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ASSESSING ASIAN COUNTRIES' COMPETITIVENESS: TWO-STAGE DEA ANALYSIS OF GLOBAL INNOVATION INDEX AND LOGISTICS PERFORMANCE INDEX INTEGRATION

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Supervisor's signature **Ha Noi, August 2023**

Thesis's Authors

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ABSTRACT

Competitiveness is pivotal in policymaking and research, molding a nation's economic prowess. It involves institutions, policies, and factors that mold global success. Unravelling productivity drivers is vital for policymakers, necessitating a multi-faceted competitive assessment.

This study gauges Asian countries' competitiveness, merging the Global Innovation Index (GII) and Logistics Performance Index (LPI). Via Data Envelopment Analysis (DEA) models - Super Slack-Based Measure (Super SBM) and Malmquist, competitiveness among 30 Asian nations from 2012 to 2018 is thoroughly evaluated.

Validation of seven key GII and LPI factors as vital competitive dimensions initiate the research. Super-SBM measures competitiveness efficiency across these countries. DEA-Malmquist scrutinizes shifts in productivity and competitiveness, revealing change-inducing factors. Combining these models unveils holistic competitiveness dynamics. Results expose Asian countries' competitive efficiency, highlighting leaders like China, Pakistan, and Kuwait. Areas for growth are pinpointed for countries with lower competitiveness. Yearly disparities underscore competitiveness' fluid nature. Implications guide governments and policymakers, steering effective strategies. Insights from competitiveness evaluation inform innovation, logistics, and economic growth policies.

In summary, this study amalgamates GII and LPI to assess Asian competitiveness comprehensively. DEA-Super SBM and DEA-Malmquist unveil efficiency and productivity trends. Findings enrich policymakers' understanding, steering strategies for Asian economic development.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF CHARTS

ABBREVIATIONS AND ACRONYMS LIST

Abbreviation	Full definition
DEA	Data Envelopment Analysis
Super-SBM	Super Slacks-Based Measure
DMU	Decision-Making Unit
GII	Global Innovation Index
WTO	World Trade Organization
LPI	Logistics Performance Index
CU	Catch-Up
FS	Frontier-Shift
BCC	Banker-Charners-Cooper
CCR	Charners-Cooper-Rhodes
GCI	Global Competitiveness Index
WIPO	World Intellectual Property Organization
MPI	Malmquist Productivity Index
IDT	Innovation-Driven Theory
TFT	Trade Facilitation Theory
R&D	Research And Development
INSEAD	Institut Européen d'Administration Des Affaires

CHAPTER 1: INTRODUCTION

1.1. Topic Background

1.1.1. Competitiveness of countries

Nowadays, countries' competitiveness plays a highly significant role in affirming the position of a country in the international arena. The significance of competitiveness lies in its pivotal contribution to a country's economic performance, as it profoundly influences the nation's capacity to attain sustainable economic growth and enhance the welfare of its citizens. The European Commission (2004) defines competitiveness as the capacity of an economy to deliver valuable goods and services that improve the standard of living and employment opportunities for its population. By delivering high-quality products and services, nations can bolster their global competitiveness, attracting domestic and foreign investments, stimulating innovation and productivity, and fostering comprehensive economic development. Moreover, a competitive economy is characterized by its adeptness at adapting to evolving market conditions, embracing technological advancements, promoting research and development, and cultivating a skilled workforce. These factors collectively contribute to the sustenance of competitiveness and the attainment of long-term prosperity. Policy interventions aimed at fortifying competitiveness often encompass initiatives to enhance education and training systems, improve infrastructure networks, streamline regulatory frameworks, facilitate access to financial resources, foster entrepreneurship, and promote international trade and collaboration. Placing a central emphasis on competitiveness enables countries to create an environment conducive to economic growth, job creation, and improving living standards for their populations.

Critical determinants influence country's competitiveness, including social infrastructure and political institutions, monetary and fiscal policy, and the microeconomic environment (Delgado *et al.,* 2012). These determinants collectively shape a nation's capacity to attract investments, foster entrepreneurship, stimulate productivity growth, and establish sustainable economic development. Social infrastructure, including education, healthcare, and social welfare systems, contributes to competitiveness by equipping individuals with the skills and knowledge necessary for economic growth and innovation. Additionally, well-functioning political institutions that uphold the rule of law, ensure transparency, and protect property rights facilitate ease of doing business, encourage investment, and promote entrepreneurial activity. Stable monetary policies, characterized by low inflation and effective exchange rate management, promote investment, trade, and economic stability. Effective fiscal policies that balance government spending, taxation, and public debt management create a favourable macroeconomic environment that encourages long-term investment and economic growth. The microeconomic environment, encompassing market competition, business regulations, and access to finance, significantly impacts competitiveness—competitive markets with efficient regulatory frameworks and intellectual property protection foster innovation, productivity growth, and efficiency.

Ülengin et al. (2011) explored the relationship between national competitiveness and the human development index (HDI). Thus, Sergi et al. (2021) determined the interrelationship between the LPI and the Global Competitiveness Index (GCI). Previous research also has shown the appropriateness of these indicators. Global innovation is worth mentioning as it indicates national competitiveness (Pudelko and Mendenhall, 2009). In addition, the assessment was collaboratively developed by Cornell University's SC Johnson College of Business, INSEAD, and the World Intellectual Property Organization (WIPO) (2020) to evaluate multiple dimensions of a country's innovation ecosystem.

1.1.2. Important of Global Innovation Index

Innovation is crucial for driving economic progress and fostering competitiveness, pivotal in developed and developing economies. Recognizing this, many governments have strategically placed innovation at the forefront of their growth strategies. In line with this perspective, the GII is a remarkable tool for measuring innovation while providing a rigorous statistical benchmark. It aims to comprehensively capture the intricate dynamics of national innovation ecosystems, enabling a more holistic assessment.

The GII is a yearly assessment that ranks countries based on their capacity for and accomplishments in innovation. It is published by the WIPO, an international organization dedicated to intellectual property rights. The GII project was initiated in 2007 by Soumitra Dutta at INSEAD. In 2011, WIPO joined forces with the GII, becoming a co-publisher of the index starting in 2012. In the following year, Cornell University also became a co-publisher. The collaboration between Cornell University, INSEAD, and WIPO continued until 2020. However, since 2021, WIPO has taken over the publication of the GII, partnering with the Portland Institute, various corporate and academic network partners, and the GII Advisory Board (Global Innovation Index, 2023).

The GII considers various factors when evaluating a country's innovation performance (Carpita and Ciavolino, 2017). These dimensions encompass investment in research and development. The assessment also considers the quality of scientific publications, the volume of patent applications filed, and the calibre of innovation outputs as essential indicators to gauge a country's innovation environment. The GII comprises sub-indices called Innovation Input and Innovation Output (**Figure 1.1**). Each sub-index consists of specific conditions that innovators need to fulfil. These conditions are categorized into five prerequisites: Institutions, Human Capital and Research, Infrastructure, Market Sophistication, and Business Sophistication, which serve as inputs. Innovation outputs are captured through the components of the Knowledge and Technology Outputs and Creative Outputs (Carpita and Ciavolino, 2017).

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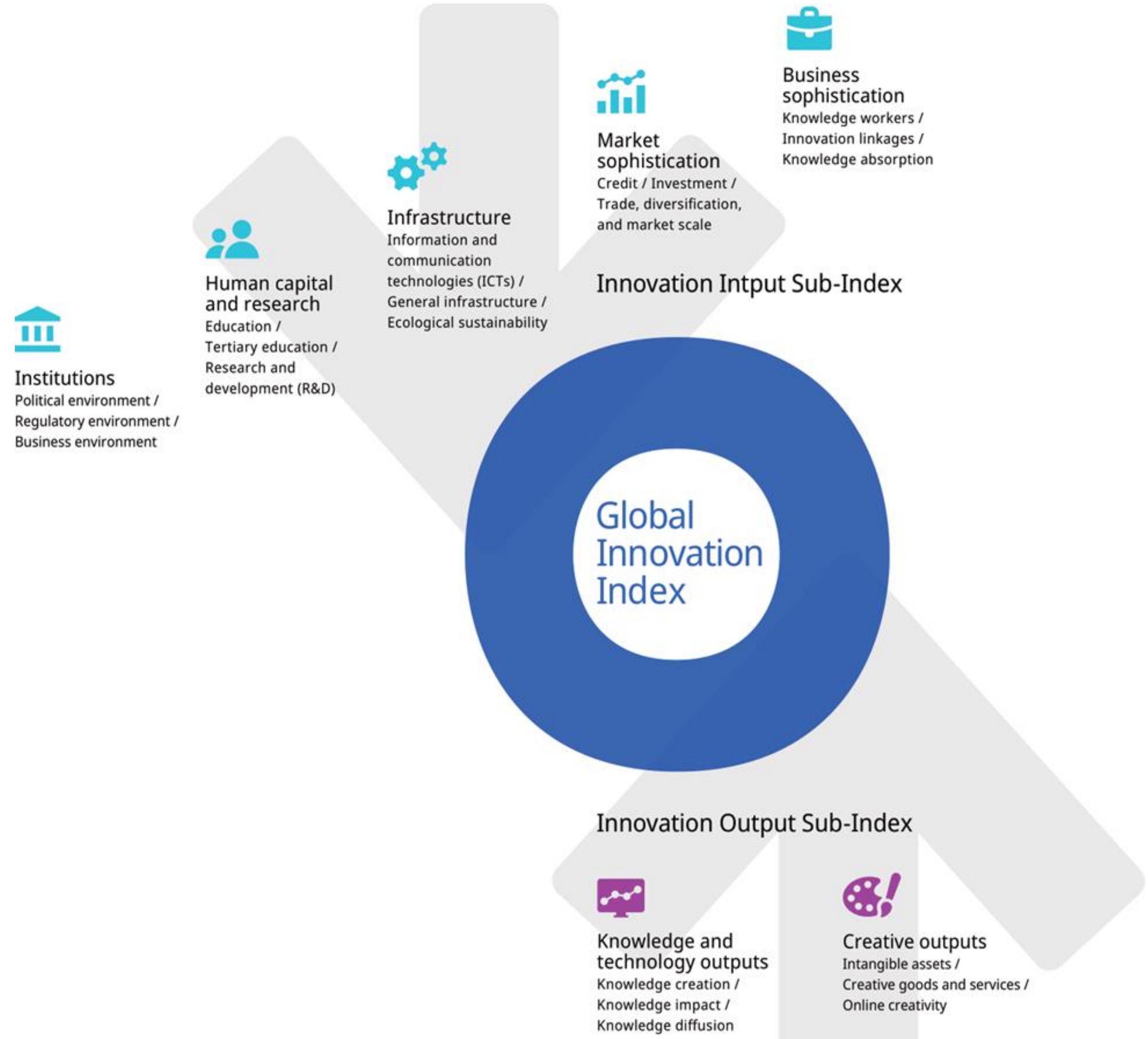

Figure 1.1: The Global Innovation (Source: Global Innovation Index, 2023)

The GII plays a significant role in identifying fundamental drivers, trends, and challenges within global innovation. Through its comprehensive analysis of diverse contributing factors such as institutions, human capital, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs, the GII offers a multidimensional approach. This approach enables policymakers to comprehensively understand the innovation landscape, empowering them to make well-informed decisions to foster innovation within their nations. Moreover, the GII helps to determine areas requiring improvement by examining the strengths and weaknesses observed across different economies. It, in turn, allows for the prioritization of investments in education and research, the development of supportive regulatory frameworks, the enhancement of intellectual property protection, and the facilitation of collaboration among academia, industry, and government. By benchmarking their performance against other countries, policymakers can establish goals and targets to enhance their innovation ecosystem and stimulate economic development.

