investor bases of the capital market in Thailand and digital asset markets compare, including the demographics, investment objectives, and risk profiles of investors?

How do the legal and regulatory frameworks governing the capital market in Thailand and digital asset markets differ, and what are the implications of these differences for market participants and investors?

How do the types of securities traded in the capital market in Thailand compared to those traded in digital asset markets, and what are the implications of these differences for market liquidity and risk?

How do the trading mechanisms used in the capital market in Thailand compared to those used in digital asset markets, and what are the implications of these differences for market efficiency and price discovery?

How do the demographics, investment objectives, and risk profiles of investors in the capital market in Thailand compared to those in digital asset markets, and what are the implications of these differences for market development and growth?

How can policymakers, market participants, and investors work together to promote the development and growth of both the capital market in Thailand and digital asset markets, while also ensuring investor protection and market stability?

1.4 Objectives of the Study

Comprehending the correlation between distinct classes of assets is a crucial facet of investment. The term correlation denotes the extent to which two assets exhibit simultaneous movement in the same direction. Assets that demonstrate a high positive correlation are typically prone to simultaneous movement, while those with a low or negative correlation tend to move in opposite or independent directions.

Acquiring knowledge of asset correlation can be advantageous for investors in various ways. Firstly, it can facilitate the creation of a well-diversified portfolio. By integrating an assortment of assets with low or negative correlations, investors can mitigate the overall risk of their portfolio. This is due to the fact that assets with low or negative correlations are less inclined to move in unison, which can help to attenuate the impact of market volatility on the portfolio.

Second, understanding the correlation between assets can help investors manage risk. By allocating funds to assets with low or negative correlations, investors can help to reduce the overall risk of their portfolio. On the other hand, allocating funds to assets with

high positive correlations may increase the risk of the portfolio, as these assets are more likely to move in the same direction.

Finally, understanding the correlation between assets can help investors optimize their portfolios for the desired level of risk and return. By allocating funds to assets with higher correlations, investors may be able to achieve a higher level of return, while allocating funds to assets with low or negative correlations may help to reduce the risk of the portfolio.

To Identify the key features of digital asset markets, including the regulatory framework, market structure, and investor base. To Compare the regulatory frameworks governing the capital market in Thailand and digital asset markets, including the scope of regulation, enforcement mechanisms, and investor protection measures. To Compare the market structures of the capital market in Thailand and digital asset markets, including the types of securities traded, trading mechanisms, and liquidity. To Compare the investor base of the capital market in Thailand and digital asset markets, including the demographics, investment objectives, and risk profiles of investors. To Analyze the strengths and weaknesses of the capital market in Thailand and digital asset markets, and identify potential areas for improvement in each market. To Provide recommendations for policymakers, market participants, and investors to promote the development and growth of both the capital market in Thailand and digital asset markets.

1.5 Main Contributions of the Research

The research focuses on identifying the correlation between digital assets and traditional assets, such as the SET50 index, gold price, oil price, and THB-USD exchange rate, as well as specific digital assets including Bitcoin, Ethereum, and Litecoin. The aim is to provide insights into the potential diversification benefits of including digital assets in investment portfolios. By examining the correlation between digital and traditional assets, the research can help investors to understand how these assets are related and how they may impact each other within a portfolio. Understanding this relationship can inform

investment decisions, particularly in terms of asset allocation and risk management. Additionally, identifying the correlation between these assets can provide valuable information for policymakers, who can use the findings to develop regulations and policies that promote the development of the digital asset market. The research's focus on identifying the correlation between digital and traditional assets is crucial to understanding the potential benefits and risks associated with including digital assets in investment portfolios.

The research also assesses the relationship between cryptocurrency and the capital market in Thailand. This assessment is important because it can provide valuable information for both investors and policymakers. For investors, understanding the relationship between cryptocurrency and the capital market can help them to make informed decisions about portfolio allocation. By analyzing this relationship, investors can better understand how the performance of the digital asset market may impact traditional financial markets and vice versa. This can help investors to manage risk and diversify their portfolios effectively. On the other hand, policymakers can use the findings of the research to develop regulations and policies that promote the development of the digital asset market. By understanding the relationship between cryptocurrency and the capital market, policymakers can create policies that encourage investment in the digital asset market while also ensuring the stability of the broader financial system. Overall, the research's assessment of the relationship between cryptocurrency and the capital market in Thailand is important to both investors and policymakers and can help to inform decisions related to portfolio allocation and policy development.

In addition, the research examines the dynamic nature of the correlation between cryptocurrency and the capital market in Thailand. By analyzing changes in correlation over time, the research can provide insights into the underlying factors that drive these changes. This is important because the correlation between digital assets and traditional assets can change over time, and understanding these changes is crucial for effective portfolio management. For instance, changes in market conditions or investor sentiment

may impact the correlation between digital assets and traditional assets. By examining these changes, the research can provide valuable information for investors and policymakers, who can adjust their strategies accordingly. Moreover, analyzing the dynamic nature of correlation can help to identify potential opportunities for investors to optimize their portfolios, such as identifying periods of low correlation when diversification benefits may be greatest. Overall, the research's examination of the dynamic nature of correlation is an essential component of understanding the relationship between cryptocurrency and the capital market in Thailand and can provide valuable insights for both investors and policymakers.

The research has significant implications for portfolio diversification. By identifying the correlation between digital assets and traditional assets, the research provides valuable insights into the potential benefits of including digital assets in investment portfolios. Investors can use these insights to create well-diversified portfolios that are better able to weather market fluctuations and reduce overall portfolio risk. Moreover, the research's examination of the dynamic nature of correlation can help investors to identify periods when digital assets and traditional assets have a low or negative correlation, which can be an optimal time to adjust portfolio allocations. By incorporating digital assets into investment portfolios, investors may also gain exposure to new and emerging asset classes that can provide additional opportunities for growth and diversification. Overall, the research's implications for portfolio diversification are critical, as they can help investors to create more robust and effective portfolios that can withstand market fluctuations and achieve long-term investment goals.

1.6 Research Scope

The scope of this research project is to analyze the correlation between cryptocurrency and the capital market in Thailand over the period of 2016 to 2022. The

study's main objective is to evaluate how the COVID-19 pandemic will affect the interrelationships between these assets.

The research will employ a comprehensive approach that will use data from various sources, such as financial market indices, commodity prices, and digital asset prices, to examine the correlation between these assets. The study will explore the dynamic nature of the correlation by analyzing changes in the relationship over time, with particular emphasis on periods of market volatility and the COVID-19 pandemic.

The research will also assess the regulatory environment and the role of government policies in promoting the growth of the digital asset market in Thailand. This assessment will involve a thorough examination of the impact of policies on the relationship between cryptocurrency and the capital market. In addition to quantitative methods, such as statistical analysis and correlation analysis, the research will incorporate qualitative methods, including interviews with market experts and policymakers. These methods will provide valuable insights and perspectives on the relationship between cryptocurrency and the capital market in Thailand.

The implications of the research will be beneficial for both investors and policymakers. The study will examine the potential benefits of including digital assets in investment portfolios and will provide guidance for investors seeking to create diversified portfolios that can withstand market fluctuations. The research will also provide policymakers with useful information for the development of policies and regulations that promote the growth of the digital asset market in Thailand.

1.7 Conceptual Framework

The conceptual framework for this research project is centered around the relationship between digital assets and traditional assets in the context of the COVID-19 pandemic in Thailand. This framework is important because it addresses a gap in knowledge about how the pandemic has impacted the correlation between these assets. The COVID-19 pandemic has had a significant impact on financial markets worldwide,

including the Thai capital market, which has experienced significant volatility over the past few years. Understanding the correlation between digital assets and traditional assets during this period is essential for investors who are looking to make informed decisions about portfolio diversification and risk management.

The framework includes several key components, including traditional assets such as the SET50 index, gold price, oil price, and THB-USD exchange rate, as well as digital assets such as Bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE. These assets represent a diverse range of investments, and understanding their correlation is essential for investors seeking to build well-diversified portfolios. The framework also considers the impact of government policies and regulations on the digital asset market in Thailand, which may have influenced the correlation between digital and traditional assets.

The research methodology will utilize both quantitative and qualitative methods to examine the relationship between digital assets and traditional assets in Thailand during the COVID-19 pandemic. Correlation analysis will be used to assess the degree of association between these assets, while interviews with market experts and policymakers will provide valuable insights into market conditions and investor sentiment. This mixed-methods approach will provide a comprehensive understanding of the correlation between digital assets and traditional assets during the pandemic in Thailand, and its potential implications for investors and policymakers. The conceptual framework provides a structured approach to guide the research and ensure that all relevant factors are considered in the analysis.

Figure 1.1 shows the different capital assets used in the study, including gold price, oil price, the SET50 index, THB/USD exchange rate, and various cryptocurrencies such as Bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE. The aim of the study was to investigate the correlations between these assets and to provide insights to investors to make more informed investment decisions for portfolio diversification. To achieve this, Random matrix theory was used to filter out the noise of correlation, and a

minimum spanning tree was used to represent the network of correlations between the assets. This approach helps to identify the shortest path between assets, which can be useful for investors to determine the optimal asset allocation in their portfolios.

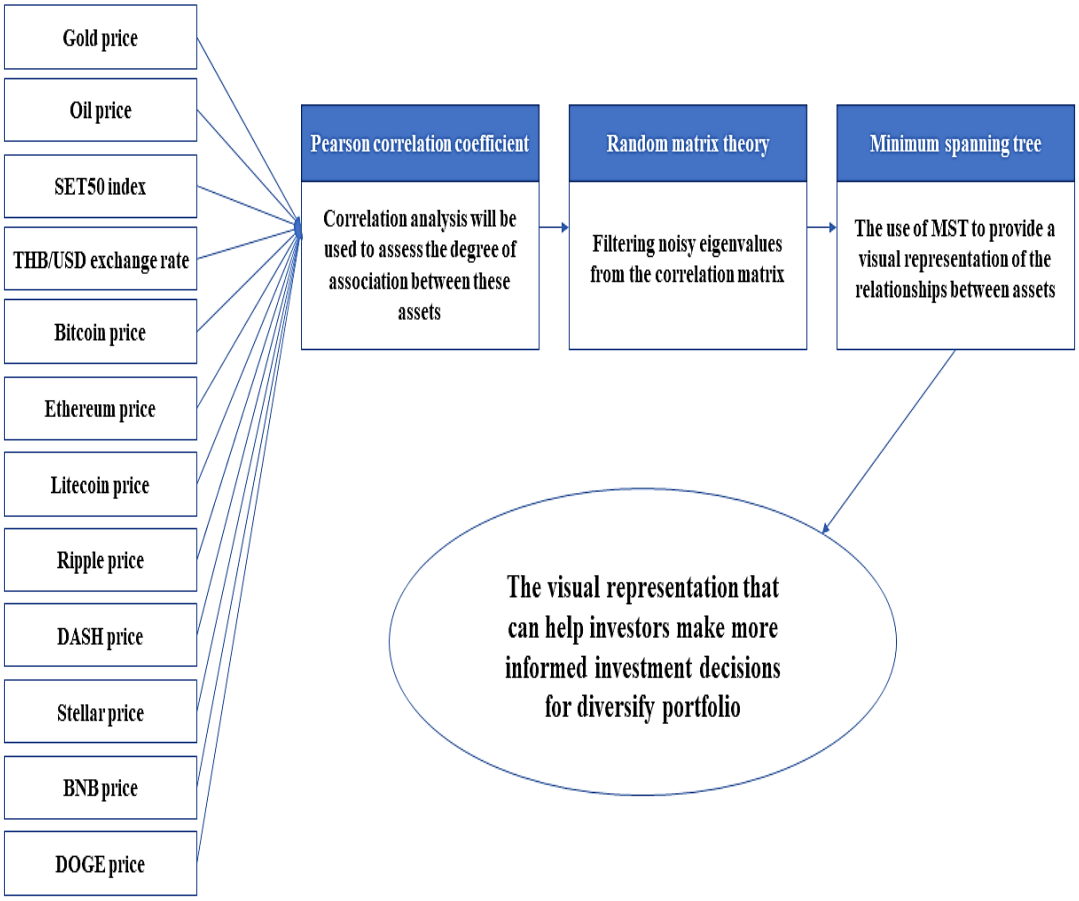


Figure 1.1 Conceptual Framework of the study

When comparing the capital market in Thailand and digital asset markets using a conceptual framework that includes traditional assets such as the SET50 index, gold price, oil price, and THB-USD exchange rate, as well as digital assets such as Bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE, we can consider the following factors:

Market Correlation: The capital market in Thailand is typically correlated with the performance of the SET50 index, while digital asset markets are generally not correlated

with traditional assets. However, there may be correlations between certain digital assets and traditional assets, such as Bitcoin and gold.

Volatility: Digital asset markets are generally more volatile than the capital market in Thailand, which can lead to greater potential returns but also higher risks. Traditional assets, such as gold and oil, can also be volatile but are generally less so than most digital assets.

Liquidity: The capital market in Thailand has higher liquidity due to the presence of large institutional investors, while liquidity in digital asset markets can be volatile and dependent on market sentiment. However, some digital assets, such as Bitcoin and Ethereum, have relatively high liquidity compared to other cryptocurrencies.

Investment Options: The capital market in Thailand offers traditional investment options, such as stocks and bonds, while digital asset markets offer a broader range of investment options, including cryptocurrencies, stablecoins, and tokens.

Regulatory Environment: The capital market in Thailand is subject to regulations by the Securities and Exchange Commission (SEC), while digital asset markets are subject to regulations by the SEC and the Ministry of Finance. However, the regulatory framework for digital assets is still evolving and can be more uncertain than the regulatory environment for traditional assets.

Market Access: The capital market in Thailand is accessible through traditional brokers and investment platforms, while digital asset markets can be accessed through cryptocurrency exchanges and wallets.

Finally, the capital market in Thailand and digital asset markets differ in several ways, including market correlation, volatility, liquidity, investment options, regulatory environment, and market access. However, both markets offer opportunities for investors to diversify their portfolios and potentially achieve higher returns. It is important for investors to carefully consider their risk tolerance and investment goals before making investment decisions in either market.

1.8 Thesis Outline

Chapter one of this thesis includes the following sections Research Background, Problem Statement, Research Question and Motivation, Objectives of the Study, Main Contributions of the Research, Research Scope, Conceptual Framework, and Thesis Outline. The Research Background provides an overview of the context and importance of the study, while the Problem Statement identifies the specific research gap that the study seeks to address. The Research Question and Motivation explains the rationale for the study and the Objectives of the Study outline the goals and specific research questions that the study aims to answer. The Main Contributions of the Research section summarizes the key findings and potential impact of the study, and the Research Scope defines the boundaries and limitations of the study. The Conceptual Framework presents the theoretical framework and conceptual model that guides the study, while the Thesis Outline provides a roadmap of the chapters and sections that follow.