Governments worldwide have used the GII to boost innovation efforts for many years. Performance, and to help design evidence-based innovation strategies. According to a survey conducted by WIPO at the beginning of 2022, the GII is utilized by 70% of WIPO member states (Global Innovation Index, 2023). Among the 110 received responses, 68 countries utilized the GII to enhance their innovation ecosystems and inform policymaking between 2020 and 2021. Notably, 37 countries even incorporated the GII as a specific reference in their economic plans or policies. Certain regions in Asia, such as South East and East Asia, have shown progress in closing the innovation gap with Northern America and Europe (Global Innovation Index, 2023).

In addition, the GII plays a critical role in assisting businesses and investors in identifying potential markets and centers of innovation (Global Innovation Index, 2023). By providing valuable insights into the innovation capabilities of various countries, the index empowers businesses to make well-informed decisions regarding investment, collaboration, and the establishment of research and development facilities. It facilitates companies in leveraging the expertise and resources available in specific nations, thereby fostering knowledge exchange and collaboration that drive innovation and enhance competitiveness.

1.1.3. Important of Logistic Performance Index

Logistics refers to a comprehensive network of services that facilitate the physical transportation of goods, supporting both domestic and international trade (Khan *et al.*, 2019). This network encompasses a range of activities, including transportation, warehousing, brokerage, express delivery, terminal operations, and information management. These components work together to ensure goods' efficient and seamless movement throughout the supply chain (Qazi, 2022). It is a fundamental pillar for a country's trade relations across borders, highlighting the significance of efficient logistics networks for global trading. The effectiveness of logistics within an economy relies on the services, interventions, and policies implemented by the public sector. These include regulating services, developing transportation infrastructure, enforcing international goods controls, and fostering high-quality public-private partnerships. Moreover, interventions now encompass efforts to enhance training, provide resources, foster digital resilience, and promote environmental, social, and economic sustainability (Sergi et al., 2021). Consequently, it is essential to note that all aspects of logistics also impact a country's competitiveness (Carpita and Ciavolino, 2017).

The LPI is a comprehensive benchmarking tool designed to assist nations in identifying the challenges and opportunities they encounter regarding trade logistics and determining strategies for enhancing their performance (Worldbank, 2023). Additionally, the LPI is an indispensable monitoring tool for countries to track their progress over time. By actively participating in the LPI surveys regularly, nations can gauge the effectiveness of their initiatives, evaluate the impact of policy changes, and make essential adjustments to enhance their logistics systems continuously (Worldbank, 2023). The LPI comprises two fundamental components:

Firstly, it incorporates a global survey involving international logistics operators, including global freight forwarders and express carriers, who provide valuable insights into the logistical "friendliness" of the countries they engage in trade. These choices subsequently impact decisions regarding production location, supplier selection, and company target markets (Song and Lee, 2022). Although there are limitations to be mindful of, such as the potential lack of expertise among survey respondents and the unique challenges encountered by landlocked countries, island nations, and those heavily reliant on logistics, the LPI has gained widespread acceptance as a set of fundamental performance indicators for transportation and logistics.

Secondly, the LPI leverages detailed and frequent data on maritime shipping, container tracking, postal services, and air freight activities collected and made accessible to the LPI through collaborations with multiple data partners. The LPI 2018 edition covers 160 countries and assesses their performance across six key indicators: customs, infrastructure, international shipments, logistics quality and competence, tracking and tracing, and timeliness (Worldbank, 2018). Each indicator is evaluated on a 5-point scale, and the LPI is computed by taking the weighted average of these six areas of logistics performance: Customs, infrastructure, quality of services, timeliness, tracking and tracing, and ease of arranging shipments. Experts are requested to assign scores to eight countries for each component, utilizing a 1 – 5 scale ranging from poor to excellent performance.

Consequently, the LPI evaluates logistics performance across various dimensions and offers dual perspectives: one based on the perceptions of international logistics professionals assessing their partner countries and the other based on the actual speed of global trade as measured through tangible supply chain tracking information. It has become a standard point of reference in numerous studies related to trade logistics. However, it is improbable that all components of the LPI hold equal significance in practice. Gaining insights into the relative importance of each component would assist countries in identifying areas to prioritize and improve their logistics performance efficiently (Rezaei, van Roekel and Tavasszy, 2018; Önsel, Kabak and Ülengin, 2019).

1.1.4. The interrelationship between the Global Innovation Index and the Logistics Performance Index with Countries' Competitiveness.

The relationship between the GII, the LPI, and a country's competitiveness is vital in today's global economy. These two indices provide valuable insights into a country's performance and significantly assess its competitiveness. The GII comprehensively assesses country's innovation performance (Global Innovation Index, 2023). It considers various indicators such as research and development expenditures, intellectual property rights protection, and the presence of high-tech industries. The GII provides a holistic view of a country's innovation ecosystem by analyzing these factors. It identifies areas of strength that require improvement and highlights the potential for growth and development through innovation (Global Innovation Index, 2023).

On the other hand, the LPI focuses on evaluating a country's logistics capabilities. It examines factors such as infrastructure quality, efficiency of customs procedures, ease of arranging international shipments, and overall logistics competence (Worldbank, 2023). The LPI sheds light on a country's ability to facilitate seamless trade and supply chain operations. It is an essential measure of a nation's efficiency in moving goods and services, reducing costs, and enhancing overall competitiveness in the global market (Worldbank, 2023). Efficient logistics and transportation networks, as measured by the LPI, are crucial for a country's competitiveness in global trade. Reliable supply chains, fast delivery times, and low transportation costs can enhance a country's attractiveness to investors and ability to participate in international markets.

The relationship between these two indices and a country's competitiveness is intricate and interdependent. Innovation and logistics are critical drivers of economic growth and development. Innovation fuels the development of new technologies, processes, and products, enabling countries to gain a competitive edge in the global market. Efficient logistics systems, conversely, enable the smooth flow of goods, services, and information, supporting the effective implementation and commercialization of innovative ideas. The capacity of a nation to engage in international trade is heavily contingent upon the traders' access to well-functioning logistics networks, which hinge upon the provision of governmental services, investments, and policies (Önsel Ekici, Kabak and Ülengin, 2016). In addition, nations aiming to bolster their competitive edge in international trade embark on a journey of innovation across all domains, maximizing productivity while minimizing costs (Sener and Delican, 2019).

A high ranking in the GII indicates a country's ability to foster a culture of innovation, invest in research and development, and nurture a conducive environment for innovative activities (Global Innovation Index, 2023). New technologies and processes can lead to more streamlined supply chains and improved transportation systems, such as innovations in digital tracking, automation, and data analytics can enhance logistics performance. It enhances the country's competitiveness by enabling it to produce cutting-edge products and services, attract investment, and create high-value jobs. Innovation can positively influence logistics performance by driving technological advancements in logistics processes, optimizing supply chain management, and enhancing overall efficiency (Magazzino, Alola and Schneider, 2021).

At the same time, a high ranking in the LPI reflects a country's strong logistics infrastructure, efficient customs procedures, and streamlined supply chain operations (Worldbank, 2023). Efficient logistics and transportation networks, as measured by the LPI, are crucial for a country's competitiveness in global trade. Reliable supply chains, fast delivery times, and low transportation costs can enhance a country's attractiveness to investors and ability to participate in international markets. It contributes to a competitive advantage by reducing transportation costs, minimizing delivery lead times, and ensuring the timely availability of goods in domestic and international markets.

1.1.5. Practical Problem

The relationship between the GII, the LPI, and a country's competitiveness is of practical significance, particularly when examining the competitiveness of Asian countries. However, some practical issues arise when using these indexes to assess competitiveness, which needs to be considered. One of the primary concerns is the suitability of the GII and the LPI as comprehensive indicators for assessing the competitiveness of Asian countries. While these indexes provide valuable insights into innovation performance and logistics capabilities, they may not capture the entirety of factors that contribute to the competitiveness of Asian countries.

Furthermore, the effectiveness of Asian countries in utilizing resources to improve competitiveness is an important research question. Assessing resource utilization requires a more comprehensive analysis, considering human capital, natural resources, infrastructure development, and institutional frameworks. Therefore, to thoroughly examine the effectiveness of Asian countries in resource utilization and its impact on competitiveness. Additionally, exploring the changes in resource optimization among Asian countries is crucial to understanding their competitiveness over time. Examining trends in these areas would provide a more comprehensive understanding of how Asian countries have optimized their resources and improved competitiveness over time.

To address the mentioned practical problems above regarding the appropriateness of these indexes for assessing competitiveness, the effectiveness of Asian countries in resource utilization, and the changes in resource optimization, a broader range of indicators and data sources should be considered. It needs a more comprehensive analysis of the practical problems associated with the relationship between the GII, the LPI, and the competitiveness of Asian countries. This study suggests an integrated Data Envelopment Analysis (DEA) model of the Super Slacks-Based Measure (Super-SBM) and Malmquist examine and elucidate the factors contributing to the exceptional performance of certain Asian countries compared to others at a competitive level and provide feasible recommendations for optimizing the resources to improve competitiveness.

1.2. Research Objectives

This study aims to assess the competitiveness of Asian countries by integrating the GII and the LPI using an integrated DEA model of the Super-SBM and Malmquist. The research focuses on achieving the following primary objectives:

Research Objective 1: To assess the competitiveness of Asian countries by combining the GII and the LPI.

Research Objective 2: To analyze and evaluate Asian countries' effectiveness in using resources to improve competitiveness.

Research Objective 3: To see the change in optimizing the resources of Asian countries over the years (2012-2018).

1.3. Research Questions

To effectively address the research objectives, this thesis formulates questions that serve as guiding principles for achieving the intended purposes. These questions are designed to provide clarity and direction in the pursuit of the research objectives:

Research Question 1: Are the GII and the LPI appropriate sets of indexes to assess the competitiveness of Asian countries?

Research Question 2: Are Asian countries effective in using resources to improve competitiveness?

Research Question 3: How has there been a change in optimizing the resources of Asian countries?

1.4. Research Scope

This study aims to evaluate the competitiveness of Asian countries by combining the GII and the LPI. This study proposes an integrated DEA-Super SBM and DEA-Malmquist model to assess the competitiveness of 30 Asian countries via data from 2012 to 2018.

1.5. Methodology and data overview

1.5.1. Research Methodology

The methodology employed in this research draws upon the widely recognized and advantageous approach of DEA for performance evaluation and benchmarking. DEA is the preferred method due to its effectiveness and versatility (Nguyen et al., 2022). DEA offers a comprehensive framework for assessing the relative efficiency of Decision-Making Unit (DMU) across diverse industries and sectors. One of its primary strengths is its nonparametric nature, which allows for an unbiased evaluation of efficiency without imposing specific functional forms or assumptions. This flexibility makes DEA applicable to various organizational settings and prevents potential biases resulting from unrealistic assumptions. Furthermore, DEA enables the consideration of multiple inputs and outputs, enabling a holistic evaluation of performance that captures the complexities of real-world systems. (Nguyen et al., 2022).

Within the DEA methodology, several models are available to assess the relative efficiency of DMUs. This study suggests utilizing the Charnes-Cooper-Rhodes Model (CCR), Banker-Charnes-Cooper Model (BCC), Slack-Based Measure Model (SBM), and Malmquist Productivity Index (Tone, 2001; Guan et al., 2006; Abdullah Aldamak and

Zolfaghari, 2017; Nguyen et al., 2023). These models offer valuable tools for evaluating efficiency and productivity in different contexts (Nguyen et al., 2022).

To achieve the objectives of this research, an integrated DEA model of the Super-SBM and Malmquist is proposed. This integrated approach enables a comprehensive examination of the factors contributing to the exceptional performance of certain Asian countries compared to others at a competitive level. By utilizing this model, the study aims to shed light on the key drivers of competitiveness and provide practical recommendations for optimizing resources to enhance competitiveness. The Super-SBM component of the model allows for a more nuanced evaluation of efficiency, while the Malmquist component enables the analysis of productivity changes over time (Nguyen et al., 2022).

This research adopts the DEA methodology due to its performance evaluation and benchmarking advantages. The integration of the Super-SBM and Malmquist models within DEA offers a robust framework to explore the factors underlying the competitive performance of Asian countries. The findings of this study will provide valuable insights and actionable recommendations for optimizing resources to improve competitiveness in the Asian context.

1.5.2. Data View

The data utilized in this study comprises the LPI and the GII of 30 Asian countries, spanning 2012 to 2018. The data source for this research is the World Bank.

1.6. Conclusion

Chapter 1 serves as a foundational component of this study, offering essential background information and key points related to the topic. The chapter establishes the thematic background, presents the practical problem, outlines the research objective, formulates research questions, defines the research scope, and elucidates the chosen methodology. Furthermore, Chapter 1 sets the stage for the main idea and provides a clear direction for the subsequent chapters. Building upon this groundwork, the upcoming chapter will delve into the technical terms and concepts utilized throughout the research, ensuring a comprehensive understanding of the study's theoretical framework.

1.7. Thesis Outline

Chapter 1: Introduction

This section sets the stage for the research by providing the necessary background, presenting the problem statement, objectives, research questions, scope, methodology, and an overview of the study. It establishes the foundation for subsequent chapters to delve deeper into the analysis of Asian countries' competitiveness by integrating the GII and the LPI using an integrated DEA model of the Super-SBM and Malmquist.

Chapter 2: Literature Review

This chapter provides a comprehensive review of the existing literature related to assessing the competitiveness of Asian countries through the integration of these and the LPI. This section aims to identify relevant studies, theories, and methodologies utilized in this research area. By examining prior research, this chapter establishes a solid theoretical foundation for the present study and highlights the knowledge gaps the current research intends to address.

Chapter 3: Methodology

This chapter provides a comprehensive overview of the methodology employed in assessing the competitiveness of Asian countries through the integration of the GII and the LPI. The research team used two techniques: The Super-SBM model and DEA Malmquist, which allows for a robust evaluation of countries' competitiveness by considering innovation performance and logistics efficiency.

Chapter 4: Results and Discussions

This chapter is an essential chapter of the research topic. From the data analysis, the research team offers the results of research methods and discussion about their significant implications. Also, this chapter focuses on presenting the results and discussions obtained from assessing Asian countries' competitiveness using the Super-SBM model and DEA Malmquist through the LPI and the GII. The chapter aims to provide a comprehensive overview of the findings derived from the analysis and initiate meaningful discussions surrounding the implications of the results.

Chapter 5: Conclusions, Limitations, and Recommendations

This chapter presents the conclusions drawn from the study. The chapter also highlights the limitations encountered during the research process and suggests potential avenues for future work.

CHAPTER 2: LITERATURE REVIEW

2.1. Literature Review on Theoretical Foundation

In an increasingly globalized and interconnected world, competitiveness has become a crucial concept underpinning nations' success and sustainability. Countries strive to enhance their competitiveness to secure economic growth and prosperity in the ever-evolving global landscape. Several theories shed light on factors contributing to a nation's competitive advantage. The Innovation-Diffusion Theory (IDT) (Porter, 2001) and the Trade Facilitation Theory (TFT) (Wilson, 2003) are two prominent theories that significantly impact a country's competitiveness. This study aims to delve into these theories, exploring their relevance and impact on countries' abilities to achieve and sustain competitiveness. Firstly, the IDT postulates that countries exhibiting a high level of innovation are more likely to possess a competitive edge (Porter, 2001). Innovation acts as a catalyst for economic growth, productivity, and overall development. An innovative ecosystem fosters the creation and implementation of new ideas, technologies, and processes, leading to enhanced productivity, efficiency, and adaptability.

Consequently, countries that prioritize and invest in innovation tend to perform better than their peers in terms of competitiveness (Apak and Atay, 2015). Innovation-driven countries allocate substantial resources to research and development (R&D) activities, promoting scientific advancements, technological break-throughs, and knowledge creation (Jungsberg et al., 2020). This theory recognizes the importance of knowledge-intensive sectors such as information technology, biotechnology, and advanced manufacturing, which thrive on cut-ting-edge research and continuous innovation. Such sectors create high-value jobs, at-tract foreign investment, and contribute to economic diversification, thus strengthen-ing a country's competitiveness. The previous studies (Tan et al., 2021; Aytekin et al., 2022; Lee, Jun and Lee, 2022; Smallbone, Saridakis and Abubakar, 2022) adopt the lens of IDT to evaluate the competitiveness of nations, examining the crucial role of innovation in shaping their long-term economic growth and prosperity. The GII is crucial in measuring and benchmarking countries' innovation capabilities. By assessing various indicators like R&D expenditure, patent applications, and high-tech exports, the GII provides valuable insights into a nation's innovation landscape (Nakagaki, Aber and Fetterhoff, 2015). It enables policymakers to identify strengths, weaknesses, and areas for improvement, guiding strategic decisions to foster innovation-led competitiveness.

Secondly, the TFT emphasizes logistics systems' efficient and effective functioning in enhancing a country's competitiveness (Wilson, 2003). Trade plays a crucial role in economic growth, and countries with streamlined, trans-parent, and reliable logistics processes gain a competitive edge in international trade. Trade facilitation encompasses a range of activities, including infrastructure development, customs procedures, logistics services, and supply chain management (Song and Lee, 2022). Countries that invest in modern infrastructure, including transport networks, ports, and logistics hubs, enhance their connectivity and reduce transportation costs. Efficient transportation networks enable the timely delivery of goods, reduce lead times, and increase competitiveness. A well-developed logistics infrastructure also attracts foreign direct investment, providing a conducive environment for businesses to operate and expand their operations (Rehman and Noman, 2020). Trade facilitation simplifies customs procedures, reduces bureaucracy, and enhances transparency (Hassan, 2020). Countries that establish efficient customs clearance processes enable faster movement of goods across borders, reducing delays and associated costs.

Moreover, effective supply chain management is vital in trade facilitation and competitiveness. Countries emphasizing coordination and integration among suppliers, manufacturers, and distributors create a seamless flow of goods and information (Wuni and Shen, 2023). This ensures reliability, responsiveness, and cost-effectiveness, which is crucial to enhancing competitiveness. The previous studies (Trade Facilitation in Asean Member Countries: Measuring Progress and Assessing Priorities by Ben Shepherd, John S. Wilson :: SSRN, no date; Shepherd and Wilson, 2009; Hoekman and Shepherd, 2015; Chen, Chen and Yao, 2020) employed the TFT framework to assess the competitiveness of countries have provided valuable insights into the critical role of streamlined trade procedures and policies in shaping their economic performance and global market integration. By evaluating the LPI indicators such as infrastructure quality, customs performance, logistics competence, and timeliness of shipments, these indicators provide a comprehensive overview of a nation's logistics capabilities (Mešić et al., 2022).

Thus, the IDT and the TFT theories offer valuable insights into the factors con-tributing to a country's competitiveness. Innovation-driven governments prioritizing research, development, and knowledge-intensive sectors gain a competitive advantage in today's global economy (Aytekin et al., 2022). Similarly, countries that focus on trade facilitation by investing in infrastructure, streamlining customs processes, and implementing efficient supply chain management enhance their ability to participate effectively in international trade. By embracing these theories, countries can build resilient and competitive economies, leading to sustainable growth and prosperity.