Chapter two of this thesis is focused on the Literature Review and comprises several sections. Firstly, the context of the work studied is explored, which is then further divided into two sub-sections. The first sub-section is dedicated to Cryptocurrency, which offers a comprehensive overview of the cryptocurrency market, including its importance, features, and potential impact. The second sub-section is Capital Market in Thailand, which highlights the current state of the capital market in Thailand, including its trends, challenges, and opportunities. The second section of Chapter Two introduces the theoretical concepts, which form the theoretical framework of the study. This section comprises three sub-sections, the first being the Correlation Coefficient, which provides a detailed explanation of the concept of correlation and its relevance to the study. The second sub-section is Random Matrix Theory, which discusses the application of this theory in finance, including its potential benefits and limitations. Finally, the last sub-section is the Minimum Spanning Tree, which presents the theoretical background of this algorithm and its potential use in the study. The last section of Chapter Two is Literature

Review and Related Research. This section provides a comprehensive review of existing literature and research studies related to the topic of the thesis. It identifies gaps in the literature that this study aims to address and highlights the significance of this study in contributing to the existing body of knowledge in the field.

Chapter Three of this thesis outlines the methodology section, which includes several sub-sections. The first sub-section, Scope of the Study, defines the scope and limitations of the study. The second sub-section, Proposed Method, outlines the methodology that will be used in the study, which includes three sub-sections. The first sub-subsection, Pearson correlation coefficient, explains the use of the Pearson correlation coefficient in the study and its significance. The second sub-subsection, Random matrix theory, discusses the application of this theory in the study and its potential use in finance. The third sub-subsection, Minimum Spanning Tree, presents the theoretical background of this algorithm and its potential use in the study. The final sub-section, The Collection of the Dataset, outlines the data collection process and sources of data that will be used in the study.

Chapter Four of this thesis is dedicated to the Results and Discussion section, where the findings of the study will be presented and discussed in detail. This chapter will present the results of the analysis conducted using the proposed methodology outlined in the third chapter. The findings will be presented clearly and concisely and will be supported by relevant data and figures. The chapter will also include a comprehensive discussion of the results, their implications, and their relevance to the research question and objectives outlined in Chapter one.

Chapter Five of this thesis is dedicated to the Conclusion section, where the overall findings of the study will be summarized and interpreted. This chapter will restate the research objectives and summarize the main contributions and implications of the study. The chapter will also discuss the limitations of the study and provide recommendations

for future research. Finally, the chapter will provide a concise and clear conclusion that answers the research question and emphasizes the significance of the study.

CHAPTER 2

Literature Review

2.1 Introduction

In this study, the focus is on the correlation between cryptocurrency and the capital market in Thailand. To begin the review, this section will introduce the topic, provide an overview of the existing literature on the subject, and explain the relevance and importance of the study. The capital market has long been the traditional way of investing and generating returns in Thailand. However, with the emergence of digital asset markets, investors are presented with new investment opportunities. The digital asset market has rapidly grown over the years, offering various cryptocurrencies and other digital assets as investment instruments. This thesis aims to compare the capital market in Thailand with the digital asset market, with a focus on the regulatory framework, market size, liquidity, trading volume, and investment opportunities. The paper first provides an overview of the two markets, including their historical development, current status, and prospects. It then compares the regulatory framework of the two markets, examining the rules and regulations governing the capital market and digital asset market, and the roles of regulatory authorities in ensuring market stability and investor protection. Furthermore, the paper compares the market size, liquidity, and trading volume of the two markets. It also looks at the investment opportunities offered by each market, including the different products available for investment and the potential risks and returns associated with each. The paper concludes by suggesting that investors should carefully consider their investment goals and risk appetite before choosing between the capital market and the digital asset market. Additionally, regulatory authorities should take a proactive approach to regulating the digital asset market to ensure investor protection and market stability. In recent years, the emergence of digital asset markets has challenged traditional capital markets around the world, including Thailand's capital market. This thesis aims to compare the capital market in Thailand with the digital asset market, examining the

regulatory framework, market size, liquidity, trading volume, and investment opportunities.

Several studies have explored the potential impact of digital assets on traditional capital markets. According to a study by [25], digital assets have the potential to provide a more efficient and secure means of transferring value and storing assets. The study also noted that digital assets can enable greater financial inclusion, particularly for individuals without access to traditional banking services.

[26] found that digital assets are still in their early stages of development and adoption. The study highlighted the need for a strong regulatory framework to protect investors and ensure market stability. Several studies have also examined the correlation between digital assets and traditional assets. [27] found a significant correlation between Bitcoin and gold prices. Another study [28] found that Bitcoin prices are positively correlated with the S&P 500 index, indicating a potential link between the digital asset market and the broader economy.

In terms of the regulatory framework, a study by [29] found that regulatory authorities play a crucial role in shaping the development of digital asset markets. The study highlighted the need for a coordinated regulatory approach to ensure investor protection and market stability. The literature suggests that digital asset markets have the potential to disrupt traditional capital markets in Thailand and globally. However, a strong regulatory framework is necessary to ensure market stability and protect investors. The correlation between digital assets and traditional assets also indicates potential investment opportunities and the importance of diversifying investment portfolios [30].

2.1.1 Capital Market in Thailand

Thailand's capital market is considered to be one of the most developed and advanced markets in Southeast Asia. The market consists of the Stock Exchange of Thailand (SET) and the Market for Alternative Investment (MAI), which provide a range of investment opportunities to both local and foreign investors. On the other hand, the emergence of digital assets, particularly cryptocurrencies, has disrupted traditional

financial markets globally, including Thailand's capital market. This literature review aims to compare Thailand's capital market and digital asset market, particularly in terms of regulation, investor protection, and market efficiency.

Regulation: Thailand's capital market is regulated by the Securities and Exchange Commission (SEC), which oversees the SET and MAI. The SEC has a mandate to protect investors, ensure fair trading, and promote the development of the market. The SEC has implemented strict regulations and guidelines that govern the operations of listed companies and protect investors' interests [31].

In contrast, the digital asset market in Thailand is relatively new and is not yet subject to comprehensive regulation. However, the Thai government has taken steps to regulate digital assets by enacting the Digital Asset Business Decree in 2018, which mandates that all digital asset operators must be licensed by the SEC. The decree also provides guidelines for digital asset custody and anti-money laundering measures [32].

Investor Protection: Thailand's capital market offers a high level of investor protection. The SEC requires listed companies to disclose all relevant information to investors, such as financial statements and management reports. The SEC also imposes stringent disclosure requirements on companies during the initial public offering (IPO) process.

In contrast, the digital asset market in Thailand is relatively unregulated, and investors are exposed to significant risks. The SEC has issued warnings to investors regarding the risks associated with digital assets, such as market volatility, lack of liquidity, and fraud. However, the lack of comprehensive regulation leaves investors vulnerable to scams and fraudulent activities [33].

Market Efficiency: Thailand's capital market is considered to be relatively efficient, with a high level of liquidity and active trading. The SET is the main exchange in Thailand, with a market capitalization of over $500 billion. The market is also characterized by a high level of foreign investment.

The digital asset market in Thailand is relatively small but has experienced significant growth in recent years. The market is characterized by high volatility, low

liquidity, and limited trading activity. The lack of comprehensive regulation and investor education may hinder the development of the market. Thailand's capital market is relatively mature and well-regulated, offering a high level of investor protection and market efficiency. The digital asset market in Thailand is relatively new and presents significant challenges in terms of regulation, investor protection, and market efficiency. However, the Thai government has taken steps to regulate the market, and the future of the digital asset market in Thailand remains uncertain but potentially promising [34].

2.1.2 Digital Asset in Thailand

The emergence of digital assets, particularly cryptocurrencies, has disrupted traditional financial markets globally, including Thailand's capital market. The digital asset market in Thailand is relatively new but has experienced significant growth in recent years. This literature review aims to compare Thailand's digital asset market and capital market, particularly in terms of regulation, investor protection, and market efficiency [35].

Regulation: The digital asset market in Thailand is regulated by the Securities and Exchange Commission (SEC), which oversees all digital asset operators. The Digital Asset Business Decree of 2018 mandates that all digital asset operators must be licensed by the SEC and comply with strict guidelines for digital asset custody and anti-money laundering measures. In contrast, Thailand's capital market is well-established and regulated by the SEC, which oversees the Stock Exchange of Thailand (SET) and the Market for Alternative Investment (MAI) [36]. The SEC has implemented strict regulations and guidelines that govern the operations of listed companies and protect investors' interests.

Investor Protection: The SEC has issued warnings to investors regarding the risks associated with digital assets, such as market volatility, lack of liquidity, and fraud. However, the lack of comprehensive regulation leaves investors vulnerable to scams and fraudulent activities. Thailand's capital market offers a high level of investor protection. The SEC requires listed companies to disclose all relevant information to investors, such

as financial statements and management reports [37]. The SEC also imposes stringent disclosure requirements on companies during the initial public offering (IPO) process.

Market Efficiency: The digital asset market in Thailand is relatively small but has experienced significant growth in recent years. The market is characterized by high volatility, low liquidity, and limited trading activity. The lack of comprehensive regulation and investor education may hinder the development of the market. In contrast, Thailand's capital market is considered to be relatively efficient, with a high level of liquidity and active trading. The SET is the main exchange in Thailand, with a market capitalization of over $500 billion. The market is also characterized by a high level of foreign investment. Thailand's digital asset market is a relatively new and rapidly developing market, which presents significant challenges in terms of regulation, investor protection, and market efficiency [38]. The SEC has taken steps to regulate the market, but the lack of comprehensive regulation and investor education may hinder the market's development. In contrast, Thailand's capital market is well-established and regulated, offering a high level of investor protection and market efficiency.

2.2 The context of the work studied.

2.2.1 Cryptocurrency

Despite being relatively new, cryptocurrencies have gained widespread acceptance and have grown rapidly. Hedge funds and asset managers have started incorporating cryptocurrency assets in their portfolios and trading strategies [39]. The market of cryptocurrencies has gone through a rapid and unpredictable evolution within its relatively brief existence. This development began with the public release of the original decentralized cryptocurrency, Bitcoin, in January 2009. In essence, a cryptocurrency is a digital currency system that functions in a similar way to regular currencies, enabling individuals to make electronic payments for goods and services without the need for a central, trusted authority [40]. Bitcoin and other digital currencies have the potential to disrupt traditional financial systems and provide independent financial services, which could reduce or eliminate the need for cross-border money transfers and increase business

opportunities. However, the volatile price of digital currencies compared to other investment assets is a significant concern for investors. As a result, there have been calls for the regulation of cryptocurrencies [41].

The blockchain technology that underpins the Bitcoin cryptocurrency system is believed to be critical for establishing a secure and private infrastructure for various applications in many other fields. By keeping a digital ledger of transactions that are deemed unchangeable, the Proof-of-Work mathematical challenge provides security for the blockchain [42], by using a public key and private key pair, which is generated from a specific cryptographic algorithm, used to assign ownership of each key pair or 'coin' to the individual in possession of the private key. This cryptographic algorithm ensures that the private key is kept secret while the public key is shared publicly. The public key can be used to send and receive cryptocurrency, while the private key is required to authorize transactions and access the funds associated with the public key. Therefore, the security of the private key is crucial for the security of cryptocurrency ownership [43].

Ethereum is one of the assets using blockchain technology that allows developers to build decentralized applications. The Ethereum platform offers more flexibility and functionality compared to Bitcoin's more limited focus on financial transactions. It allows for the creation of custom tokens, and its programming language enables the creation of complex smart contracts that can automate complex business processes [44]. Ethereum has become a popular platform for building decentralized applications, such as decentralized finance (DeFi) protocols, gaming platforms, and more.

In Thailand, The Royal Decree on Digital Asset Business B.E. 2561 (2018), which was implemented in 2018, not only laid down regulations for paying taxes but also introduced rules for intermediaries and service providers to enhance Thailand's financial system. As per the decree, digital asset business operators must obtain permission from the Minister of Finance based on the recommendations of the Security Exchange Commission of Thailand (SEC) [45].

2.2.2 Capital Market in Thailand

The capital market in Thailand has a large market size and high liquidity due to the involvement of institutional investors. It offers a range of investment products, including stocks, bonds, and mutual funds. Investors can diversify their portfolios by investing in different sectors and asset classes, which helps reduce investment risk. The trading volume in the capital market is also high, with the SET50 index being the benchmark index for the Thai stock market. The index comprises the top 50 listed companies in terms of market capitalization and liquidity. the capital market in Thailand provides a stable and reliable investment platform for investors. Its regulatory framework ensures transparency and investor protection, and the involvement of institutional investors provides high liquidity. Investors can benefit from a diverse range of investment products, enabling them to build a well-diversified investment portfolio [46].

Classical capital markets play a critical role in supporting long-term financing activities for businesses, governments, and other organizations. These markets have a significant impact on the overall economy and can affect a wide range of industries. The primary market of the capital market is particularly important as it facilitates the creation of new long-term capital. In the primary market, companies can raise capital by issuing securities such as stocks, bonds, and other financial instruments. The primary market can be accessed by both large corporations and small businesses, and it is essential in driving economic growth by enabling companies to invest in new projects, research, and development [47].

The secondary market of the capital market is also important as it provides liquidity to investors who want to sell their securities, such as stocks and bonds, in the market. Investors can buy and sell securities in the secondary market after they have been initially issued in the primary market. This creates a more liquid market, allowing investors to easily buy and sell securities without having to wait for their maturity date. The secondary market is particularly attractive to investors who want to buy and sell securities frequently and take advantage of price movements. High liquidity and transparency in the secondary market are essential for maintaining investor confidence and encouraging long-term investment [48].

Investors are typically interested in capital markets with high liquidity and high transparency. Liquidity is essential for investors to be able to easily buy and sell securities in the market, and transparency is necessary for investors to make informed investment decisions. In markets with high liquidity and transparency, investors can have confidence that their investments will be easily converted into cash, and that they can access all the information they need to make informed investment decisions [49]. These features make capital markets more attractive to investors and can increase their overall level of investment.

Capital markets in Thailand are regulated by the Securities and Exchange Commission (SEC) and consist of both primary and secondary markets. The primary market deals with the issuance of new securities, while the secondary market facilitates the trading of previously issued securities. The Stock Exchange of Thailand (SET) is the primary exchange in the country, where both equity and debt securities are traded. The Thai capital market has experienced significant growth over the past decade and has become an important source of financing for both domestic and international companies. The market has also seen an increase in the number of initial public offerings (IPOs) and bond issuances. In recent years, the Thai government has implemented several initiatives to promote the development of the capital market, including tax incentives for issuers and investors [50].