2.2. Literature Review on Competitiveness from Innovation Perspectives

In the contemporary global landscape, developed and emerging economies must prioritize innovation as an essential catalyst for driving economic progress and bolstering their competitive edge. Recognizing the transformative power of innovation, these nations have realized that it serves as an indispensable cornerstone in pursuing their growth objectives. As the world becomes increasingly interconnected and interdependent, the race to stay at the forefront of economic development intensifies, prompting governments, businesses, and individuals to accord innovation the status of a pivotal component in their strategic agendas. By fostering a culture of innovation, these economies seek to unleash the untapped potential of their resources, nurture creativity and entrepreneurship, and foster technological advancements that spur productivity gains, enhance market diversification, and unleash a wave of prosperity. Embracing innovation as a fundamental pillar of their growth trajectory, these nations strive to establish themselves as dynamic and forward-thinking actors in the global marketplace, perpetually adapting to evolving trends and seizing opportunities to thrive in an ever-changing economic landscape. According to Aytekin et al (2022), innovation encompasses the process of developing and implementing new inventions, as well as the creation of novel items, systems, or processes. The GII aims to provide policymakers with a comprehensive and data-driven approach to innovation. By evaluating various indicators and metrics, the GII assists in assessing a country's in-novation performance and enhancing its global competitiveness. The GII serves as a valuable tool for policymakers to identify strengths, weaknesses, and areas for improvement in their country's innovation ecosystem (Global Innovation Index, 2023). Countries can enhance their competitiveness, drive economic growth, and foster sustainable development by promoting innovation.

The GII rating, a widely recognized measure of innovation performance, is derived from the analysis of two sub-indices that hold equal importance (Global Innovation Index, 2023). The first sub-index, known as the innovation input sub-index, comprises five distinct pillars that serve to identify and evaluate the economic factors that foster and facilitate creative activities. These pillars encompass a comprehensive range of elements that contribute to the overall innovation ecosystem, including investments in research and development, quality of human capital, availability of infrastructure, level of market sophistication, and business-friendly regulations (Global Innovation Index, 2023). Each pillar is crucial in providing a conducive environment for innovation to thrive and flourish. Simultaneously, the second sub-index, the innovation output sub-index, represents the tangible outcomes and results of the creative economic operations. It encompasses the innovations, such as new products, services, and processes, and their impact on various sectors and industries (Global Innovation Index, 2023). Calculating each sub-pillar within these sub-indices involves meticulously aggregating and weighting the individual indicator scores.

Each indicator's relative significance is considered by assigning appropriate weights to ensure a comprehensive and accurate assessment. To facilitate meaningful comparisons across countries and regions, the indicator scores are further normalized to create a standardized scale ranging from 0 to 100 (Global Innovation Index, 2023). This normalization process allows for a more intuitive interpretation and understanding of the GII scores, enabling policymakers, researchers, and stakeholders to gauge different economies' relative strengths and weaknesses regarding their innovation performance. A detailed breakdown of all the pillars and indicators used in the GII framework can be found in **Table 2.1**, providing a comprehensive overview of the multifaceted aspects that are taken into consideration when evaluating innovation capabilities at a global scale.

Table 2.1: The GII Indicators (Source: Global Innovation Index)

No.	Indicators	Definition	References
1	Institutions	Political environment/Regulatory environment/Business environment	(Global Innovation Index (GII), 2022)
2	Human capital and research	Education / Tertiary education / Research and development (R&D)	(Global Innovation Index (GII), 2022)
3	Infrastructure	Information and communication technologies (ICTs)/Ecological sustainability/General infrastructure.	(Global Innovation Index (GII), 2022)
4	Market sophistication	Credit/Investment/Trade, diversification, and market scale	(Global Innovation Index (GII), 2022)
5	Business sophistication	Knowledge workers/Innovation linkages/Knowledge absorption	(Global Innovation Index (GII), 2022)
6	Knowledge and technology outputs	Knowledge creation/Knowledge impact/Knowledge diffusion	(Global Innovation Index (GII), 2022)
7	Creative outputs	Intangible assets/Creative goods and services/Online Creativity	(Global Innovation Index (GII), 2022)

By examining and analyzing these pillars, policymakers and stakeholders can gain valuable insights into the areas where countries excel or require further attention, thus informing strategies and policies to enhance innovation-driven growth and competitiveness. For example, Aytekin et al. (2022) conducted a research study that utilized the GII to investigate and compare the efficiency of global innovation, focusing specifically on European countries. Their study recognized the significance of innovation efficiency as a crucial economic factor and utilized the GII as a benchmark for their analysis. Similarly, Huarng et al. (2022) conducted a study that provided a new ranking of countries' innovation competitiveness based on the GII indicators for the year 2020. This research aimed to offer insights into the relative performance of countries in terms of innovation, enabling policymakers and stakeholders to identify areas for improvement and develop targeted strategies to enhance their innovation competitiveness. Another study by Yu et al. (2021) delved into the overall complexity of the GII framework, which measures multiple dimensions of the national innovation ecosystem. They examined the interrelationships and causal combinations of different GII indicators across years to identify the most consistent and comprehensive factors driving innovation. By identifying this causal combination, their research shed light on the underlying mechanisms contributing to innovation. It provided a deeper understanding of the GII as a representative measure of national innovation capabilities.

These studies highlight the diverse applications and research possibilities offered by the GII. Researchers can utilize the rich data provided by the GII indicators to investigate various aspects of innovation, ranging from efficiency and competitiveness to the complexity of the innovation ecosystem. By utilizing the GII as a reliable and comprehensive benchmark, these studies contribute to global innovation knowledge and provide valuable insights for policymakers, researchers, and stakeholders seeking to foster innovation-driven growth and economic development.

2.3. Literature Review on Competitiveness from Logistic Performance Perspectives

Logistics, which encompasses a wide range of activities involved in the management and flow of goods, materials, and information, holds a critical and multifaceted role in assessing, analyzing, and optimizing the movement of goods within the complex and interconnected global supply chain networks (Anwer AL-Shboul, 2022). With its inherent emphasis on efficiency, coordination, and strategic planning, logistics is a fundamental pillar underpinning supply chains' seamless and effective functioning across industries and geographic boundaries. By orchestrating the intricate processes of transportation, warehousing, inventory management, packaging, and distribution, logistics professionals and organizations ensure that goods are delivered timely, cost-effectively, and following customer expectations. Moreover, logistics acts as a vital link that connects suppliers, manufacturers, distributors, retailers, and end consumers, facilitating the smooth flow of products from their points of origin to their final destinations. In this context, logistics not only enables the physical movement of goods but also encompasses the broader aspects of information management, risk assessment, and coordination among various stakeholders, all of which contribute to enhancing supply chain efficiency, reducing costs, mitigating disruptions, and ultimately fostering overall competitiveness in the global marketplace.

Analyzing appropriate measures at the national level becomes necessary when considering the foundational elements of a country's economic progress (Önsel, Kabak and Ülengin, 2019). The relationship between logistics and economic performance is significant for international trade, as logistics plays a crucial role in facilitating the movement of goods and services. However, it is important to note that the impact of logistics is contingent upon various economic and geographical factors (Song and Lee, 2022). To facilitate a comparative evaluation of trade logistics and competitiveness across multiple countries, the World Bank developed the LPI. The index is a tool for evaluating and comparing logistics performance in trade operations. The LPI is important as it is a primary means of evaluating and comparing countries' relative positions and developmental levels. It highlights areas that contribute to economic growth and enables comparative analyses with other indicators or correlation studies with global metrics, ensuring the reliability of the LPI (Kabak, Önsel Ekici and Ülengin, 2020).

Furthermore, the LPI is instrumental in evaluating the sustainability of logistics performance by comparing it to other relevant indices, thus affirming its validity (Song and Lee, 2022). The LPI is developed through a survey among international shipping and logistics experts. Not based in the evaluated country, these experts are requested to provide ratings on six components using a scale of 1 to 5. **Table 2.2** presents the six components of the LPI and the explanations provided to the experts who participated in the questionnaire to create the LPI survey.

Table 2.2: The LPI Indicators (Source: The World Bank)

No.	Indicators	Definition	References
1	Customs	The effectiveness and smoothness of customs and border management clearance	(Worldbank, 2018)
2	Infrastructure	The quality of trade and transport infrastructure	(Worldbank, 2018)
3	Ease of arranging shipments	The ease of arranging competitively priced shipments	(Worldbank, 2018)

4	Quality of logistics services	The competence and quality of logistics services trucking, forwarding, and customs brokerage	(Worldbank, 2018)
5	Tracking and tracing	The ability to track and trace consignments	(Worldbank, 2018)
6	Timeliness	The rate at which shipments are delivered to recipients within the designated or anticipated timeframe	(Worldbank, 2018)

A comprehensive body of research has investigated the impact of trade promotion and its relationship to logistics performance, particularly utilizing the LPI as a critical measure. These studies have revealed diverse effects on country-level growth and regional dynamics, highlighting this intricate and multifaceted relationship. In Asia, the significance of logistics performance in driving economic growth within the region cannot be overstated. Asian economies heavily rely on efficient logistics systems to support their trade activities, emphasizing the pivotal role played by logistics in shaping the economic landscape. Notably, the performance of the logistics sector has been recognized as a critical factor influencing international trade, with the efficiency and effectiveness of logistics operations directly impacting trade flows and competitiveness (Tang and Abosedra, 2019). However, the logistics system's performance is influenced by many factors, and policy priorities may vary accordingly. Song and Lee (2022) highlight the complexity of logistics performance and the need to consider various factors when analyzing and evaluating its effectiveness. Previous studies in this field have faced limitations that warrant attention and further investigation. One such limitation pertains to the need to comprehensively understand the key determinants of competitiveness within the global context. Kaliszewski et al. (2020) emphasize the importance of examining the interplay of various factors contributing to a country's competitiveness, urging researchers to explore beyond individual factors and consider the holistic impact of multiple determinants. Another limitation lies in the prevailing focus on establishing a correlation between a country's competitiveness and logistics performance, overlooking the intricate interdependencies and synergistic effects that can arise from the interaction of multiple factors. Existing regression models primarily analyze the influence of specific factors on the LPI score, failing to account for the complex interplay between various elements that can generate synergies or negate each other's effects (Göçer, Özpeynirci and Semiz, 2022). Furthermore, the limited focus on establishing a connection between a country's risk drivers and the LPI poses another constraint in the existing research.

Qazi (2022) emphasizes the importance of gaining insights into the relationship between country risk factors and logistics performance, enabling governments and policymakers to prioritize significant risk factors based on specific indicators and devise effective risk mitigation strategies.

Addressing these limitations and advancing the understanding of the intricate relationship between trade promotion, logistics performance, and overall economic competitiveness is crucial. Future research endeavors should explore the synergistic effects of multiple factors, delve into the global context of competitiveness, and establish robust connections between country risk drivers and logistics performance. Such insights can empower policymakers, researchers, and stakeholders to develop targeted strategies, policies, and interventions that enhance logistics performance, foster trade promotion, and drive sustainable economic growth at national and regional levels.

2.4 Literature Review on DEA Methods

The DEA approach is commonly used to assess the performance of DMUs. The roots of the DEA can be traced back to the research conducted by Farrell in 1957. His theory of the production possibility frontier evaluates the effectiveness of enterprises within the same industry by considering both total technological efficiency and resource allocation efficiency (Farrell, 1957). However, the fundamental disadvantage of Farrell's efficiency is the weighing of input and output. Harness et al. (1978) solved this issue by introducing an improved approach. The CCR methodology produced a curve representing the production possibility frontier based on DMU data using a nonparametric method, and it used several mathematical programming techniques to calculate DMU efficiency (Aldamak and Zolfaghari, 2017). This approach assesses the comparative efficiency of DMUs without relying on fixed weights or time series analysis. Banker et al. (1984) proposed an extended CCR model by incorporating variable returns to scale (VRS) scenarios, enabling a more comprehensive examination of DMU efficiency. Besides, Tone (2001) introduced SBM, which employed the slack's objective function to determine the surplus of inputs and the deficiency of outputs for each unit. This model transformation from radial to non-radial was made possible because the validation of inputs and outputs no longer needed to be conducted simultaneously.

Furthermore, the Malmquist Productivity Index (MPI) in the DEA Malmquist model is derived from the combination of the catch-up index (efficiency change) and the frontier-shift index (technical change). This model represents an expansion of the original DEA model (Y. Jafari, 2014). Numerous studies have investigated regional competitiveness analysis using the DEA approach (Guan et al., 2006; Halkos and Tzeremes, 2007; Charles V and Zegarra L.F, 2014). For example, Charles and Zegarra (2014) suggested a DEA-based technique for measuring and ranking the competitiveness of all Peruvian regions. They emphasized the adaptability of the DEA technique by highlighting its advantages over other approaches, such as an extreme-point method that does not rely on assumptions of a functional relationship between inputs and outputs. By utilizing the BCC model, they concluded that the regions with the highest level of economic development are also the most competitive. Guan et al. (2006) used DEA to investigate the association between technical innovation capabilities and competitiveness.

The study employed the classic DEA model and found that only 16% of the firms utilized it, indicating a practice border. The results revealed many firms' organizational, innovative capability, and competitiveness anomalies. A multi-objective DEA projection model also served as a baseline for auditing competitive-ness. Based on the study's findings, businesses have significant potential to enhance their competitiveness. Halkos and Tzeremes (2007) utilized DEA to examine the effects of worldwide strategies implemented by the top 50 ICT multinationals. They established benchmarks, evaluated performances, and identified significant characteristics of strategic behavior in the ICT industry. The study's findings indicated that competitors in the communication and electronic/equipment industries demonstrate higher levels of competitiveness. Wei-Wen (2011) offered a solution to the competitiveness-ranking problem in travel and tourism by combining the DEA approach, Grey system theory, and artificial neural network theory, as well as using the Borda count methodology to integrate these ranks. However, the integration of multiple methodologies may introduce complexities and potential biases.

On the other hand, Stanikova and Skokan (2012) used DEA to evaluate the competitive potential of EU countries. However, this research discovered that this method is suitable for evaluating national competitiveness; its existence limits the generalizability of the findings to countries outside of the Euro-pean Union. Melecky (2013) utilized the MPI to evaluate the efficiency trend in the "old" 15 EU nations from 2000 to 2011. The study concluded that competitiveness and efficiency are interconnected objectives that cannot be disregarded in both economic theory and practice. Similarly, with the limit mentioned above, the study focusing on the "old" 15 EU nations may not capture the dynamics and challenges faced by emerging economies or non-European countries. The findings may not be directly applicable to other regions or global contexts. Despite the available research literature, none of the previous studies have combined the novel methodologies of Super-SBM and Malmquist to evaluate the competitiveness of Asian countries. This highlights the need for further research to apply these methodologies in evaluating the competitiveness of Asian nations. The Super-SBM model will investigate the input-output slacks in the case study. Slacks refer to the potential improvements in input and output variables for inefficient units compared to the benchmark objective (Fried, Schmidt and Yaisawarng, 1999). The super-efficiency DEA model can handle and rank DMUs with an efficiency value of 1 in the standard model (Pan et al., 2020). In the case of DMUs with an efficiency value of 1, the frontier remains unchanged in the evaluation process, and the Super-SBM model is applied similarly to the SBM model. However, there is a distinction in the Super-SBM model. It excludes the evaluated DMU, reconstructs a new frontier, and then assesses the distance between the DMU and the new frontier to determine its final ranking. This approach is explicitly utilized for DMUs with an efficiency value of 1 (Su and Ji, 2021).

However, it is essential to note that the Super-SBM approach has limitations. It primarily focuses on static analysis and cannot capture and reflect changes that occur over the defined Period. On the other hand, the MPI offers a different perspective by comparing the relative growth in productivity between two specific periods. This allows for a more dynamic analysis that considers changes in productivity over time (Färe, Grosskopf and Roos, 1998). The MPI is useful for evaluating productivity's relative progress or development over two different periods. Malmquist's methodology is highly valuable in the assessment of productivity. The Malmquist model, an enhancement of the conventional DEA model, offers significant advantages in tracking the productivity of DMUs over time.

The Super-SBM method assesses and provides recommendations for inefficient and efficient DMUs by considering their scores, ranks, and slack indicators. On the other hand, the Malmquist model calculates efficiency change scores by analyzing output factors and input variables. Input indicators that most closely reflect the competitiveness evaluation criteria will be carefully considered. **Table 2.3** covers DEA applications, including input and output components examining the literature to assess the Asian countries' competitiveness.

Table 2.3: List of related Studies (Source: Thesis Team)

No.	Studies	Inputs	Outputs	Methods	Sample and Region
1	Charles and Zegarra (2014)	Regional competitiveness index	Rank the competitiveness	DEA-BCC model	Peru
2	Guan et al. (2006)	Technological innovation capability dimensions	Competitiveness factors	DEA-CCR model and DEA-BCC model	China
3	Halkos and Tzeremes (2007)	The number of employees, The R&D expenditure, The market capitalization	Revenues; The net income	DEA	Top 50 ICT company
4	Wei-Wen 2011)	Travel & Tourism Competitiveness Index	Travel & Tourism competitiveness ranking	Super-efficiency DEA; grey system theory (GST); artificial neural network (ANN)	
5	Stanikova and Skokan (2012)	Four of EU Policy indicators; EU Structural (Lisbon) indicators and indicators of Strategy Europe 2020	Two of EU Policy indicators; EU Structural (Lisbon) indicators and indicators of Strategy Europe 2020	DEA-CCR model and DEA-BCC model	27 EU countries
6	Melecky (2013)	Institution; Macroeconomic Stability; Infrastructure, Health;	Labour market efficiency; Market size; Business	DEA-Malmquist	15 EU nations

		Primary, secondary and Tertiary Education; Training and Lifelong Learning; Indicators for technological readiness	sophistication; Innovation		
7	Kuo et al. (2020)	Terminal area; Terminal length; Equipment	Throughput; Ship calls	DEA-CCR model	53 Vietnamese ports
8	Liu et al. (2018)	Outlets; Warehouses; Suppliers	Inhabitants; Market concentration; Consumer spending; Market share; Total sales; ROI	DEA	124 organizations in the global retailing industry.
9	Nguyen et.al (2023)	Entry costs; Land access and security; Transparency; Informal charges; Time Costs and Regulatory; Compliance; Policy bias; The proactivity of provincial leadership; Business support service; Labor training; Legal institution	FDI capital; FDI by cases	Super-SBM model; The DEA–Malmquist	63 provinces in Vietnam
10	Tachega et al. (2021)	Energy; Economic	Desirable output (GDP); undesirable output (CO2)	DEA-Malmquist	Africa countries
11	Giacalone et al. (2020)	Judges employed; Number of	Cases finished	DEA-Malmquist	Italian judicial system

		administrative; Pending cases; New cases filed.			
12	Zheng Z (2021)	Capital stock; Working population; total energy consumption	Expected output (GDP); non-expected output (sulfur dioxide, wastewater discharge, PM2.5)	DEA Malmquist DEA SBM	23 China cities

2.5. Research Gaps

While the previous studies have addressed countries' competitiveness as an important topic, several research gaps could be further explored to enhance the understanding of competitiveness assessment and its implications for Asian countries in this study.

Based on the literature mentioned above review, it is evident that few previous researchers have assessed the competitiveness of entire Asian countries. The present study, therefore, represents the first endeavor to evaluate the competitiveness of all Asian nations comprehensively. This research not only offers valuable insights into the strengths and weaknesses of Asian countries within the global markets but also facilitates the identification of areas of excellence and areas requiring improvement. Consequently, this assessment is a foundation for informing strategies to foster economic development and growth. Another research gap that could be addressed is the integration of Super-SBM and Malmquist techniques in assessing the competitiveness of Asian countries. While the current study focuses on the comprehensive evaluation of all Asian nations, it does not incorporate these advanced methodologies. By integrating these approaches, a more comprehensive and precise evaluation of competitiveness can be attained, considering both efficiency and productivity dynamics over a given period.

Furthermore, this study integrates the GII and the LPI as indicators of competitiveness, but competitiveness is a multidimensional concept influenced by various factors. Additional indicators such as economic performance, education, infrastructure, political stability, and technological advancements would provide a more holistic assessment. Exploring the integration of a wider range of factors would enable the development of a comprehensive framework for evaluating competitiveness.

2.6 Conclusion

In conclusion, this research utilizes a functional framework to evaluate Asian Countries' Competitiveness by employing an integrated approach that combines the DEA-Super SBM, and the DEA-Malmquist. The objective is to assess Asian Countries' Competitiveness from 2012 to 2018. The Super-SBM model is applied to measure the competitiveness of all 30 nations in Asia during the time mentioned above. Furthermore, the DEA-Malmquist model is utilized to analyze the overall changes in productivity within the competitiveness performance of these 30 nations. These findings hold valuable implications for policymakers and other stakeholders, offering insights that can aid in formulating effective strategies to foster overall economic development.