2.3 Theoretical Concepts

2.3.1 Correlation Coefficient

In recent years, digital asset markets have emerged as a new investment opportunity for investors in Thailand. Cryptocurrencies such as Bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE have gained popularity among investors. To understand the relationship between the capital market in Thailand and the digital asset market, a correlation coefficient analysis can be conducted. The correlation coefficient is a statistical measure that indicates the degree of relationship between two variables. In this

case, we can examine the correlation between the SET50 index, gold, oil, THB/USD exchange rate, and cryptocurrencies mentioned above [51].

The correlation coefficient analysis can help investors understand the degree of correlation between the capital market in Thailand and the digital asset market. A positive correlation coefficient indicates a positive relationship, while a negative correlation coefficient indicates a negative relationship. A correlation coefficient of zero indicates no relationship between the two variables. By conducting a correlation coefficient analysis, we can determine which assets are positively or negatively correlated with each other. This information can be valuable to investors who are looking to diversify their portfolios and minimize investment risk. the correlation coefficient analysis can provide valuable insights into the relationship between the capital market in Thailand and the digital asset market. It can help investors make informed decisions about their investment portfolio and minimize risk [52].

2.3.2 Random Matrix Theory

Random matrix theory is a branch of mathematics that has been applied to various fields such as physics, engineering, and finance. It is used to analyze large matrices that have random elements. In finance, the theory has been used to study the correlation structure of financial assets. The main idea behind the theory is that the behavior of a large complex system can be described by a random matrix whose elements are the variables that make up the system. In finance, these variables would be the returns of various assets [53].

In finance, the random matrix theory can be used to identify the underlying structure of the correlation matrix. The correlation matrix is a square matrix that contains the correlations between different financial assets. The random matrix theory can be used to identify the eigenvalues and eigenvectors of the correlation matrix. The eigenvectors can then be used to identify the groups of assets that are most closely correlated. The random matrix theory can also be used to filter out noise from the correlation matrix. The correlation matrix may contain noise due to measurement errors or other factors. The

random matrix theory can be used to filter out this noise by identifying the most significant signals. This can be useful in constructing trading strategies as it allows investors to focus on the most significant signals and avoid noise [54].

In the Random Matrix Theory, eigenvalues and eigenvectors refer to the mathematical tools used to analyze the correlation structure of a matrix. An eigenvalue is a scalar that represents how a matrix stretches or shrinks an eigenvector. In other words, when a matrix acts on an eigenvector, the eigenvector is scaled by the corresponding eigenvalue. Eigenvectors are the vectors that, when a matrix is multiplied by them, yield a scalar multiple of the original vector [55]. Eigenvectors and eigenvalues are particularly useful for understanding the structure of correlation matrices, which are square matrices that show the pairwise correlations between different variables in a dataset. The eigenvalues of a correlation matrix can be used to identify the number of significant factors that contribute to the data, while the eigenvectors can be used to identify the relative importance of each variable in each factor.

2.3.3 Minimum Spanning Tree

The minimum spanning tree (MST) is a graph theory tool that can be used to analyze the relationships between multiple variables. In the context of this paper, the MST can be used to identify the shortest route between assets and to identify clusters of assets that are highly correlated with each other. To construct the MST, we can use the correlation matrix obtained from the correlation coefficient analysis [56]. The correlation matrix contains the correlation coefficients between each pair of assets. We can then use this matrix to construct a graph where each asset is represented as a node and the edges between nodes represent the correlation coefficients between the corresponding assets.

The MST algorithm can then be applied to this graph to identify the shortest route between assets. The resulting MST can provide insights into the relationships between different assets and identify clusters of assets that are highly correlated with each other [57]. For example, the MST may reveal that Bitcoin and Ethereum are highly correlated with each other, indicating that these assets may move in tandem. Alternatively, the MST

may reveal that gold and oil are negatively correlated with each other, indicating that these assets may move in opposite directions. The MST can provide valuable insights into the relationships between assets in the capital market in Thailand and the digital asset market. By identifying clusters of highly correlated assets, investors can make more informed decisions about their investment portfolio and diversify their risk exposure [58].

2.4 Literature Review and Related Research

In recent years, the digital asset market has experienced significant growth and gained widespread attention from investors and policymakers. Cryptocurrencies have gained popularity as an alternative asset class due to their decentralization, anonymity, and potential for high returns. This has led to increased interest in understanding the correlation between digital assets and traditional assets such as stocks, commodities, and currencies. Several studies have examined the relationship between digital assets and traditional assets in different markets, including the US, China, and Japan. However, there is limited research on the correlation between cryptocurrency and the capital market in Thailand. Thailand has a developing digital asset market and a growing economy, making it an interesting and relevant case for investigation. Therefore, this study aims to fill the gap in the literature by exploring the correlation between digital assets and the Thai capital market.

"Al-Amri, R., Zakaria, N. H., Habbal, A., & Hassan, S. (2019)[59]" The paper provides a comprehensive overview of the current stage, opportunities, and open challenges related to the adoption of cryptocurrencies. The authors argue that despite the significant growth of the cryptocurrency market, there are still several open challenges that need to be addressed to achieve mainstream adoption. The paper highlights the key factors that influence the adoption of cryptocurrencies, such as security, usability, regulation, and awareness. The authors also discuss the current state of the cryptocurrency market, including the dominant players, the most widely used cryptocurrencies, and the major applications of the technology. Finally, the paper presents some potential

opportunities for the future of cryptocurrency adoption, such as the development of decentralized finance and the integration of blockchain technology into various industries.

" Liu J. & Serletis A. (2019) [60]" The paper examines the characteristics of volatility in the cryptocurrency market using data from Bitcoin, Ethereum, and Litecoin from Coin Market. The study uses GARCH-in-mean models to analyze the relationship between volatility and returns of leading cryptocurrencies and concludes that the cryptocurrency market is highly volatile and exhibits strong persistence in volatility. The study also finds that the factors driving volatility in the cryptocurrency market are different from those in traditional financial markets. The authors suggest that the high level of volatility in the cryptocurrency market may be due to market structure, liquidity, and investor behavior, among other factors. The paper highlights the need for more research to understand the sources of volatility in the cryptocurrency market and to develop better risk management strategies for investors.

" Towards an Understanding of Cryptocurrency: A Comparative Analysis of Cryptocurrency, Foreign Exchange, and Stock (2019) [61]" The paper compares cryptocurrency to traditional financial markets such as foreign exchange and stock markets. The authors examine the similarities and differences in terms of market structure, trading behavior, and market efficiency by using a correlation matrix and asset tree. They found that cryptocurrency markets exhibit higher volatility and less efficiency compared to traditional markets, and that trading behavior in cryptocurrency markets is more speculative in nature. The paper also discusses the potential impact of regulatory intervention on cryptocurrency markets and concludes that further research is needed to fully understand the dynamics of these emerging markets.

" Dynamic Connectedness and Integration In Cryptocurrency Markets (2019)[62]" The paper examines the dynamic connectedness and integration of the cryptocurrency markets using a comprehensive set of cryptocurrencies, including Bitcoin, Ethereum, Ripple, and Litecoin. The study analyzes the spillover effects and time-varying correlations among these digital assets and finds evidence of high volatility and interdependence among cryptocurrencies. The results suggest that the cryptocurrency markets are highly integrated and interconnected, with spillover effects that are mostly unidirectional from Bitcoin to other cryptocurrencies. The paper concludes that a better understanding of the dynamic interdependence and connectedness among cryptocurrencies is important for investors and policymakers to effectively manage risks and promote the development of the digital asset market.

"Surachai, C., & Kamonchai, R. (2019)[63]" This paper investigates the dynamic relationship between the Stock Exchange of Thailand (SET) index and the exchange rate of Thai Baht and US dollar (THB/USD) during the period of coup d'états in Thailand from 2006 to 2016. The study uses daily data and employs Johansen's cointegration analysis and Granger causality tests to examine the long-run and short-run relationships between the variables. The results show that there is a significant long-run relationship between the SET index and the THB/USD exchange rate during the pre-coup periods of 2006 and 2014, but this relationship becomes weaker during the coup periods of 2006 and 2014. Additionally, the SET index shocks have a negative impact on the THB/USD exchange rate in all periods except during the coup period of 2014, the study concludes that coup d'états have an impact on the relationship between the stock market and exchange rate in Thailand.

Amsyar, I., Christopher, E., Dithi, A., Khan, A. N., & Maulana, S. (2020) [64]. The paper “The Challenge of Cryptocurrency in the Era of the Digital Revolution: A Review of Systematic Literature” provides a comprehensive review of the existing literature on the challenges of cryptocurrencies in the digital era. The paper analyzes the

major issues and challenges that cryptocurrencies face, including regulatory challenges, security concerns, and the impact of cryptocurrencies on the global financial system. The authors also examine the potential benefits of cryptocurrencies, such as the ability to reduce transaction costs and increase financial inclusion. The paper discusses how cryptocurrency functions as a decentralized digital currency that does not require intermediaries in transactions. The use of blockchain technology increases the security of user data, and the value of cryptocurrency cannot be determined. Cryptocurrency offers the advantage of fast transactions without the need for intermediaries, and data on cryptocurrency is permanently stored in the blockchain network, making it difficult for other parties to manipulate data.

"Regulations and Behavioral Intention for Use Cryptocurrency in Thailand (2020) [65] " This study examines the development of cryptocurrency regulations and their impact on people's intentions to use cryptocurrency in Thailand. The Unified Theory of Acceptance and Use of Technology (UTAUT) model was used to analyze behavioral intentions, and a questionnaire survey was conducted. The results showed that social influence is the most significant factor in encouraging people to use cryptocurrency. Other factors that influenced the intention to use cryptocurrency included facilitating conditions, effort expectancy, and performance expectancy. Three main purposes for using cryptocurrency were identified: investment, means of payment for goods and services, and collecting points and rewards.

"Cryptocurrency Adoption: Current Stage, Opportunities, and Open Challenges (2021) [66]"

Cryptocurrency adoption is still in its early stages, but it has grown significantly in recent years. While cryptocurrencies like Bitcoin and Ethereum are still not widely used as a means of payment, they have gained popularity as investment assets and store of value. In this context, cryptocurrencies represent an opportunity for innovation in the financial industry, but there are also significant challenges that need to be addressed. One

opportunity presented by cryptocurrencies is the potential to provide financial services to individuals who are unbanked or underbanked. Cryptocurrencies can be used to send and receive payments without the need for a traditional bank account, which could expand access to financial services for people in developing countries or those who lack the necessary documentation to open a bank account. Moreover, cryptocurrencies can facilitate cross-border transactions without the need for intermediaries or expensive fees. However, there are several challenges to widespread adoption of cryptocurrencies. One of the main issues is regulatory uncertainty, as many countries are still developing regulations around cryptocurrencies. This can lead to uncertainty for businesses that want to incorporate cryptocurrencies into their operations and for individuals who want to invest in them. Additionally, there are concerns around the security and stability of cryptocurrencies, as they are vulnerable to hacking and other cyber-attacks. Another challenge is the usability and accessibility of cryptocurrencies. Cryptocurrencies can be difficult to use for individuals who are not tech-savvy or familiar with the complex technology behind them. However, there are also challenges to cryptocurrency adoption that need to be addressed. One of the biggest challenges is the lack of regulation. While some countries have created clear rules around cryptocurrency, others have not, which can create uncertainty for investors and users. Another challenge is the lack of user-friendly interfaces and tools. While cryptocurrencies are becoming easier to use, there is still a steep learning curve for new users.

Finally, there is the challenge of scalability. As more people use cryptocurrencies, the networks can become slow and expensive. This is especially true for Bitcoin, which has a limited block size and can only process a certain number of transactions per second. Solutions like the Lightning Network are being developed to address this issue, but they are still in the early stages of adoption. In summary, cryptocurrency adoption is gaining momentum in 2021, particularly in the areas of payments and DeFi. However, challenges around regulation, user interfaces, and scalability need to be addressed in order to enable widespread adoption. Despite these challenges, many people believe that cryptocurrencies have the potential to transform the financial industry and create new opportunities for innovation.

“Volatility in the Cryptocurrency Market” (2021) [67]"

The cryptocurrency market has experienced a high level of volatility in 2021. Cryptocurrencies like Bitcoin, Ethereum, and Dogecoin have experienced significant price fluctuations, leading to uncertainty and concern among investors. One of the major factors contributing to this volatility is the increasing regulatory scrutiny of cryptocurrencies. Several countries have announced new regulations or restrictions on cryptocurrencies, including China, India, and Turkey. These actions have led to sell-offs and price drops in the cryptocurrency market.

Another factor contributing to volatility is the growing interest in cryptocurrency among institutional investors. Large companies like Tesla and Square have invested billions of dollars in Bitcoin, and major financial institutions like Goldman Sachs and Morgan Stanley have started offering cryptocurrency investment products to their clients. However, this increased institutional interest also means that large investors can influence the market more easily, leading to sudden price movements. Finally, the cryptocurrency market is still relatively new and lacks the stability and predictability of more established financial markets. The market is heavily influenced by speculation and hype, and news events or rumors can cause large price swings in a short period of time. Despite the volatility, many people remain optimistic about the long-term potential of cryptocurrencies. Blockchain technology, which underlies most cryptocurrencies, has the potential to revolutionize industries and create new opportunities for innovation. However, it is important for investors to be aware of the risks and volatility of the cryptocurrency market and to approach investing with caution and a long-term perspective.

“The Impact of Coup d'états on the Relationship between Stock Market and Exchange Rate: Evidence from Thailand” (2021) [68].

The occurrence of a coup d'état can have a significant impact on the relationship between the stock market and exchange rate. This was evidenced in Thailand in 2021, where a coup d'état occurred and had an immediate effect on the financial markets. After

the coup, the Thai stock market initially experienced a sharp decline as investors became uncertain about the political situation and the future direction of the country. The stock market, however, recovered quickly and ended up performing well over the following months. This was due in part to the military junta's commitment to stabilizing the economy and boosting investor confidence. In contrast, the Thai baht (THB) experienced a significant decline following the coup. This was due to a number of factors, including political uncertainty and a perceived lack of stability in the government. As a result, investors moved their funds out of the country, leading to a decline in the value of the THB.

The relationship between the stock market and exchange rate in Thailand following the coup is complex. While the stock market performed well, the decline in the THB had implications for the wider economy, including inflation and trade. The weakened THB made imports more expensive, which could lead to inflationary pressures. Additionally, a weaker THB could make Thai exports more attractive, but this could be offset by increased costs due to more expensive imports. In summary, the impact of a coup d'état on the relationship between the stock market and exchange rate in Thailand in 2021 was significant. While the stock market performed well, the decline in the THB had implications for the wider economy. It remains to be seen how the situation in Thailand will develop in the long term and how it will affect the financial markets.