CHAPTER 3: METHODOLOGY

3.1. Research Process

Based on Cooper et. al (2011), DEA is a versatile method employed to examine different dimensions of a research problem or inquiry. It assesses the efficiency and effectiveness of a group of entities or DMUs by considering multiple input and output factors. DEA's strength lies in its ability to identify the most efficient DMUs and uncover the factors contributing to their performance without relying on predefined hypotheses. Although DEA does not formulate hypotheses, it can provide valuable insights and data to guide the development of hypotheses for further investigation (Farrell, 1957). For example, the findings derived from DEA can serve as a foundation for formulating hypotheses regarding the factors that influence the efficiency and performance of DMUs. Therefore, this research presents a novel hybrid approach of the Super-SBM and Malmquist to assess the competitiveness of Asian countries. **Figure 3.1** illustrates the research process for the technique, which comprises seven sequential steps outlined as follows:

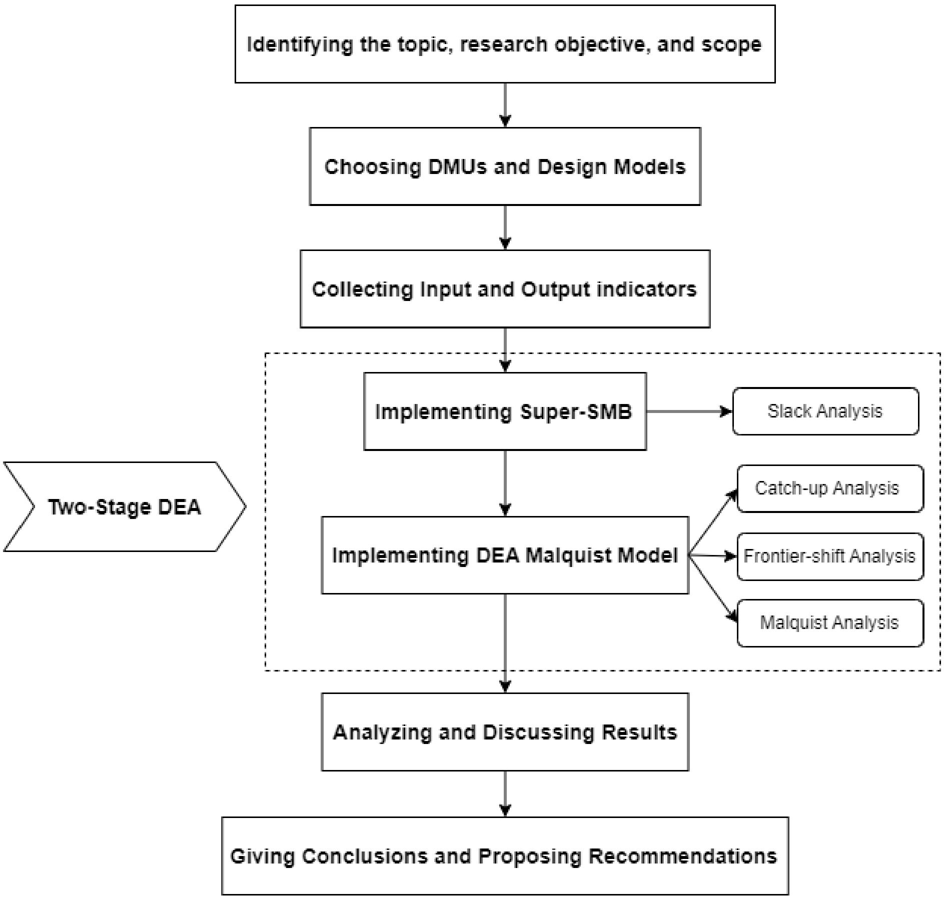

Figure 3.1: The Research Process (Source: Thesis Team)

Step1: Identifying the topic, search objective, and scope

The first step in the research process involves identifying the research topic, specifying the study's objectives, and defining the research scope. This crucial step ensures that the chosen research topic is relevant, feasible, and holds significant academic value. By clearly defining the objectives and scope, researchers can ensure that our study addresses specific research questions and contributes meaningfully to the existing body of knowledge.

Step 2: Choosing DMUs and Design Models

In this step, the focus is on selecting DMUs and designing appropriate models to evaluate their efficiency. DMUs are the entities or units that will be analyzed to assess their performance in the research study. These units could be organizations, countries, companies, or other relevant entities depending on the research context. The next task is to design suitable models that will serve as analytical tools for evaluating the efficiency of these selected DMUs. These models can be quantitative frameworks, such as the DEA models, that compare the inputs and outputs of the DMUs to determine their relative efficiency. The choice of models will depend on the research objectives and the specific requirements of the study.

Step 3: Collecting input and output indicators

The next step in the research process is collecting data on the input and output factors of the selected DMUs. Inputs refer to the resources utilized by the DMUs, while outputs represent the products or services produced by the DMUs. It is essential to gather accurate and comprehensive data to ensure the validity and reliability of the research results. Collecting relevant data on inputs and outputs enables researchers to quantitatively analyze the efficiency and performance of the DMUs using the selected models. Careful attention should be given to collecting high-quality data that adequately represent the characteristics and operations of the DMUs under study.

Step 4: Two-Stage DEA

In the first stage, the Super-SBM model assesses the competitiveness efficiency among 30 Asian countries within the designated time frame. This model allows for an evaluation of the relative efficiency of these countries in terms of competitiveness. In the second stage, the DEA-Malmquist model is utilized to analyze the comprehensive changes in productivity and competitiveness across the countries. This model enables an examination of the shifts in productivity and competitiveness over time, providing insights into the dynamic nature of these factors among the countries under study.

Step 5: Analyzing and discussing results

In this step, the research results are analyzed, and the implications of the findings are discussed. The analysis should be comprehensive, objective, and supported by evidence derived from the collected data and the application of the chosen models. It is crucial to thoroughly examine the research results, identifying patterns, trends, and significant findings. The discussion should go beyond presenting the results and provide insights into the research topic and its broader context. It should explore the implications of the findings concerning existing literature, theories, and real-world applications. The discussion may also highlight any limitations or potential areas for further research. By offering a comprehensive and insightful discussion, the research study contributes to understanding the research topic and its implications within a broader context.

Step 6: Giving a conclusion and proposing recommendations

In this stage, the research findings are carefully synthesized and summarized to provide a comprehensive overview of the key discoveries and insights obtained throughout the study. Drawing upon the evidence presented in the research, conclusions are then derived to offer well-grounded and substantiated statements that encapsulate the main outcomes and implications of the investigation. Furthermore, practical recommendations are formulated based on the research findings and conclusions. By offering valuable insights into the research topic and giving practical recommendations, the study contributes to the existing knowledge base. It paves the way for further exploration and implementation in relevant domains.

3.2. DEA Models

3.2.1. Data Envelopment Analysis (DEA)

i. Evaluating performance and trade-offs

All business activities involve altering materials to create value and convert them into desired products and services for customers (Farrell, 1957). Managers regularly aim to assess the efficiency of diverse processes using multiple performance measures. Organizations aim to gauge their resource utilization, including labor, materials, energy, machinery, against outcomes like product quality, service excellence, and customer contentment. For instance, examining hospital operations reveals metrics like doctors, nurses, supplies, equipment, patient count, training efforts, and more. In a buyer-seller supply chain, buyers might compare sellers based on criteria like response time, costs, flexibility, service, quality, and personalization. Enhancing or removing inefficient processes reduces costs and boosts productivity. Appraising and benchmarking performance contribute to enhancing the effectiveness and efficiency of business activities.

Assessing performance serves as a crucial means for businesses to continuously enhance themselves and maintain competitiveness. This is particularly significant in the context of a fierce and escalating global market competition. The practice of evaluating performance and comparing against benchmarks compels every business unit to consistently adapt and refine their strategies, ensuring survival and growth within the realm of global competition. Conducting performance evaluations facilitates several outcomes:

(1) Uncovering both strengths and areas needing improvement in business functions and processes.
(2) Better aligning the business with customer demands and expectations.
(3) Pinpointing chances for refining ongoing operations, innovating processes, and introducing novel products and services.

The foundational technique in evaluating performance and benchmarking often involves a single-measure gap analysis. Nevertheless, an issue highlighted by Camp (1995) arises when dealing with benchmarks that involve multiple measurements. Relying solely on one metric rarely suffices for comprehensive performance assessment. Financial ratios such as return on investment (ROI) and return on sales (ROS), both representing single outputs in relation to inputs, can serve as indicators for financial performance. However, these metrics are inadequate for distinguishing "best practice" and lack the capacity to fully evaluate operational efficiency. Given that a business unit's performance is a multifaceted phenomenon, it necessitates more than a single criterion to capture its essence. For instance, as underscored by Sherman (1984), a bank branch might exhibit profitability based on interest and revenue earned versus costs, but this profitability measure does not elucidate the efficient management of resources allocated for customer service.

Further, using single measures ignores any interactions, substitutions, or tradeoffs among various performance measures. Each business operation has specific performance measures or metrics with tradeoffs. For example, consider the tradeoff between total supply chain cost and supply chain response time, measured by the amount of time between an order and its corresponding delivery. **Figure 3.2** illustrates alternate supply chain operations S1, S2, S3, and S, and the best-practice (efficient) frontier or tradeoff curve determined by them. A supply chain whose performance (or strategy) is on the efficient frontier is non-dominated (efficient) because no alternate supply chain's performance is strictly better in both cost and response time. Through performance evaluation, the efficient frontier that represents the best practice is identified, and an inefficient strategy (e.g., point S) can be improved (moved to the efficient frontier) with suggested directions for improvement (to S1, S2, S3, or other points along the frontier).