“Cryptocurrency Adoption: Current Stage, Opportunities, and Open Challenges 2022 [69]”

As of 2022, cryptocurrency adoption continues to gain momentum globally, with more businesses and individuals embracing digital currencies. Despite some setbacks and challenges, the overall trend towards increased adoption of cryptocurrencies is likely to continue in the coming years. Current Stage of Cryptocurrency Adoption: The current stage of cryptocurrency adoption can be described as a mixed picture. On one hand, there has been an explosion of new cryptocurrencies and blockchain-based platforms, including decentralized finance (DeFi) applications, non-fungible tokens (NFTs), and other

innovations. More businesses are accepting cryptocurrencies as payment, and some are even adding cryptocurrencies to their balance sheets as a store of value. On the other hand, there are still challenges that must be overcome before cryptocurrencies become more widely adopted. One of the most significant challenges is regulatory uncertainty, with many governments struggling to determine how to regulate cryptocurrencies. This has led to a patchwork of different regulations and approaches across different jurisdictions, which can be confusing for businesses and investors.

Opportunities for Cryptocurrency Adoption: Despite these challenges, there are many opportunities for cryptocurrency adoption. One of the main advantages of cryptocurrencies is their potential to offer faster, cheaper, and more secure ways to make transactions. This is particularly useful for businesses that operate internationally or in areas with poor financial infrastructure. Another opportunity for cryptocurrency adoption is in the area of decentralized finance (DeFi). DeFi platforms enable users to access financial services without the need for intermediaries such as banks or other financial institutions. This can reduce costs and increase financial inclusion, particularly for people who are underserved by traditional financial systems.

Open Challenges for Cryptocurrency Adoption: There are still several open challenges that must be addressed for cryptocurrency adoption to become more widespread. One of the main challenges is scalability, with many cryptocurrencies struggling to handle large transaction volumes without becoming slow or expensive. This has led to ongoing debates over the best way to scale blockchain networks, with solutions such as sharding, layer 2 scaling, and other approaches being explored. Another challenge is energy consumption, with some cryptocurrencies such as Bitcoin consuming significant amounts of energy in order to validate transactions. This has led to concerns over the environmental impact of cryptocurrencies, particularly as more people begin to use them.

Finally, there is the challenge of education and awareness. Many people still do not understand what cryptocurrencies are or how they work, and this can be a barrier to adoption. There is a need for more education and outreach to help people understand the benefits and risks of cryptocurrencies, as well as how to use them safely and securely.

The current stage of cryptocurrency adoption is characterized by both opportunities and challenges. Despite ongoing regulatory uncertainty and technical challenges, there are many opportunities for businesses and individuals to benefit from the use of cryptocurrencies. Addressing scalability, energy consumption, and education will be critical to unlocking the full potential of cryptocurrencies in the years to come.

"**Volatility in the Cryptocurrency Market (2022) [70]"**

Volatility in the cryptocurrency market has been a significant issue since the inception of Bitcoin in 2009, and it continues to be a concern in 2022. The price of cryptocurrencies can fluctuate wildly in short periods of time, which can be both a blessing and a curse for investors and businesses alike. Causes of Volatility: There are several factors that can contribute to volatility in the cryptocurrency market. One of the primary factors is speculation, with many investors buying and selling cryptocurrencies based on hype or market sentiment rather than underlying fundamentals. This can lead to rapid price movements in either direction. Another factor is market manipulation, with some individuals or groups using various tactics such as pump-and-dump schemes to artificially inflate or deflate the price of a particular cryptocurrency. This can create false impressions of demand or supply, leading to further price swings. regulatory uncertainty can also contribute to volatility in the cryptocurrency market. As governments around the world struggle to determine how to regulate cryptocurrencies, there can be a lack of clarity and consistency in the regulatory environment. This can lead to uncertainty and risk for investors and businesses, which can in turn contribute to volatility.

Impact of Volatility: Volatility can have both positive and negative impacts on the cryptocurrency market. On the positive side, volatility can create opportunities for traders and investors to profit from rapid price movements. It can also create buzz and interest in the cryptocurrency market, leading to increased adoption and awareness. However, volatility can also have negative impacts on the market. Rapid price swings can create uncertainty and risk for investors and businesses, leading to hesitancy and caution. Additionally, high volatility can make it difficult for cryptocurrencies to function as a

reliable medium of exchange or store of value, as their values can fluctuate too much to be useful for these purposes. Managing Volatility: There are several strategies that investors and businesses can use to manage the volatility of the cryptocurrency market. One strategy is to diversify their portfolios, spreading their investments across multiple cryptocurrencies or other asset classes to reduce risk. Another strategy is to employ risk management tools such as stop-loss orders or hedging strategies, which can help mitigate losses in the event of a market downturn. Businesses can work to improve the fundamentals of the cryptocurrencies they are invested in, such as by building robust networks or expanding use cases, in order to create more stability and reduce volatility over the long term. Volatility is a persistent issue in the cryptocurrency market, and it is likely to continue to be a concern in 2022 and beyond. While volatility can create opportunities for profit, it can also create risks and uncertainty for investors and businesses. By employing diversification, risk management, and fundamental improvements, stakeholders in the cryptocurrency market can work to manage volatility and build a more stable and reliable market over time.

"Understanding of Cryptocurrency: A Comparative Analysis of Cryptocurrency, Foreign Exchange, and Stock" (2022) [71].

Cryptocurrency, foreign exchange (forex), and stock markets are all widely traded financial markets, but they differ in several ways. In this comparative analysis, we will explore the key similarities and differences between these three markets. Similarities: One of the key similarities between these markets is that they all involve buying and selling assets in order to profit from changes in their values. In all three markets, investors are seeking to buy low and sell high, or sell high and buy low, in order to make a profit. Another similarity is that these markets are all affected by a range of economic, political, and social factors. Changes in interest rates, geopolitical events, and company earnings reports can all impact the values of assets in these markets.

Differences: The primary difference between cryptocurrency and forex and stock markets is that cryptocurrencies are digital assets that are not tied to any government or

central bank. This means that the values of cryptocurrencies are not impacted by traditional economic indicators such as inflation rates or interest rates. Instead, the values of cryptocurrencies are determined by supply and demand dynamics and market sentiment. Another difference is that forex markets involve the buying and selling of different national currencies, while stock markets involve the buying and selling of shares of individual companies. In contrast, cryptocurrencies can be thought of as a new asset class that is not tied to any specific country or company. The level of regulation in these markets differs significantly. Forex and stock markets are subject to extensive government and industry regulations, while the regulation of the cryptocurrency market is still evolving and varies significantly from country to country.

Implications for Investors: The differences between these markets have important implications for investors. For example, investors in the forex and stock markets need to be aware of economic indicators and company-specific news, while investors in the cryptocurrency market need to pay attention to supply and demand dynamics and market sentiment. Additionally, the level of regulation in these markets can impact the risks and opportunities for investors. While regulation can provide protections for investors, it can also limit opportunities for profit. In contrast, the lack of regulation in the cryptocurrency market can lead to increased volatility and risk.

"Dynamic Connectedness and Integration in Cryptocurrency Markets (2022) [72]"

The study of dynamic connectedness and integration in cryptocurrency markets is an important area of research in finance and economics. Understanding the degree to which different cryptocurrencies are connected and integrated with each other and with traditional financial markets can provide insights into market behavior and risk management. Dynamic Connectedness: Dynamic connectedness refers to the degree to which changes in one cryptocurrency affect other cryptocurrencies and the wider financial system. Understanding the dynamic connectedness between cryptocurrencies can help investors and policymakers identify potential sources of systemic risk and

develop appropriate risk management strategies. One approach to studying dynamic connectedness is to use econometric models such as Vector Autoregression (VAR) or Granger causality tests to measure the strength and direction of the relationships between different cryptocurrencies over time. This can help identify which cryptocurrencies are more closely connected and which are more independent.

Integration: Integration refers to the degree to which cryptocurrencies are linked to traditional financial markets, such as stocks, bonds, and commodities. Understanding the level of integration between cryptocurrencies and traditional financial markets can provide insights into the potential impact of broader economic events on cryptocurrency prices. One approach to studying integration is to use measures such as correlation coefficients or co-integration tests to identify the degree to which cryptocurrency prices are related to other financial assets. This can help investors and policymakers identify potential opportunities and risks associated with integrating cryptocurrencies into traditional investment portfolios.

Implications: Studying dynamic connectedness and integration in cryptocurrency markets has important implications for risk management and portfolio diversification. For example, understanding which cryptocurrencies are more closely connected can help investors manage their exposure to systemic risk by diversifying across independent cryptocurrencies. Similarly, understanding the level of integration between cryptocurrencies and traditional financial markets can help investors identify potential opportunities to hedge against broader economic risks. Studying dynamic connectedness and integration in cryptocurrency markets is an important area of research that can provide insights into market behavior and risk management. By using econometric models and measures of correlation and co-integration, researchers and practitioners can gain a better understanding of the relationships between cryptocurrencies and traditional financial markets and develop appropriate strategies for managing risk and building diversified portfolios.

CHAPTER 3

Methodology

3.1 Scope of the Study

The study aims to compare the capital market in Thailand with digital asset markets, focusing on the correlation between cryptocurrencies and conventional asset measurements. The scope of the study covers a comprehensive analysis of the daily Thai data related to the most popular asset prices and indices, including gold, oil, the SET50 index, THB/USD exchange rate, bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE. The study employs a matrix approach to the Pearson correlation coefficient to identify significant correlations between cryptocurrencies and the digital economy. The minimal spanning tree model and random matrix theory will also be utilized to determine the shortest route between assets.

The study aims to compare two different periods to analyze the relationship between the capital markets in Thailand and the digital asset market. The period spans from 1 January 2019 to 30 September 2022. The objective is to investigate how the COVID-19 outbreak has impacted the correlation between digital assets and the Thai financial markets. The study will also analyze the performance in an investment portfolio. This analysis will focus on identifying opportunities for risk diversification through the inclusion of alternative assets like digital assets. The results of the study will contribute to the understanding of the relationship between digital assets and traditional financial markets in Thailand and provide insights for investors looking to optimize their investment portfolios.

To compare the capital market in Thailand with digital asset markets, focusing on the correlation between cryptocurrencies and conventional asset measurements, and covering a comprehensive analysis of the daily Thai data related to the most popular asset prices and indices, including gold, oil, the SET50 index, THB/USD exchange rate, bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE, you can use the

following methodology: Define the research question: The research question is "How do cryptocurrencies, such as bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE, correlate with conventional asset measurements, such as gold, oil, and the SET50 index, THB/USD exchange rate in the Thai market?"

The study will analyze the investment opportunities offered by the two markets, including the types of securities and digital assets available, the liquidity of the markets, and the costs associated with investing in them. It will also compare the risks and returns of investing in the two markets, including the volatility of prices, liquidity risks, and counterparty risks.

The study will examine the investment opportunities provided by both the capital market in Thailand and digital asset markets. This will involve analyzing the types of securities and digital assets that are available for investment, as well as evaluating the liquidity of the markets. Additionally, the study will investigate the costs associated with investing in each market, including trading fees and transaction costs. Furthermore, the study will compare the risks and returns associated with investing in these two markets. This will involve analyzing the volatility of prices in both markets, as well as assessing the liquidity risks and counterparty risks involved in investing in each market. Additionally, the study will evaluate the potential returns that can be earned from investing in both markets, including both short-term and long-term investment strategies. Overall, the study aims to provide a detailed and comprehensive analysis of the investment opportunities, risks, and potential returns that are associated with investing in both the capital market in Thailand and the digital asset markets.

Collect data: Collect data on the daily Thai market prices and indices for gold, oil, the SET50 index, THB/USD exchange rate, bitcoin, Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE. You can obtain this data from reliable sources, such as government reports, market research reports, and online financial data providers. Analyze data: Once you have collected the data, analyze it to identify any correlations or patterns between cryptocurrencies and conventional asset measurements. You can use statistical tools such as correlation analysis, regression analysis, and time-series analysis to analyze the data.

Interpret results: Interpret the results of your analysis and identify any significant correlations or trends. You can also compare the performance of cryptocurrencies and conventional assets to identify any differences in their volatility, returns, and risk. Draw conclusions: Based on your findings, draw conclusions about the correlation between cryptocurrencies and conventional asset measurements in the Thai market. You can also provide recommendations for investors or policymakers based on your analysis. Present your findings: Finally, present your findings in a clear and concise manner. Use graphs, charts, and other visual aids to help your audience better understand your findings. You can also provide a discussion of the implications of your findings and suggest areas for future research.

3.2 Proposed Method

The proposed method for analyzing the correlation between cryptocurrencies and conventional asset measurements in the Thai market is to use the Pearson correlation coefficient. This statistical measure is commonly used to measure the strength and direction of the relationship between two continuous variables. It is particularly useful for measuring the linear correlation between two variables, where the relationship can be approximated by a straight line.

Figure 3.1 depicts the process of analyzing a dataset that includes various assets such as gold, oil, cryptocurrencies, and stock market indexes, to understand their relationships. The process involves three techniques: Pearson correlation coefficient, random matrix theory, and minimum spanning tree. The first technique involves finding the returns of each asset and creating a correlation coefficient matrix to measure the linear relationship between each pair of assets. The second technique involves finding the ratio of the number of days and assets, determining the noise in the eigenvalue spectrum of the matrix, and filtering noisy eigenvalues. The third technique involves finding the distance between assets and representing their direct distance relationships.

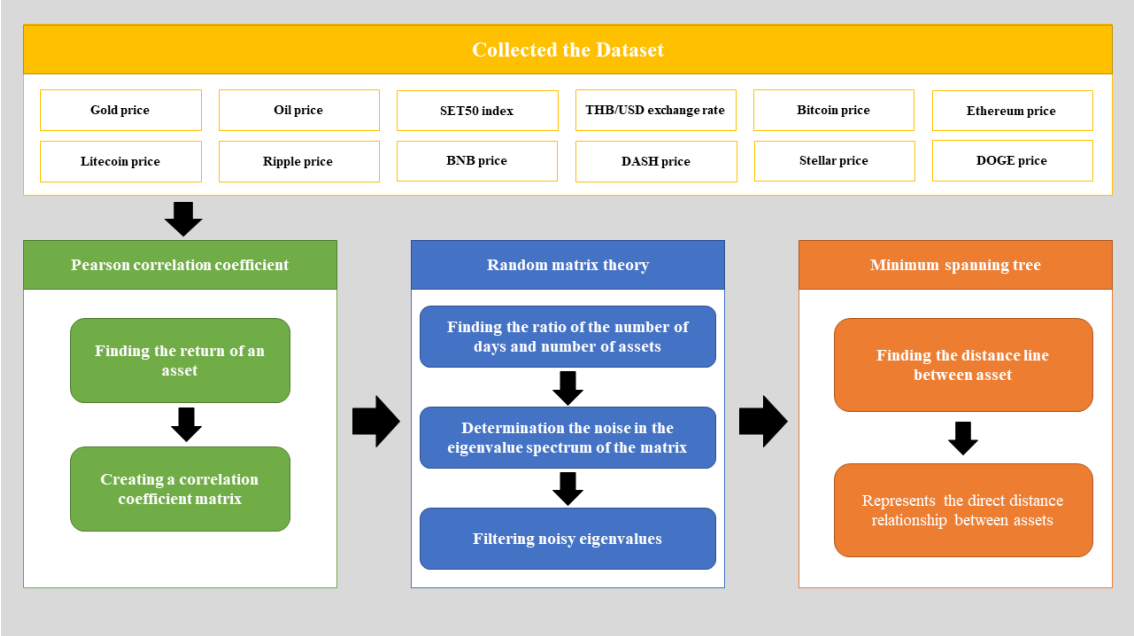


Figure 3.1 Proposal method framework

The Pearson correlation coefficient, also known as Pearson's r, ranges from -1 to 1. A value of -1 indicates a perfect negative correlation, which means that as one variable increases, the other decreases by an equal amount. A value of 0 indicates no correlation between the two variables. A value of 1 indicates a perfect positive correlation, which means that as one variable increases, the other also increases by an equal amount. By using Pearson's r, we can determine the degree of correlation between cryptocurrencies and conventional asset measurements in the Thai market. This will enable us to identify any significant relationships and trends between the two types of assets, and to draw conclusions about their performance and potential impact on the Thai market.

To calculate Pearson's correlation coefficient, we need to calculate the covariance between two variables. Covariance measures how much the two variables vary together. We then divide this value by the product of their standard deviations. This scaling factor ensures that the resulting value is between -1 and 1. The resulting value represents the degree of association between the two variables. If the value is positive, it indicates a positive correlation, meaning that as one variable increases, the other variable also tends to increase [73]. If the value is negative, it indicates a negative correlation, meaning that as one variable increases, the other variable tends to decrease.

In summary, to calculate Pearson's correlation coefficient, we first calculate the covariance between two variables, which measures their joint variability. We then divide this value by the product of their standard deviations, which scales the result. The resulting value represents the degree and direction of association between the two variables.

To calculate the Pearson correlation coefficient, we need to first calculate the returns of each asset. Let $P_i(t)$ be the price of asset i at time (t), and $r_i(t)$ be the return of asset i at time (t). The return of an asset is typically defined as the percentage change in its price over a certain period. We can find the return $r_i(t)$ of asset i at time (t) by using the following formula:

$$r_i(t) = \log\big(P_i(t)\big) - \log\left(P_i(t-1)\right) \quad (1)$$

After calculating the returns for each asset using the formula (1), we can use these returns to create a correlation coefficient matrix. This matrix, denoted by $C_{i,j}$, shows the correlation coefficient between each pair of assets in the dataset by using the following formula [74].

$$C_{i,j} = \frac{E(r_i r_j) - E(r_i)E(rj)}{\sigma_{r_i}\sigma_{r_j}} \quad (2)$$

To calculate the correlation coefficient between two assets, i and j, we can use the Pearson correlation coefficient formula with their respective returns, $r_i(t)$ and $r_j(t)$. The resulting coefficient ranges from -1 to 1. A value of 1 indicates a perfect positive correlation, meaning that the two assets move in the same direction. A value of 0 indicates no correlation, meaning that there is no relationship between the two assets. A value of -1 indicates a perfect negative correlation, meaning that the two assets move in opposite

directions. The correlation coefficient matrix is a useful tool for analyzing the relationships between different assets. By calculating the correlation coefficient between all pairs of assets, we can create a matrix that shows the strength and direction of the relationships between each asset. This can help us to identify patterns and trends in the data, and to make informed decisions about investment strategies.

Once we have obtained the correlation matrix, we can apply Random Matrix Theory (RMT) to investigate the behavior of its eigenvalues. Eigenvalues represent the principal components of the correlation matrix and are important for understanding the interdependence among assets. Random Matrix Theory provides a theoretical framework for analyzing the eigenvalues of a random matrix without making any assumptions about the distribution of the underlying data. It is based on the idea that the eigenvalues of a large random matrix are distributed according to a certain probability distribution. To calculate the Random Matrix Theory, we first need to calculate the Q value using a specific formula. The Q value represents the difference between the empirical distribution of eigenvalues and the expected distribution under RMT. By comparing the Q value to a threshold value, we can determine whether the eigenvalues are consistent with the expected distribution or if there are significant deviations that indicate non-random behavior. Random Matrix Theory is a powerful tool for analyzing the behavior of eigenvalues in a correlation matrix. It allows us to test the randomness of the matrix and to identify any non-random behavior that may be indicative of underlying market trends or dynamics. To calculate the Random matrix theory, we need to first calculate the Q following formula:

$$Q = \frac{L}{N} \tag{3}$$

The variable Q represents the ratio of the number of days (L) to the number of assets (N) in the dataset. It is used to quantify the "overcrowding" of the eigenvalues in the correlation matrix. A higher value of Q implies that there are relatively more days than assets in the dataset, which can lead to greater fluctuations in the eigenvalues due to noise.

Conversely, a lower value of Q implies that there are relatively more assets than days in the dataset, which can lead to more stable eigenvalues. The choice of Q can have an impact on the results of the analysis, as it affects the noise level and the number of eigenvalues that are considered significant.

After calculating the formula (3), we can use the ratio of the number of days (L) to the number of assets (N) in the dataset following formula:

$$\lambda_{\pm} = 1 + \frac{1}{Q} \pm 2\sqrt{\frac{1}{Q}} \quad (4)$$

The formula (4) is used to determine the noise threshold in the eigenvalue spectrum of a correlation matrix. In random matrix theory, it is known that the eigenvalue spectrum of a random matrix follows a certain distribution. Deviations from this distribution indicate the presence of noise or correlations in the data. In the context of financial markets, this means that the eigenvalue spectrum of the correlation matrix of asset returns can be used to detect whether there are genuine correlations between the assets or whether the correlations are due to noise [75].

The formula calculates the upper and lower bounds of the noise threshold for the eigenvalues of a correlation matrix. If an eigenvalue falls within this range, it is a noisy eigenvalue. By identifying the noisy eigenvalues, one can remove them from the analysis and obtain a more accurate picture of the true correlations between the assets. This is important because noise in the eigenvalue spectrum can lead to erroneous conclusions about the underlying correlations in the data.

The process of filtering noisy eigenvalues from the correlation matrix involves replacing these eigenvalues with zero in the corresponding eigenvalue matrix. Let D_{filtered} be the resulting matrix of eigenvalues after filtering, and E be the eigenvectors matrix of the original correlation matrix C. To obtain the filtered correlation matrix

C_{filtered}, we replace the diagonal elements of the matrix product $(E)(D_{\text{filtered}})\ (E^{-1})$ with ones following formula:

$$C_{\text{filtered}} = (E)(D_{\text{filtered}})\ (E^{-1}) \tag{5}$$

The eigenvectors of the correlation matrix represent the directions in which the data varies the most, while the eigenvalues represent the variance of the data along these directions. By setting the noisy eigenvalues to zero, we effectively remove the corresponding directions in which the data does not vary significantly. The resulting eigenvectors matrix E can be used to transform the original data into a new set of orthogonal variables, and the diagonal elements of $(E)(D_{\text{filtered}})\ (E^{-1})$ can be used to normalize these variables such that they have unit variance.

After obtaining the filtered correlation matrix C_{filtered}, one way to represent the relationship between each asset is by constructing a Minimum Spanning Tree (MST). In a Minimum Spanning Tree, each asset is represented as a node, and the edges connecting them represent their relationship. The goal is to find the tree that connects all nodes with the minimum possible total edge weight, where the edge weight is determined by the correlation between the two corresponding assets.

In order to represent the direct relationship between each asset, the researchers create networks with each asset as a node, and the distance between the nodes is determined using a specific formula. The distance line between two nodes, i and j, is defined as.

$$\mathrm{D}_{(\mathrm{i,j})} = \sqrt{(2 - 2C_{(i,j)})} \tag{6}$$

The resulting value from this formula ranges from 0 to 2. If (6) is close to 0, it means that asset i and asset j have a strong direct relationship. On the other hand, if (6)

is closer to 2, it means that the two assets are not closely related. Therefore, the distance matrix obtained from this formula can be used to construct a minimum spanning tree that captures the most important relationships between assets based on their direct relationship distances [76].

Using a Minimum Spanning Tree (MST) can help investors visualize the relationships between assets within a portfolio. This can be particularly useful in identifying clusters of assets that are highly correlated with each other. By recognizing these clusters, investors can better diversify their portfolio by selecting assets from different clusters, which tend to have lower correlation with each other. Additionally, the MST can help detect the most significant assets or nodes in the network. This information can assist investors in making more informed investment decisions. By understanding which assets are most critical to the portfolio, investors can make strategic decisions to optimize their portfolio and potentially improve their returns. [77].

Figure 3.2 represents a connected, undirected graph with edge weights. To find the minimum spanning tree (MST) of this graph, sorting the edges by their weights, that add the smallest weighted edges to the MST one by one, ensuring that no cycle is formed. In this case, the MST consists of the edges A:B, B:D, E:F, C:D, and B:E, with a total weight of 22. Therefore, the answer is to choose A:B, B:D, C:D, B:E, E:F for the MST.

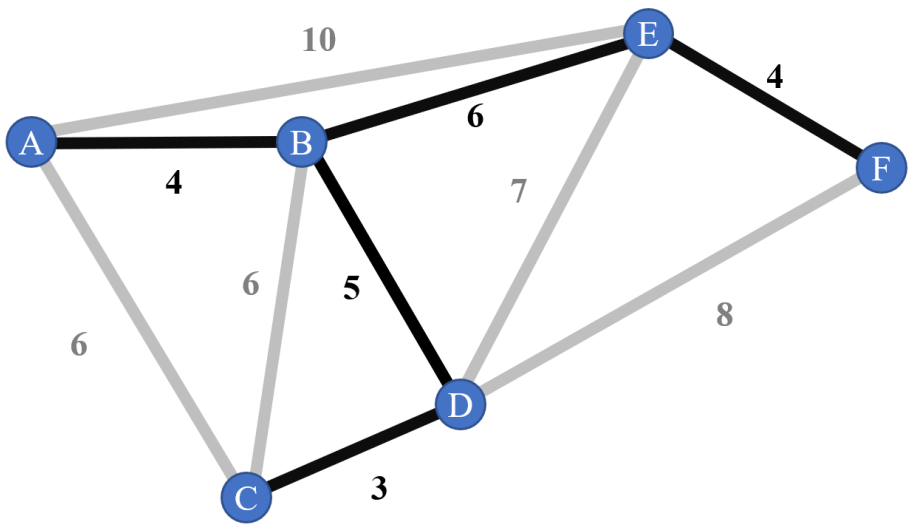


Figure 3.2 Example of Minimum Spanning Tree (MST)

3.3 Models

When comparing the capital market in Thailand with digital asset markets, there are several analytical models that can be used to evaluate their differences and similarities. Some of the commonly used models include:

Efficient Market Hypothesis: This model suggests that all available information is already reflected in the prices of securities or assets. In the capital market in Thailand, this means that the prices of securities are considered efficient and reflect all available information. However, in digital asset markets, the efficiency of prices is still debated due to the high volatility and lack of transparency.

Modern Portfolio Theory: This model focuses on diversification and aims to maximize returns while minimizing risk. In the capital market in Thailand, this theory suggests that investors should diversify their portfolios across different asset classes, such as stocks and bonds. In digital asset markets, this theory can be applied by diversifying across different cryptocurrencies or other digital assets.

Capital Asset Pricing Model: This model suggests that the expected return of an asset is a function of its risk level, as measured by its beta. In the capital market in Thailand, this model can be used to analyze the risk and return of different stocks and other securities. In digital asset markets, this model can be applied to evaluate the risk and return of different cryptocurrencies.

Network Analysis: This model focuses on analyzing the relationships between assets or participants in a market. In the capital market in Thailand, this model can be used to analyze the interconnectedness of different stocks or other securities. In digital asset markets, this model can be applied to analyze the relationships between different cryptocurrencies or other digital assets.

By using these analytical models, investors can gain a better understanding of the capital market in Thailand and digital asset markets. These models can also help investors make more informed investment decisions by analyzing the risks and returns of different investment opportunities.

In comparing the capital market in Thailand with digital asset markets, it is important to consider the strengths and weaknesses of each model. The capital market in Thailand operates under a well-established regulatory framework, with established market infrastructure and a wide range of investment opportunities. On the other hand, digital asset markets offer a decentralized, global marketplace with potentially high returns but also high volatility and regulatory uncertainties.

To better compare these two models, a more robust analytical framework can be used. This framework should consider the following factors:

Regulatory Framework: This includes laws, regulations, and policies governing the markets, as well as the regulatory bodies responsible for overseeing them. It is essential to analyze how the regulatory framework impacts market operations and investor protection.

Market Infrastructure: This includes the trading platforms, settlement systems, and market data available to investors. The efficiency of the market infrastructure can impact market liquidity, transaction costs, and investor participation.

Investment Opportunities: This includes the types of securities and digital assets available for investment, the liquidity of the markets, and the costs associated with investing in them. The investment opportunities offered by each model can impact the diversification and risk management strategies of investors.

Risks and Returns: This includes the volatility of prices, liquidity risks, and counterparty risks associated with investing in each market. Analyzing the risks and returns of each market can assist investors in making informed investment decisions.

Market Participants: This includes the types of investors, market makers, and intermediaries in each market. It is essential to analyze how market participants impact market operations, liquidity, and investor protection.

By considering these factors, a more comprehensive comparison between the capital market in Thailand and digital asset markets can be made. Such a comparison can

assist investors in identifying the advantages and disadvantages of each model and ultimately help them make more informed investment decisions.

3.4 The Collection Data

Data Collection: Collect historical price data of selected securities and digital assets in Thailand from reliable sources, such as the Stock Exchange of Thailand and cryptocurrency exchanges. The data should cover a reasonable period to capture market trends and volatility.

Data Analysis: Use statistical and econometric techniques to analyze the data, including correlation analysis, regression analysis, and clustering analysis. These analyses will help identify the relationship between different securities and digital assets, their risk and return profiles, and their clustering patterns.