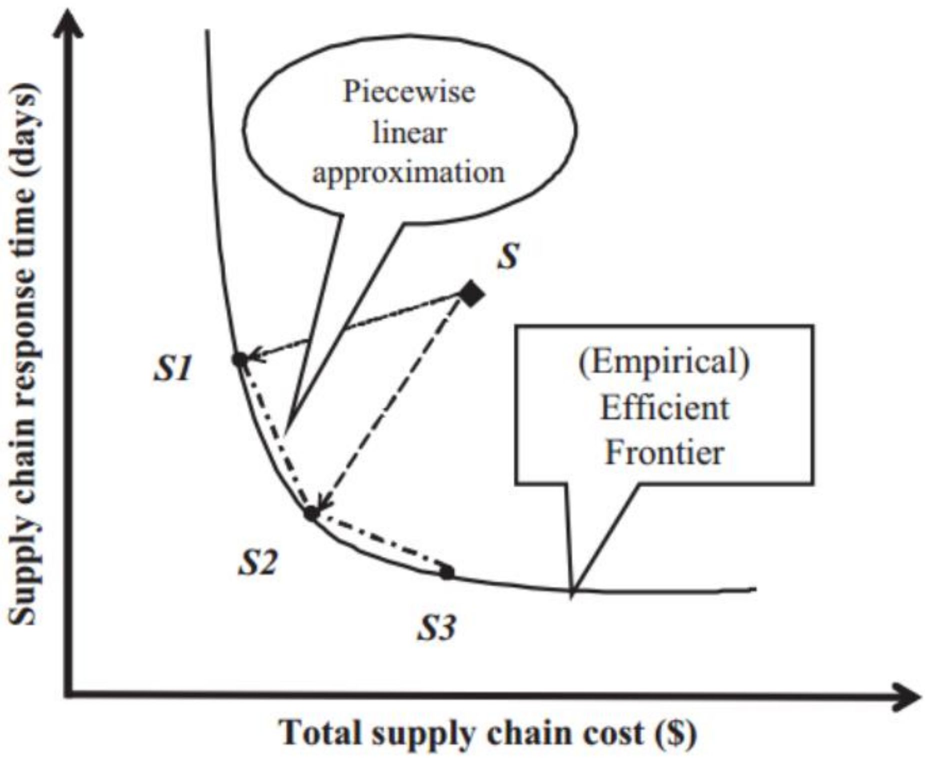

Figure 3.2: Best practice (efficient) frontier of supply chain operations

(Source: Quantitative Models for Performance Evaluation and Benchmarking)

Optimization methods can aid in approximating the efficient frontier if we possess the functional expressions describing the connections between various performance measurements. For instance, interdependent variables like stockout levels and inventory turnovers involve performance trade-offs. Innovations in technology and processes can alter cost trade-off curves by reducing the expense associated with achieving lower inventory at a given stockout level or minimizing stockouts while maintaining a certain inventory level. However, acquiring such comprehensive information is typically challenging.

When lacking a priori knowledge of trade-offs, it becomes impossible to define functional relationships. Consequently, a complete characterization of business activities and processes remains elusive. It's important to note that the purpose of performance evaluation involves assessing the current internal business operations and comparing them against similar external operations to identify optimal practices. These optimal practices can be identified empirically based on observations of a single business operation/process over time or comparable business operations within a specific timeframe.

ii. Data Envelopment Analysis (DEA)

DEA is a data analysis tool for identifying best practices as shown in **Figure 3.2** when such a best-practice frontier is characterized by multiple performance metrics. In DEA, performance metrics are classified as "inputs" and "outputs". According to Cooper et. al (2011), DEA stands as a relatively recent "data-centric" method for appraising the effectiveness of a collection of peer entities named DMUs, which transform multiple inputs into multiple outputs. The definition of a DMU is versatile and adaptable. In recent times, DEA has found a wide array of applications, used to evaluate the performances of diverse entities involved in varied activities across numerous settings and countries. These applications involve a range of DMU configurations, assessing the performance of entities such as hospitals, US Air Force wings, universities, cities, courts, business firms, and more. This scope even extends to evaluating the performance of countries, regions, and similar entities. The minimal assumptions required by DEA have also made it a feasible option for cases where other methods struggled due to the intricate and often unknown relationships between the numerous inputs and outputs within DMUs.

DEA employs DMUs as representations of business activities or processes. Each DMU is assessed using a collection of multiple performance metrics categorized as both "inputs" and "outputs".

Suppose having a set of observations on *n* DMUs. Each observation consists of values of performance measures related to a DMU_j *(j=1, ..., n)*. The selected set of performance measures are classified as *m* inputs a_{ij} *(i=1, 2, ..., m)* and *s* outputs b_{rj} *(r=1, 2, ..., s)*.

DEA used linear programming methods to discern the empirical efficient boundary or optimal practice boundary among these *n* observations. The subsequent two characteristics guarantee our ability to construct a segmented linear approximation of the efficient frontier and the region encompassed by the frontier, depicted in **Figure 3.2**.

- **Property 1** *Convexity*. $\sum_{j=1}^{n} \gamma_j a_{ij}$ *(i=1, 2, ..., m)* and $\sum_{j=1}^{n} \gamma_j b_{rj}$ *(r=1, 2, ..., s)* represents potential levels of inputs and outputs attainable by DMU_j, where γ_j *(j=1, ..., n)* constitute non-negative values in scalar form $\sum_{j=1}^{n} \gamma_j = 1$.

- **Property 2** *Inefficiency*. The same b_{rj} can be got by using $\hat{a}_{ij}$, where $\hat{a}_{ij} \geq a_{ij}$ (i.e., the same output levels can be obtained by using more inputs). The same a_{ij} can be used to obtain $\hat{b}_{rj}$, where $\hat{b}_{rj} \leq b_{rj}$ (i.e., the same input levels can be used to obtain less outputs).

Consider **Figure 3.2** where total supply chain cost and supply chain response time represent two inputs. Applying Property 1.1 to S1, S2, and S3 yields the piecewise linear approximation to the curve shown in **Figure 3.2**. Applying both properties expand the line segments S1S2 and S2S3 into the area dominated by the curve.

For specific a_i *(i=1, 2, ..., m)* and *s* outputs b_r *(r=1, 2, ..., s),* so having **Equation (1.1)**:

$$\begin{cases} \sum_{j=1}^{n} \gamma_j a_{ij} \leq a_i & i = 1, 2, \ldots, m \\ \sum_{j=1}^{n} \gamma_j b_{rj} \geq b_r & r = 1, 2, \ldots, s \\ \sum_{j=1}^{n} \gamma_j = 1 & \end{cases} \tag{1.1}$$

The subsequent phase involves determining the empirical (piecewise linear) efficient frontier described by **Equation (1.1)**. DEA employs linear programming to indirectly gauge the inherent trade-offs present within the empirical efficient frontier. The inception of DEA by Charnes et al. (1978) has been demonstrated as a potent approach for pinpointing these empirical frontiers and assessing relative levels of "efficiency". In this context, "efficiency" is a broad term covering various scenarios contingent on specific DMUs and associated performance metrics. To illustrate, when the performance metrics concern inputs and outputs of a production process, the DEA "efficiency" translates to "production efficiency". Conversely, if the performance metrics pertain to indicators of quality, the DEA "efficiency" produces a composite quality measurement.

iii. Categorizing performance metrics into inputs and outputs

The DEA methodology necessitates the classification of performance measures into inputs and outputs (Farrell, 1957). However, ensuring that the chosen measures accurately reflect the process under examination is crucial. While inputs and outputs are typically well-defined in production or service processes, they may pose challenges in the context of benchmarking. The efficient DMU also identified by DEA may not necessarily form a "production frontier" but rather signify a "best-practice frontier". It is necessary to correctly classify performance measures as inputs or outputs for DEA utilization. DEA aims to minimize inputs and maximize outputs, although exceptions exist, such as pollutants generated by a production process. In specific scenarios, a factor can simultaneously serve as both an input and an output. If the underlying DEA problem pertains to a production process, it becomes easier to identify inputs and outputs. However, for general benchmarking problems, inputs typically represent "less-the-better" performance measures, while outputs represent "more-the-better" measures. Cook et al. (2010) note that a combination of ratio data, percentage data, and raw data can also be used as inputs and outputs.

iv. Relationship between number of DMUs vs number of Inputs and Outputs

The impact of the number of inputs and outputs relative to the number of DMUs on the discriminatory power of DEA is well recognized. However, Banker et al. (1984) argued that the number of DMUs should be at least three times the combined number of inputs and outputs. Although not mandatory and lacking statistical basis, these guidelines are often followed for convenience to preserve discrimination power. It is unnecessary to strictly adhere to these rules, as there are cases where many DMUs are efficient. In situations where the population size is limited, it may not be feasible to add more actual DMUs. Nonetheless, if the objective is to reduce the number of efficient DMUs, various DEA models, such as weight restrictions, can be helpful.

In contrast to statistical regression analysis, which centers on estimating the collective behavior of a group of DMUs, DEA stands as a benchmarking instrument that highlights the performance of each individual DMU. Thus, the sample size or number of DMUs being evaluated is unimportant. Even with a small number of firms in a specific market and many inputs and outputs, DEA benchmarking results can still offer value (Cook & Zhu, 2010). Regardless of the form of the production frontier, it remains distinct from the best practice frontier. Adding a DMU to an existing set can result in it being either inefficient or efficient. In the former case, the best practice frontier remains unchanged, providing no new insights into the production frontier. In the latter case, the frontier may shift closer to the actual but unknown production frontier. To sum up, it's important to perceive DEA not as a regression model, but rather as an optimization approach rooted in frontier analysis. Setting a sample size prerequisite for DEA is inconsequential since it operates as a benchmarking tool centered on individual performance. A significant proportion of DMUs is likely to fall under the classification of being efficient.

v. Measuring and Managing Performance

If we draw a lesson from the realm of baseball known as “Moneyball”, it becomes evident that relying solely on our visual judgment is not always reliable. A pitcher carrying extra weight and using an unconventional throwing technique could bring significant value to a team, while an outfielder with impressive throwing abilities and swift bat speed might not yield the expected returns. This analogy extends to astute business managers who understand that their gut feelings can frequently lead them astray or even be entirely incorrect. Employees who appear to put in the least effort might paradoxically be the most productive. Business divisions that flaunt high profitability might, at times, be functioning with lower efficiency. This situation closely mirrors the approach taken by DEA in the realm of performance benchmarking.

The concept of DEA by Sherman and Zhu (2013) in Sloan Management Review, is referred to as "balanced benchmarking," which provides organizations with the ability to benchmark and identify best practices that might remain hidden when employing more frequently utilized management approaches. Besides, also in this publication (2013), DEA offers managers a sophisticated tool for evaluating the performance of various service providers. This involves more intricate evaluations beyond the simplistic metrics and ratios like profitability and account billings per employee. For instance, it allows for a nuanced comparison between global advertising agency branches, such as those in London and Tokyo. The insights derived from DEA enable a company to pinpoint its least efficient offices or business segments. Additionally, the analysis quantifies the extent of inefficiency and offers a basis for exploring avenues of enhancement. Furthermore, DEA empowers executives to closely examine the best-performing units, discern effective practices, and disseminate this valuable knowledge organization-wide to elevate overall performance. Lastly, DEA serves as a platform for companies to validate their assumptions, particularly before embarking on cost-cutting endeavors that could unintentionally yield counterproductive outcomes.