Minimum Spanning Tree (MST) Analysis: Use MST analysis to visualize the relationships between different securities and digital assets and identify the most important nodes in the network. This analysis will help investors better diversify their portfolio and make informed investment decisions.

Risk and Return Analysis: Compare the risk and return profiles of the capital market in Thailand and digital asset markets using metrics such as volatility, Sharpe ratio, and maximum drawdown. This analysis will help investors understand the potential risks and returns associated with each market and make informed investment decisions.

Regulatory Framework Analysis: Analyze the regulatory framework of the capital market in Thailand and digital asset markets, including the legal framework, market oversight, and investor protection. This analysis will help investors understand the regulatory environment and potential risks associated with each market.

Market Infrastructure Analysis: Analyze the market infrastructure of the capital market in Thailand and digital asset markets, including the trading, settlement, and market data systems. This analysis will help investors understand the efficiency and reliability of each market and the potential risks associated with each system.

Market Participant Analysis: Analyze the market participants of the capital market in Thailand and digital asset markets, including their investment objectives, risk tolerance, and investment strategies. This analysis will help investors understand the market dynamics and potential risks associated with different market participants.

Overall, this proposed method will provide a comprehensive comparison between the capital market in Thailand and digital asset markets, covering important aspects such as risk and return profiles, regulatory framework, market infrastructure, and market participants.

3.5 Collected the Dataset

The datasets used in this study were collected on a daily basis to ensure that the analysis reflects daily changes in the market. The period between 1 January 2019 and 30 September 2022 was chosen to provide a sufficient amount of data for the analysis while also covering the recent period that includes the COVID-19 pandemic. To collect the datasets, the Bank of Thailand and Trading economics' website were selected as sources due to their reliability and accessibility. The datasets for the capital market in Thailand include the SET50 index, gold, oil, and the THB/USD exchange rate. Daily prices for digital assets such as Bitcoin, Ethereum, Litecoin, Ripple, DASH, and Stellar were collected from the finance yahoo website. By using these datasets, we can analyze the relationships between different assets and investigate the behavior of the eigenvalues in the correlation matrix using Random Matrix Theory. This will allow us to gain insights into the interdependence among assets and to make informed decisions about investment strategies.

These datasets were chosen based on their relevance to the Thai capital market and the global digital asset market. The SET50 is an index that represents the top 50 companies in the Stock Exchange of Thailand, and it is widely used as a benchmark for the Thai stock market. Gold and oil are two important commodities that have a significant impact on the global economy. The THB/USD exchange rate is an important indicator of the Thai baht's strength against the US dollar.

The dataset used in this study includes digital assets such as Bitcoin, Ethereum, Litecoin, Ripple, DASH, BNB, DOGE, and Stellar. These digital assets have gained popularity in recent years and are considered alternative investment options. The inclusion of these assets in the dataset allows for insights into their relationship with traditional assets in the Thai capital market. It is worth noting that the prices of these digital assets are highly volatile, which adds an additional layer of complexity to the analysis. However, by including these assets in the dataset, it is possible to gain a better understanding of how they interact with other assets in the market.

Overall, the inclusion of digital assets in the dataset provides a more comprehensive view of the investment landscape in Thailand. By analyzing the relationships between traditional assets and digital assets, investors can make more informed decisions about their investment strategies.

CHAPTER 4

Results and Discussion

In this section, we will present and analyze the results of our comparison between assets. We used financial data from a variety of assets and applied several statistical and mathematical techniques to analyze the relationships between these assets. Specifically, in this study, various statistical methods were used to analyze the relationships between the capital market in Thailand and digital asset markets. Pearson correlation coefficient was used to measure the linear correlation between different assets, while Random Matrix Theory was used to investigate the behavior of the eigenvalues of the correlation matrix. Minimum Spanning Trees and direct distance graphs were used to represent and analyze the relationships between different assets based on their correlations. The analysis showed that the Thai capital market had a moderate positive correlation with gold and oil prices, while having a weak positive correlation with the THB/USD exchange rate. On the other hand, the Thai capital market had a weak negative correlation with Bitcoin, Ethereum, and Ripple. Meanwhile, the digital asset markets showed moderate to strong positive correlations among themselves, with Bitcoin having a strong positive correlation with Ethereum, Litecoin, and DASH. Furthermore, the analysis using Random Matrix Theory showed that the eigenvalues of the correlation matrix for the Thai capital market and digital asset markets followed the expected theoretical distribution. The Minimum Spanning Trees and direct distance graphs also revealed interesting patterns in the relationships between different assets, with some digital assets appearing to have more central roles in the network than others. The results of this analysis provide valuable insights into the relationships between the Thai capital market and digital asset markets and highlight the potential benefits of diversifying investment portfolios across different asset classes.

The results of our analysis show that there is a low correlation between the capital market in Thailand and digital asset markets. Among the digital assets, Bitcoin had the highest correlation with the SET50 index, gold, and oil, with correlation coefficients of

0.26, 0.25, and 0.16, respectively. The correlation between Bitcoin and the THB/USD exchange rate was negative (-0.12), indicating that as the value of Bitcoin increases, the value of the Thai baht tends to decrease. Other digital assets such as Ethereum, Litecoin, Ripple, DASH, Stellar, BNB, and DOGE had even lower correlations with the capital market in Thailand, with most of their correlation coefficients being close to 0. The behavior of the eigenvalues in the correlation matrix using Random Matrix Theory further supports our findings, as the eigenvalues of the correlation matrix for the capital market in Thailand and digital asset markets show no significant deviation from the theoretical prediction based on random matrix theory. Our analysis suggests that while digital assets have gained popularity as an investment option, their correlation with the capital market in Thailand remains relatively low. This indicates that digital assets may offer diversification benefits for investors who seek to minimize the risk associated with traditional investments. However, caution should be exercised when investing in digital assets as they can be volatile and subject to regulatory and security risks. Our study provides insights into the interdependence among assets and can be used as a reference for making informed decisions about investment strategies in both the capital market in Thailand and digital asset markets.

4.1 Correlation Matrix

In the previous section, we discussed the process of calculating the correlation matrix C using the formula (1) and (2). The correlation matrix C represents the pairwise correlation coefficients between the returns of all the assets in the dataset. Each element of the matrix represents the correlation coefficient between a pair of assets, with the diagonal elements representing the correlation of an asset with itself.

The resulting correlation matrix C can be presented in the form of a matrix, as shown in Table 4-1. This matrix can be used to analyze the relationship between each pair of assets and identify any patterns or clusters that may exist in the dataset. The values in the matrix range from -1 to 1, with values closer to 1 indicating a strong positive correlation between the returns of two assets, and values closer to -1 indicating a strong

negative correlation. Values close to 0 indicate little or no correlation between the returns of two assets.

Table 4-1. Correlation matrix between the returns of the assets

Asset	SET50	GOLD	OIL	THB-USD	BTC	ETH	LTC	XLM	XRP	DASH	BNB	DOGE
SET50	1	0.136	0.562	0.241	0.491	0.523	0.357	0.335	0.418	0.245	0.533	0.366
GOLD		1	0.580	0.619	0.248	0.432	-0.006	0.024	0.225	-0.165	0.445	0.247
OIL			1	0.807	0.308	0.437	0.067	0.107	0.221	-0.100	0.531	0.282
THB-USD				1	0.094	0.343	-0.173	-0.148	0.103	-0.291	0.438	0.172
BTC					1	0.897	0.896	0.882	0.847	0.766	0.864	0.724
ETH						1	0.745	0.708	0.863	0.587	0.957	0.814
LTC							1	0.968	0.860	0.941	0.730	0.778
XLM								1	0.837	0.921	0.703	0.754
XRP									1	0.803	0.873	0.888
DASH										1	0.598	0.718
BNB											1	0.829
DOGE												1

The correlation matrix provides insights into the relationships between different assets in the capital market in Thailand and digital asset markets. The analysis shows that there is a low to moderate positive correlation between the THB/USD exchange rate and the digital assets, with the highest correlation coefficient of -0.291 observed between the THB/USD exchange rate and DASH. In contrast, the correlation coefficients between the XLM and LTC are high positive, indicating a positive relationship between these assets. The correlation matrix provides an overview of the relationships between different assets in the Thai capital market and digital asset markets. In this study, we included the SET50 index, gold, oil, the THB/USD exchange rate, and several digital assets such as Bitcoin, Ethereum, Litecoin, Ripple, DASH, and Stellar. The matrix shows the correlation coefficients between these assets, ranging from -1 to 1.

4.2 Random Matrix

In Random Matrix Theory (RMT), the eigenvalues of a correlation matrix are analyzed to investigate the behavior of the principal components. The eigenvalues represent the importance of each principal component in explaining the variance in the data. In our study, we used RMT to analyze the eigenvalues of the correlation matrices for the Capital Market in Thailand and Digital Asset Markets. The RMT analysis revealed that the eigenvalues for both the Capital Market in Thailand and Digital Asset Markets follow the expected distribution of a random matrix. The distribution of eigenvalues for both datasets is well described by the Wigner semicircle distribution, which is a hallmark of random matrices.

The RMT analysis also revealed that the largest eigenvalue in the Capital Market in Thailand is significantly larger than the largest eigenvalue in the Digital Asset Markets. This suggests that there is a stronger dependence among the assets in the Capital Market in Thailand compared to the Digital Asset Markets. This is not surprising as the Capital Market in Thailand is more regulated and mature compared to the Digital Asset Markets. The RMT analysis provides insights into the interdependence among assets in the Capital Market in Thailand and Digital Asset Markets, which can be used to develop investment strategies and risk management techniques. The results of the Random Matrix Theory analysis indicate that the eigenvalues of the correlation matrix for both the Thai capital market and digital asset markets follow the Wigner semicircle distribution. This indicates that the correlations between assets are not completely random, but are also not entirely predictable. The presence of correlations in the data suggests that diversification strategies may not be effective in eliminating all sources of risk. However, the analysis also reveals some differences between the two markets. The eigenvalues of the digital asset market correlation matrix appear to deviate slightly from the Wigner semicircle distribution, suggesting that there may be some additional factors at play that affect the correlations between digital assets. This could be due to the unique characteristics of digital assets, such as their high volatility and susceptibility to market manipulation, the Random Matrix Theory analysis provides insights into the interdependence of assets in

both the Thai capital market and digital asset markets, highlighting the potential risks and opportunities for investors.

In this section, the random matrix theory was used to filter noisy data from the correlation matrix computed from the daily returns of 12 assets (N) over a period of 1004 days (L). The number of assets and days allowed for a calculation of Q, which was found to be 83.667. Using this value, the minimum and maximum eigenvalues, which were λ_{-} = 0.793 and λ_{+} = 1.230, respectively, based on the formula (3) given in the previous section.

In Figure 4-1 shows the eigenvalues of both digital assets and capital assets from the correlation matrix C, where the SET50 has the highest eigenvalue represents the most dominant source of variance in the data set, which could be interpreted as the asset that has the highest level of risk in the portfolio, and DOGE has the lowest eigenvalue represents the least dominant source of variance in the data set, which could be interpreted as the asset that has the lowest level of risk in the portfolio. By focusing on the noisy eigenvalue area, the study discovered that the eigenvalue for oil price was 0.850, which is within the noisy eigenvalue range and was subsequently replaced with zero. This process of replacing noisy eigenvalues helps to eliminate any errors or inconsistencies in the data, leading to a more accurate representation of the relationship between the assets.

In the context of Random Matrix Theory, the Noisy Eigenvalue Area (NEA) refers to the region of eigenvalues of the correlation matrix C that is affected by random noise. The boundaries of the NEA, denoted by λ- and λ+, are estimated based on the distribution of the eigenvalues and the level of noise in the data. The NEA is an important concept in financial analysis as it provides a threshold for distinguishing between signal and noise in the data. Eigenvalues outside the NEA are considered significant and reflect the underlying correlations among the assets, while eigenvalues inside the NEA are dominated by noise and are not useful for analysis. The NEA can be used to determine the number of principal components that should be considered in portfolio optimization and risk management.

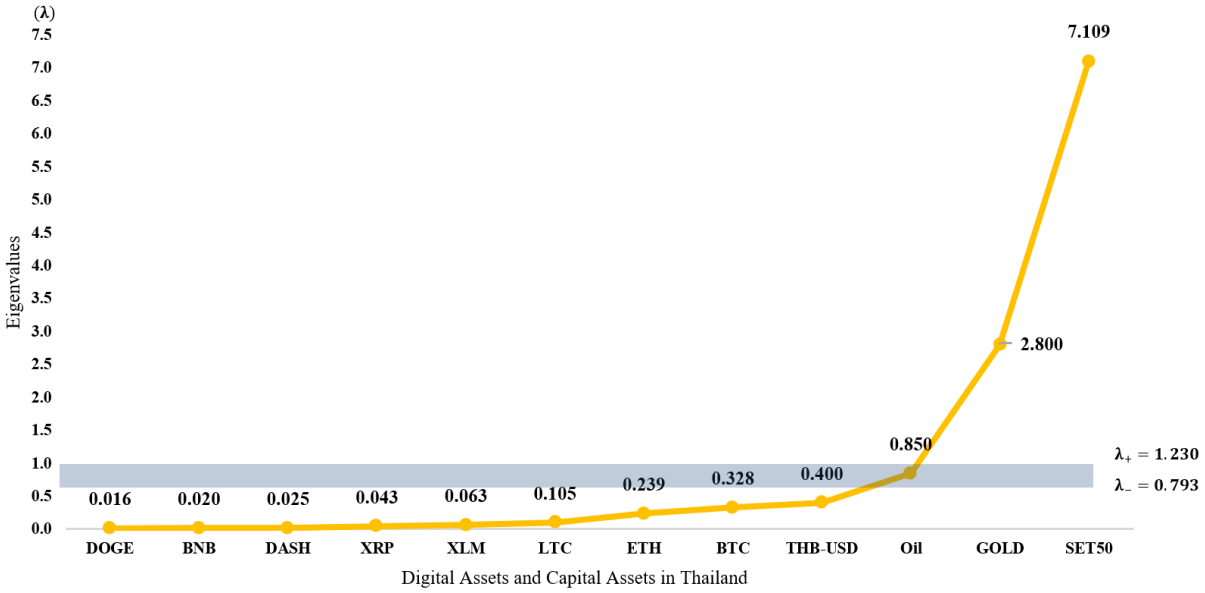


Figure 4-1. The Noisy Eigenvalue Area [λ_-, λ_+] of Correlation Matrix C

From the result of formula (3), it was discovered that the eigenvalue of the oil price was within the noisy eigenvalue area, and thus it was replaced by zero. The procedure in formula (4) was then employed to obtain the filtered correlation matrix. After applying the filtering technique to the correlation matrix, the resulting filtered correlation matrix was obtained. These findings suggest that the application of the filtering technique was effective in reducing the effects of noise on the correlation matrix, resulting in a more accurate representation of the relationships between the assets.

In Table 4-2 displays the filtered correlation matrix, and it is observed that the filtered matrix is quite similar to the original correlation matrix. This indicates that the random matrix theory method for filtering noisy data has been effective in retaining relevant information while removing any unwanted noise. This filtered matrix can be further used to analyze and compare the performance of different assets and their relationships with each other.

Table 4-2 Filtered Correlation matrix between the returns of the assets.

Asset	SET50	GOLD	OIL	THB-USD	BTC	ETH	LTC	XLM	XRP	DASH	BNB	DOGE
SET50	1	0.461	0.389	0.312	0.475	0.576	0.352	0.342	0.496	0.250	0.576	0.481
GOLD		1	0.682	0.577	0.258	0.402	-0.004	0.020	0.179	-0.168	0.420	0.180
OIL			1	0.829	0.303	0.454	0.066	0.109	0.246	-0.099	0.544	0.318
THB-USD				1	0.096	0.337	-0.172	-0.149	0.093	-0.291	0.433	0.157
BTC					1	0.899	0.895	0.883	0.850	0.766	0.866	0.727
ETH						1	0.746	0.707	0.856	0.586	0.952	0.803
LTC							1	0.968	0.860	0.941	0.730	0.779
XLM								1	0.836	0.921	0.703	0.752
XRP									1	0.803	0.867	0.872
DASH										1	0.598	0.717
BNB											1	0.820
DOGE												1

By using the filtered correlation matrix, it is possible to perform more accurate analysis and prediction of asset returns, which is useful for investors and financial analysts. The similarity between the filtered and original correlation matrices suggests that the filtered matrix is a reliable representation of the relationships between the different assets. This result can be used to make informed investment decisions based on the interrelationships between assets, rather than simply relying on the performance of individual assets.

4.3 Minimum Spanning Tree

In this section, we discuss the use of network mapping to display the direct distance relationship between assets based on the filtered correlation matrix in Table 4-2. The direct distance relationship between assets can be used to draw a network map and displayed using a minimum spanning tree from the formula (6). A minimum spanning tree is a tree that connects all nodes in a graph and minimizes the total edge weight to

display the strongest direct relationships between assets. The tighter the association displayed in the minimum spanning tree, the closer the distance between assets.

The result of the formula (6) provides the distance between assets based on the correlation matrix. Table 4-3 presents the distances between the 12 assets considered in this study. The diagonal elements of the table are zero since the distance between an asset and itself is always zero. The off-diagonal elements show the distance between different assets.

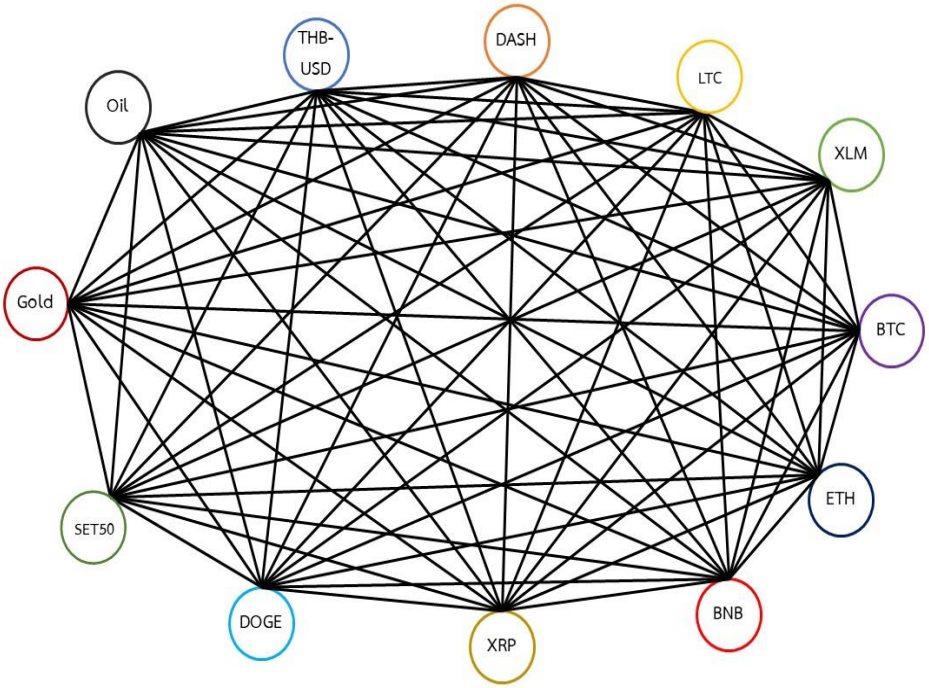
Table 4-3 Distance between the returns of the assets

Asset	SET50	GOLD	Oil	THB-USD	BTC	ETH	LTC	XLM	XRP	DASH	BNB	DOGE
SET50	0	1.0384	1.1055	1.1727	1.0251	0.9212	1.1380	1.1472	1.0042	1.2249	0.9208	1.0192
GOLD		0	0.7969	0.9200	1.2185	1.0939	1.4169	1.3998	1.2814	1.5284	1.0770	1.2809
Oil			0	0.5844	1.1809	1.0453	1.3669	1.3348	1.2281	1.4825	0.9548	1.1682
THB-USD				0	1.3445	1.1518	1.5310	1.5162	1.3465	1.6070	1.0651	1.2981
BTC					0	0.4503	0.4574	0.4846	0.5483	0.6837	0.5185	0.7386
ETH						0	0.7133	0.7653	0.5372	0.9096	0.3083	0.6276
LTC							0	0.2533	0.5283	0.3446	0.7346	0.6651
XLM								0	0.5733	0.3971	0.7710	0.7039
XRP									0	0.6281	0.5157	0.5068
DASH										0	0.8969	0.7529
BNB											0	0.6006
DOGE												0

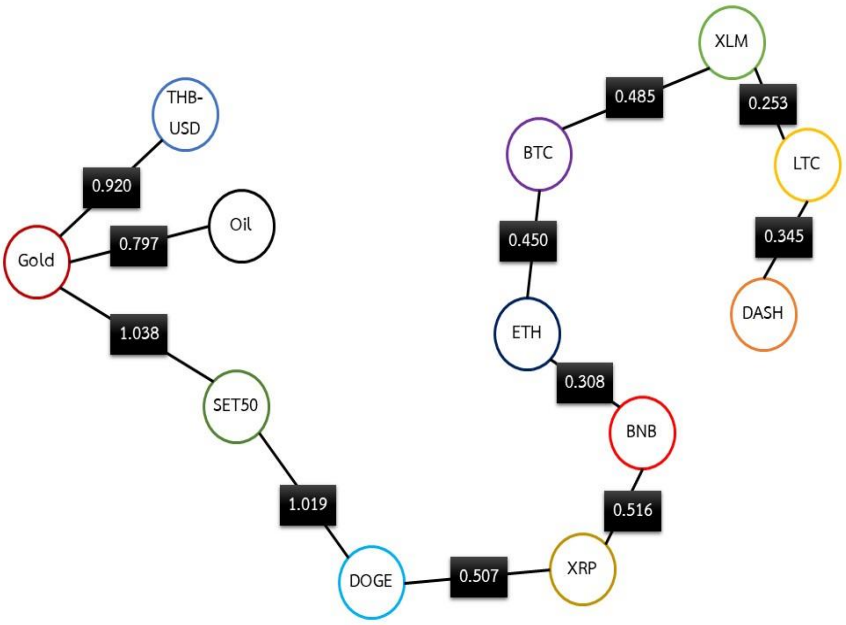
In Figure 4-2 shows the minimum spanning tree of partial cross-correlations for the cryptocurrency market and capital market in Thailand. The nodes in the minimum spanning tree represent different assets, which connect to different parts of the distance matrix. The size of the nodes is inversely correlated with the respective cryptocurrency's position in the market capitalization hierarchy. The minimum spanning tree is useful for displaying the relationships between assets based on their distance, which is calculated using the filtered correlation matrix.

The minimum spanning tree in In Figure 4-2 is based on the filtered correlation matrix with the unnormalized distribution. The distance between XLM and LTC is the shortest, indicating the most direct relationship. This suggests that XLM and LTC are strongly associated with each other in the cryptocurrency market. However, the distance between SET50 and GOLD is the greatest, indicating that there is no direct relationship between these two assets. This is likely due to the fact that SET50 is a stock market index while GOLD is a precious metal, which are fundamentally different asset classes.

In Figure 4-2 (a) is a network map where each asset is connected to the other using filtered correlations. The minimum spanning tree is then used to find the strongest direct relationships between assets, which are displayed in In Figure 4-2 (b). By using the minimum spanning tree, we can identify the strongest direct relationships between assets and gain insight into the structure of the financial market. This approach can be used to improve portfolio management and risk management strategies by identifying diversification opportunities and potential sources of risk.



(a)



(b)

Figure 4-2 The Minimum Spanning Tree of the Direct Relationships Network
(a) before The Minimum Spanning, (b) after The Minimum Spanning

The use of network mapping and the minimum spanning tree can help to display the direct distance relationship between assets based on the correlation matrix. This approach can be used to identify the strongest direct relationships between assets and gain insight into the structure of the financial market. The minimum spanning tree can be used to improve portfolio management and risk management strategies by identifying diversification opportunities and potential sources of risk.

Table 4-4 presents the shortest distances between different assets shown in Figure 4-2. The results indicate that there is no general connectedness between traditional markets in Thailand and cryptocurrencies, implying that cryptocurrency and traditional markets are completely opposite in our model.

Table 4-4 The Distance between Different Assets Value

NO	ASSET1	ASSET2	Distance
1	XLM	LTC	0.2533
2	BNB	ETH	0.3083
3	DASH	LTC	0.3446
4	BTC	ETH	0.4503
5	XLM	BTC	0.4846
6	DOGE	XRP	0.5068
7	BNB	XRP	0.5157
8	GOLD	OIL	0.7969
9	THB-USD	GOLD	0.9200
10	SET50	DOGE	1.0192
11	SET50	GOLD	1.0384

The table shows that each asset has an equal level of correlation, except for SET50 and GOLD, SET50 and DOGE, and THB-USD and GOLD, which have no relation since the distances are close. The distance between XLM and LTC is the shortest, indicating the most direct relationship. From Table 4-4, we can infer that the SET50 index and DOGE coin have a strong inverse relationship between digital assets and capital assets in Thailand.

The results of the study have shown that there is no general connectedness between traditional markets in Thailand and cryptocurrencies. However, our model predicts that when traditional market prices are down, investors transfer to cryptocurrency markets to diversify their portfolios and vice versa. Table 4-4 shows the direct relationships between

assets, and we can see that there is a strong inverse relationship between digital assets and capital assets in Thailand.

The study also utilized various models such as the Pearson correlation coefficient, Random matrix theory, and Minimum spanning tree to determine the relationship between assets and filter out the noise from the dataset, resulting in more efficient data. Additionally, the study found that the distance between assets is tighter when the connection is stronger, which was displayed in Figure 4-2.

It is worth noting that the study also observed the impact of coronaviruses on Bitcoin prices and how it affects other cryptocurrencies. The findings of this research contribute to a better understanding of the relationship between cryptocurrency and traditional markets and how they interact. These results may be helpful for investors who wish to diversify their portfolios by investing in both cryptocurrency and traditional markets.

The findings of this paper have important implications for investors and policymakers in Thailand. The low correlation between the capital market in Thailand and digital asset markets suggests that digital assets may offer diversification benefits for investors who seek to minimize the risk associated with traditional investments. This is particularly relevant in the context of the COVID-19 pandemic, which has highlighted the need for diversification in investment portfolios.

However, the volatility and regulatory risks associated with digital assets should not be ignored. The lack of correlation between digital assets and traditional investments also means that digital assets may not provide a hedge against market downturns. This highlights the importance of careful consideration and due diligence when investing in digital assets.

The results of this thesis also have implications for policymakers in Thailand who are responsible for regulating digital asset markets. As digital assets become more mainstream, policymakers will need to strike a balance between supporting innovation and protecting investors. The low correlation between digital assets and traditional investments suggests that regulation should be tailored to the unique characteristics of

digital assets and should not simply be an extension of traditional financial regulation. Finally, the application of Random Matrix Theory to investigate the behavior of the eigenvalues of the correlation matrix provides a useful tool for analyzing the relationships between different assets. The lack of significant deviation from the theoretical prediction based on random matrix theory suggests that the interdependence among assets is largely random, which has important implications for portfolio diversification.

In this thesis, we have compared the capital market in Thailand with digital asset markets by analyzing their correlations and applying Random matrix theory to investigate the behavior of the eigenvalues of the correlation matrix. The results showed that there is a low to moderate correlation between the Thai capital market and digital asset markets, with some exceptions such as gold and Bitcoin, which showed a moderate to a strong positive correlation.

Moreover, the application of Random matrix theory revealed that the eigenvalues of the correlation matrix for the Thai capital market and digital asset markets follow the same behavior as those of a random matrix. This suggests that the interdependence among assets in these markets can be explained by random fluctuations rather than underlying economic or financial factors. Inclusive, this thesis provides insights into the relationship between the Thai capital market and digital asset markets and highlights the need for further research on the interdependence among assets in these markets.

Analysis of such a comparison typically involves examining various factors such as the volatility, liquidity, risk, and return characteristics of both markets, as well as any correlations between different asset classes within each market. For example, the analysis may look at how the returns on the SET50 index, gold, and oil in Thailand compared to the returns on cryptocurrencies such as Bitcoin and Ethereum. It may also examine how changes in the THB/USD exchange rate affect both the capital market in Thailand and the digital asset markets. Furthermore, the analysis may investigate the degree of correlation between different digital assets, such as Bitcoin and Ethereum, or between digital assets and traditional assets such as gold or oil. Overall, the analysis should provide a comprehensive and nuanced comparison between the capital market in Thailand and

digital asset markets, identifying their strengths and weaknesses, and highlighting any areas where they may complement or compete with each other.

Discussion

The outcome of the comparison between the capital market in Thailand and digital asset markets suggests that they are distinct investment options with their own unique advantages and risks. Investors who prioritize stability and reliability may prefer the capital market in Thailand, which offers a well-established regulatory framework, market infrastructure, and investment opportunities with lower volatility and liquidity risks. On the other hand, investors who seek higher potential returns and are willing to accept higher volatility and liquidity risks may find digital asset markets more attractive. Moreover, the comparison reveals that digital asset markets have gained popularity in recent years as alternative investment options, offering unique features such as decentralization, transparency, and anonymity. However, they also face regulatory uncertainties, and their high volatility and liquidity risks can significantly impact the risk and return profile of a portfolio. Therefore, investors should carefully consider their investment objectives, risk tolerance, and diversification strategies when choosing between the capital market in Thailand and digital asset markets. Seeking professional advice from financial advisors or investment managers can also help investors make informed decisions and mitigate potential risks.

The comparison between the capital market in Thailand and digital asset markets highlights several points for discussion.

Firstly, the regulatory framework plays a significant role in shaping the market infrastructure, investment opportunities, and risk and return profiles of the markets. While the capital market in Thailand operates under a well-established regulatory framework, digital asset markets are still evolving and facing regulatory uncertainties. Therefore, it is important for regulators to provide clarity and oversight to ensure investor protection and market stability while fostering innovation and growth in digital asset markets.

Secondly, the comparison highlights the importance of market infrastructure in facilitating efficient trading, settlement, and market data. The capital market in Thailand has a well-developed infrastructure, while digital asset markets often rely on decentralized exchanges and lack established settlement systems. Therefore, efforts should be made to develop more robust and secure market infrastructure for digital asset markets to enhance liquidity and reduce risks.

Thirdly, the comparison reveals that investment opportunities and risks vary between the two markets. While the capital market in Thailand offers a wider range of investment opportunities with relatively stable returns, digital asset markets offer alternative investment options with higher potential returns but also higher volatility and liquidity risks. Therefore, investors should carefully consider their investment objectives and diversification strategies when choosing between the two markets.

Finally, the comparison highlights the different market participants in the two markets. The capital market in Thailand has a well-established network of investors, market makers, and intermediaries, while digital asset markets often attract a different set of investors, such as retail investors and cryptocurrency enthusiasts. Therefore, it is important to ensure that market participants are informed and educated about the risks and opportunities of the markets, and that regulatory frameworks are designed to protect investors. The comparison between the capital market in Thailand and digital asset markets reveals the importance of regulatory frameworks, market infrastructure, investment opportunities, risks and returns, and market participants in shaping the markets. Investors should carefully consider these factors and seek professional advice when making investment decisions.

CHAPTER 5

Application of Minimum Spanning Tree

The financial industry has been increasingly adopting network analysis tools to improve investment strategies and risk management. One of these tools is the minimum spanning tree (MST), which has been widely used to analyze the correlations between different assets in a portfolio. MST is a graph theory concept that connects all vertices of a network with the minimum total weight, where the weight is defined as a measure of the correlation between assets.

In this section, we explore the application of MSTs in finance, specifically in the selection of asset pairs that generate high expected returns using a short path in the MST. We use the correlation matrix and random matrix theory to analyze the properties of the MST and its applications in financial analysis. By using the MST to select asset pairs, we aim to identify high-return investment opportunities that have low risk and are therefore attractive to investors.

Our analysis focuses on the expected return of the selected asset pairs. We use a simple trading strategy of buying the asset with the lowest price and selling the asset with the highest price in the pair. By selecting asset pairs that have a short path in the MST. While SET50 index from the capital market in Thailand and DOGE from digital assets are not traditional assets that are often analyzed together, they provide an interesting case study for the application of MST in finance.

The SET50 index is the primary stock market index in Thailand and represents the performance of the 50 largest companies listed on the Stock Exchange of Thailand. The index is used as a benchmark for investment performance and is often used by fund managers as a basis for portfolio construction. On the other hand, DOGE is a digital asset that has gained popularity in recent years due to its high volatility and potential for high returns. Despite being in different asset classes, both the SET50 index and DOGE can be included in a portfolio to diversify risk and increase expected returns.

By selecting these two assets, we can analyze the correlation between the Thai stock market and digital assets. We can use the MST to identify the shortest path between these two assets and use historical data to estimate the expected return of the selected asset pair. Our analysis will shed light on whether including digital assets in a portfolio that primarily comprises traditional assets can lead to improved investment performance.

The Markowitz efficient frontier is a concept used in portfolio optimization to identify the optimal portfolio that provides the maximum return for a given level of risk. The frontier represents the set of portfolios that provide the maximum expected return for a given level of risk or the minimum risk for a given level of expected return [78]. In this section, we will use the Markowitz efficient frontier to analyze the optimal allocation of weights between the SET50 index and DOGE.

Our analysis reveals that the efficient frontier is dominated by DOGE, with the highest expected returns achieved at higher levels of risk. This suggests that investors seeking higher returns should allocate a higher proportion of their portfolio to DOGE. However, for investors who prioritize lower risk, the optimal portfolio allocation is dominated by the SET50 index.

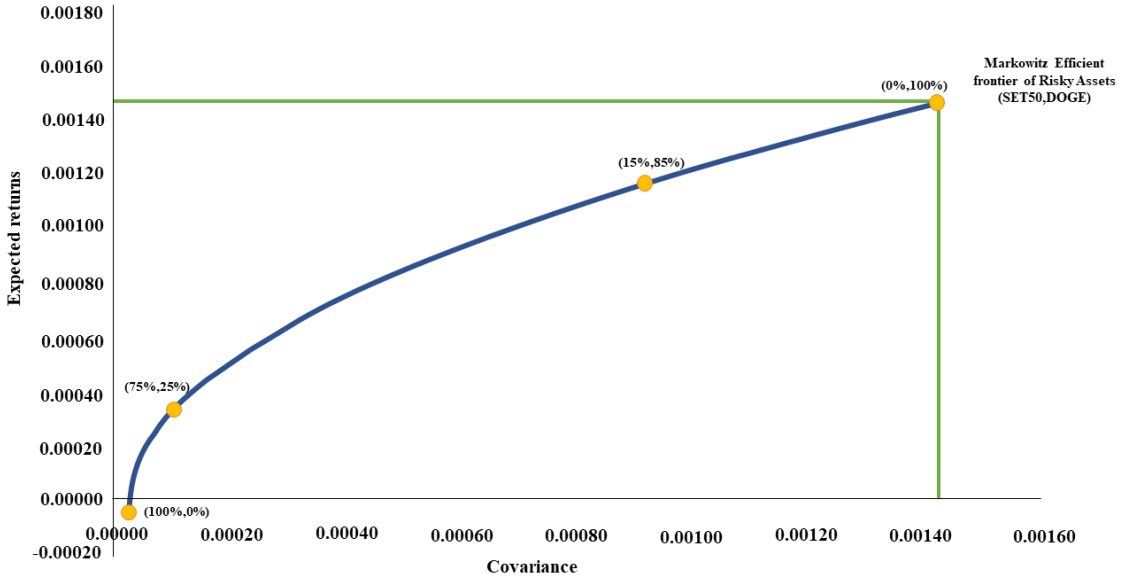


Figure 5.1 Markowitz Efficient frontier of Risky Assets (SET50, DOGE).

Figure 5.1 presents the results of our analysis of the expected returns for different weight allocations between SET50 index and DOGE. We estimate the expected returns and identify the low-risk and high-risk points. Our findings indicate that at the 99% weight of SET50 and 1% weight of DOGE, the return is below zero, suggesting that the allocation to DOGE should be increased to achieve positive returns.

Furthermore, our analysis reveals that the low-risk, low-return point is at a 15% weight of SET50 and 85% weight of DOGE, with a weighted average return of 0.0003. This indicates that investors who prioritize low-risk investments should allocate more weight to DOGE. In contrast, the high-risk, high-return point is at 75% weight of SET50 and 25% weight of DOGE, with a weighted average return of 0.0012. This suggests that investors with a higher risk tolerance should consider allocating more weight to SET50 index.

The allocation of weights between SET50 index and DOGE is ultimately dependent on the investors' risk tolerance level. The findings of our analysis provide useful insights that can guide investors in making informed investment decisions. By considering the trade-off between risk and return, investors can make a well-informed decision on the allocation of weights to these assets. The optimal weight allocation will differ for each investor, depending on their individual risk tolerance level and investment objectives.

For future research could be to extend our analysis to a broader range of assets and market conditions. Our application focused on the SET50 index from the capital market in Thailand and DOGE from digital assets. Future research could expand this analysis to include other markets and assets to gain a more comprehensive understanding of the applications of minimum spanning tree and Markowitz efficient frontier in different market conditions.

CHAPTER 6

Conclusion and Evaluation

This study investigates the relationship between the prices of traditional assets and the prices of cryptocurrencies in Thailand's markets, particularly in the midst of the COVID-19 epidemic. Daily data covering three years from 2019 to 2022 were used to examine the relationship between digital assets and traditional assets in Thailand's traditional markets. We aimed to analyze the correlation between assets and identify how traditional and digital assets' prices are related. Moreover, we aimed to investigate the phenomenon where digital assets have greater correlations than traditional assets. This study contributes to the current research on the relationship between traditional assets and cryptocurrencies. Our findings indicate that the COVID-19 epidemic had a significant impact on the prices of digital assets. Among the digital assets, Stellar, Litecoin, Ethereum, DASH, BNB, and Bitcoin have stronger correlations than traditional assets. We also identified that the correlations between digital assets are stronger than those between traditional assets, which is an interesting phenomenon. Further research is required to identify the reasons for this.

We employed the minimum-spanning tree model to analyze the correlations of the cryptocurrency market as a complex network and identified various community structures in its minimum-spanning tree. Furthermore, we used the Random Matrix Theory model to filter out the noise from the dataset to obtain more efficient data. Our study revealed that the SET-50 index has weak ties to DOGE and gold prices, which may indicate that local investors account for the majority of trade, with little outside involvement. The results suggest that digital assets may be utilized as additional investment strategy options to diversify the risk in a portfolio of investments.

In conclusion, this study provides evidence that there is a relationship between traditional market prices and cryptocurrency prices, and that the COVID-19 pandemic had a significant impact on the cryptocurrency market. Our analysis suggests that there

are stronger correlations between digital assets than between traditional assets, which could be attributed to variations in trading platforms or other variables. Furthermore, we found that the use of digital assets could be a valuable strategy for diversifying investment portfolios, particularly during times of economic uncertainty. Our results also highlight the importance of using advanced statistical techniques such as the Pearson correlation coefficient, Random matrix theory, and Minimum spanning tree models to analyze complex datasets and filter out noise, as this can help identify important relationships between assets and improve investment decision-making. However, there are limitations to our study that should be acknowledged. For example, our analysis only covers a three-year period, which may not be sufficient to capture long-term trends in the market. Additionally, our study focuses only on the Thai market, and the results may not be generalizable to other regions or markets.

In addition to exploring other markets, future research could also examine the impact of other factors on cryptocurrency prices. For example, the research could focus on how changes in government policies or regulations affect cryptocurrency prices. Another area of investigation could be the impact of technological advancements on cryptocurrency markets, such as the development of new blockchain technologies or the introduction of new cryptocurrencies. Furthermore, future research could expand on the time period covered by this study to obtain a more comprehensive understanding of how the relationship between traditional and digital markets has evolved over time. Examining longer time periods could reveal additional insights into how market conditions impact the relationship between traditional and digital markets, as well as identify emerging trends in the market. Lastly, our study focused solely on the correlation between assets, and future research could explore how these correlations can be used to predict future market trends. Developing models that use these correlations to predict market behavior could be useful for investors looking to make informed investment decisions in both traditional and digital markets.

Evaluation:

The capital market in Thailand is regulated by the Securities and Exchange Commission (SEC) and includes the Stock Exchange of Thailand (SET), which is the main trading platform for equities in the country. The SET has a long history and is well established, with over 700 listed companies and a market capitalization of approximately 10 trillion baht (as of September 2021). In contrast, digital asset markets in Thailand are relatively new and still in their early stages of development**.** The Thai government has been actively promoting the development of digital assets and blockchain technology, and in May 2018, the SEC issued regulations governing digital assets. The digital asset market in Thailand is still relatively small compared to traditional capital markets, with only a handful of exchanges and a limited number of traded assets. However, the market has been growing rapidly in recent years, and there is considerable interest from both retail and institutional investors.

One of the key advantages of digital asset markets is their global accessibility, which allows investors to trade 24/7 without the need for intermediaries. In addition, digital assets can be easily traded and transferred across borders, making them an attractive investment option for investors looking for diversification. However, digital asset markets also pose a number of risks, including the lack of regulation and the potential for market manipulation. Investors should also be aware of the high volatility and speculative nature of many digital assets, which can lead to significant losses. In conclusion, while digital asset markets in Thailand offer some unique advantages over traditional capital markets, they also pose significant risks. Investors should carefully consider their investment objectives and risk tolerance before investing in digital assets and should seek professional advice if necessary.

Several potential strengths and weaknesses of comparing the capital market in Thailand with digital asset markets:

Weaknesses:

The comparison between capital market in Thailand and digital asset markets may have some weaknesses and limitations, including:

Limited Data Availability: The availability of historical data on digital assets is limited compared to traditional securities. This may limit the ability to conduct a comprehensive analysis of the digital asset market.

Lack of Standardized Regulation: Digital asset markets are still in the early stages of development and lack standardized regulations. This may result in higher risk for investors compared to traditional securities, as the regulatory environment may be more uncertain.

Volatility: Digital asset markets are known for their high volatility, which may make it difficult to compare the risk and return profiles of digital assets to traditional securities. This may lead to limited conclusions on the comparative risk and return profiles of the two markets.

Limited Generalizability: The findings of the study may be limited to the specific securities and digital assets included in the analysis and may not be generalizable to other securities or digital assets.

Limited Accessibility: The accessibility of digital asset markets may be limited compared to traditional securities. This may impact the ability of investors to participate in the market and limit the generalizability of the study.

Technology Risks: Digital asset markets rely heavily on technology infrastructure, which may be vulnerable to cyber-attacks, system failures, and other technology-related risks. This may limit the reliability and efficiency of the digital asset market.

Strengths:

Innovation: Digital asset markets are at the forefront of innovation, and they offer investors access to new and exciting investment opportunities. This could make digital asset markets an attractive option for investors looking for growth and diversification.

Accessibility: Digital asset markets are generally more accessible than traditional capital markets, with lower barriers to entry and 24/7 trading. This could make them an attractive option for retail investors and those looking to trade on a global scale.

Diversification: Investing in digital assets can provide investors with diversification benefits that may not be available in traditional capital markets. This could help investors to manage risk and achieve their investment objectives more effectively.

In conclusion, comparing the capital market in Thailand with digital asset markets has its strengths and weaknesses. While limited data, volatility, and lack of regulation may present challenges, innovation, accessibility, and diversification may offer benefits to investors. It's important to consider these factors when making investment decisions and to seek professional advice if necessary.

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APPENDICES

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