3.2.2. Super-SBM Model

According to Tone (2001), the SBM model is an alternative to the traditional CCR and BCC models, which use radial measurement. The SBM model incorporates relaxation variables into the objective function, allowing for direct slack handling in the relevant DMU inputs and outputs. Unlike the traditional models, the efficiency results in SBM are independent of the unit of the input-output variables, and the efficiency value exhibits a monotonically decreasing trend with each input and output relaxation variable. The SBM model is expressed as follows by **Equation (1)**:

$$min\ \rho = \frac{1 - \frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{x_{i0}}}{1 + \frac{1}{s}\sum_{r=1}^{s}\frac{s_r^+}{y_{r0}}}$$

s.t.

$$\sum_{j=1}^{n} x_{ij}\gamma_j + s_i^- = x_{i0}, \forall i \qquad (1)$$

$$\sum_{j=1}^{n} y_{rj}\gamma_j - s_r^+ = y_{r0}, \forall r$$

$$\gamma_j \geq 0, \forall j$$

$$s_r^+, s_i^- \geq 0, \forall i, r$$

Here, ρ is the DMU efficiency value. Each DMU has *m* input variables and *s* output variables. We use x_{i0} and y_{r0} to denote the input and output of a specific DMU, respectively, while s_i^- and s_r^+ denote the relaxation vectors of corresponding inputs and outputs, respectively; x_{ij} and y_{rj} are the input and output matrices, and γ_j is a column vector representing the weights for each DMU.

To better distinguish and categorize efficient DMUs when multiple effective ones are present, Tone (2002) introduced the Super-SBM model. The current study utilizes the Super-SBM model, represented by **Equation (2)**.

$$min\ \rho = \frac{\frac{1}{m}\sum_{i=1}^{m}\frac{\bar{x}_i}{x_{ik}}}{\frac{1}{s}\sum_{r=1}^{s}\frac{\bar{y}_r}{y_{rk}}} \qquad (2)$$

s.t.

$$\sum_{j=1,\ j\neq k}^{n} x_{ij}\gamma_j \leq \bar{x}_i, \forall i$$

$$\sum_{j=1,\ \ j\neq k}^{n} y_{rj}\gamma_j \ \geq \bar{y}_r, \forall r$$

$$\bar{x}_i \geq x_{ik}, \forall i$$

$$\bar{y}_r \leq y_{rk}, \forall r$$

$$\gamma_j \geq \ 0, \forall j\ (j \neq k)$$

Where ρ can be considered the average distance between a specific production unit and the production frontier, this distance ρ is dimensionless, and the efficiency value can be greater than ρ in **Equation (1)**.

3.2.3. DEA Malmquist

The Malmquist index is a metric used to assess the efficiency change of DMUs over two different periods. It is calculated as combining two components: the "Catch-up (efficiency change)" and "Frontier-shift (technical change)" terms. The "Catch-up" term represents the efforts made by the DMU to improve its efficiency. In contrast, the "Frontier-shift" term captures the changes in the efficient frontiers surrounding the DMU between the two time periods (period 1 and period 2) (Caves et al., 1982). To compute the catch-up effect, we compare the DMU's efficiency at period 1 (represented as (x_0^1, y_0^1)) and its efficiency at time period 2 (represented as (x_0^2, y_0^2)). The catch-up effect is quantified using the following **Equation (3)**.

$$Catch\text{-}up = \frac{Efficiency\ of\ (\ x_0{}^2, y_0{}^2\ )\ with\ respect\ to\ the\ period\ 2\ frontier}{Efficiency\ of\ (\ x_0{}^1, y_0{}^1\ )\ with\ respect\ to\ the\ period\ 2\ frontier} \quad (3)$$

In the evaluation of each element (efficiency) in the previously mentioned formula, non-parametric DEA models are utilized. DEA is a method used to assess the relative efficiency of multiple DMUs by comparing as an illustration for the DEA analysis. In this context, a single input and a single output are considered for each DMU. The DEA model evaluates how efficiently a DMU utilizes its input(s) to produce the output(s) relative to other DMUs in the dataset. The DEA analysis helps in determining the efficiency of each DMU in the dataset and facilitates the calculation of the "Catch-up" and "Frontier-shift" terms in the Malmquist index formula. By using DEA, researchers can identify the extent to which each DMU has improved its efficiency over time and how the efficient frontiers surrounding the DMUs have shifted between the two time periods (Caves et al., 1982). The MI can be decomposed into two components.

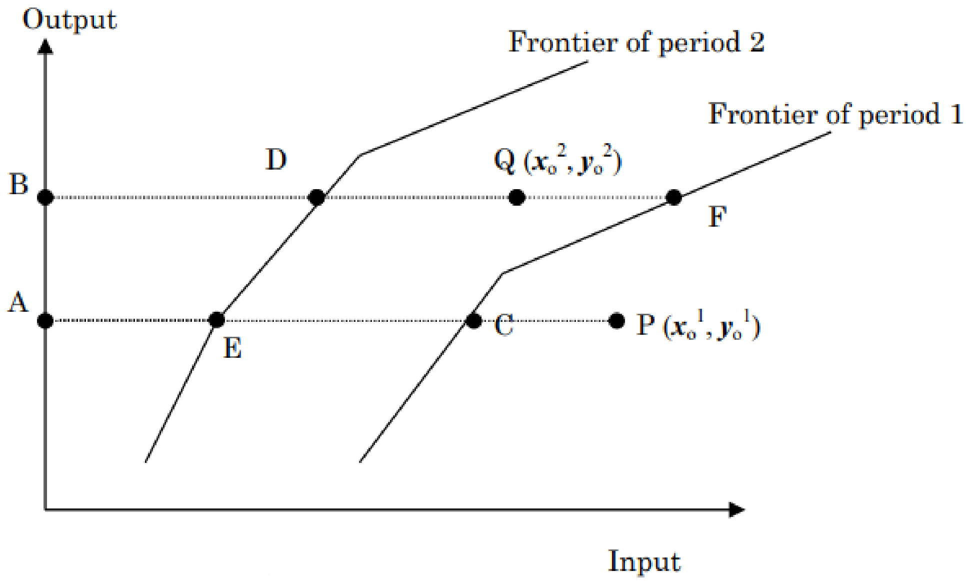

Figure 3.3: Single input and output case (Source: Caves et al., 1982)

The catch-up effect (in input-orientation) can be computed using the following **Equation (4)**:

$$Catch\text{-}up = \frac{\frac{BD}{BQ}}{\frac{AC}{AP}} \qquad (4)$$

- **Catch-up > 1**: This indicates progress in relative efficiency from period 1 to period 2. A catch-up effect more significant than 1 means that the DMU has improved its input efficiency over time, moving closer to the efficient frontier or catching up with more efficient units in the dataset.
- **Catch-up = 1**: This represents the status quo. A catch-up effect equal to 1 implies that the DMU's input efficiency remains unchanged between the two time periods. It neither regressed nor progressed in relative efficiency.
- **Catch-up < 1**: This indicates a regress in efficiency from period 1 to period 2. A catch-up effect of less than 1 means that the DMU's input efficiency has worsened over time, moving further away from the efficient frontier or falling behind compared to more efficient units in the dataset.

Apart from considering the catch-up term, it is crucial to factor in the frontier-shift effect to assess the efficiency changes in the DMUs comprehensively. This is essential because the catch-up term depends on the efficiencies measured by the distances from the respective frontiers. In the straightforward case of **Figure 3.3**, the implementation can be done as follows: The reference point C at (x_o^1, y_o^1) shifted to E on the frontier of period 2. Consequently, the frontier-shift effect at (x_o^1, y_o^1) is assessed by comparing the distance from the period one production possibility set to point (x_o^1, y_o^1) with the distance from the period two production possibility set to the same point (x_o^1, y_o^1). This evaluation of the frontier-shift effect enables us to understand the alterations in the production possibilities between the two time periods, indicating changes in the DMU's efficiency frontier and its relative efficiency compared to other units. The frontier-shift effect at (x_o^1, y_o^1) is evaluated in **Equation (5)**:

$$\alpha_1 = \frac{AC}{AE} = \frac{\frac{AC}{AP}}{\frac{AE}{AP}} = \frac{Efficient\ of\ (x_0^1, y_0^1)\quad with\ respect\ to\ the\ period\ 1\ frontier}{Efficient\ of\ (x_0^1, y_0^1)\quad with\ respect\ to\ the\ period\ 2\ frontier} \qquad (5)$$

The numerator of **Equation (5)** on the right-hand side has already been calculated in **Equation (3)**. The denominator is determined by measuring the distance from the period two production possibility set to point (x_o^1, y_o^1). Similarly, the expression for the frontier-shift effect at point (x_o^2, y_o^2) is given by **Equation (6)**:

$$\alpha_2 = \frac{BF}{BD} = \frac{\frac{BF}{BQ}}{\frac{BQ}{BD}} = \frac{Efficient\ of\ (x_0^2, y_0^2)\ with\ respect\ to\ the\ period\ 1\ frontier}{Efficient\ of\ (x_0^2, y_0^2)\ with\ respect\ to\ the\ period\ 1\ frontier} \qquad (6)$$

The numerator mentioned above can be assessed using DEA models. By utilizing *α1* and *α2*, we define the "Frontier-shift" effect as the geometric mean of these two values in **Equation (7)**:

$$\textit{Frontier-shift} = \alpha = \sqrt{\alpha_1 \alpha_2} \qquad (7)$$

The "Malmquist index" is now calculated as the result of multiplying the "Catch-up" and "Frontier-shift" values together as **Equation (8)**.

$$\textit{Malmquist index} = (\textit{Catch-up}) \times (\textit{Frontier-shift}) \qquad (8)$$

This index serves as a representation of the Total Factor Productivity (TFP) of the DMU. It indicates both improvements and declines in the efficiency of the DMU. It also considers advancements or setbacks in frontier shift.

To measure the efficiency score of DMU *(x_o, y_o) t1* concerning the frontier *t2*, we now use the following **Equation (9)**.

$$\beta^{t_2} = ((x_0, y_0)^{t_1}) \qquad (t_1 = 1,2 \text{ and } t_2=1,2) \qquad (9)$$

Using this notation, the catch-up effect (C) in [3] can be expressed as **Equation (10)**:

$$C = \frac{\beta^2((x_0,y_0)^2)}{\beta^1((x_0,y_0)^1)} \qquad (10)$$

The frontier-shift effect is measured as **Equation (11)**:

$$F = \sqrt{\frac{\beta^1((x_0,y_0)^1)}{\beta^2((x_0,y_0)^1)} \times \frac{\beta^1((x_0,y_0)^2)}{\beta^2((x_0,y_0)^2)}} \qquad (11)$$

We derive the following **Equation (12)** for calculating MI by multiplying C and F together.

$$MI = \sqrt{\frac{\beta^1((x_0,y_0)^2)}{\beta^1((x_0,y_0)^1)} \times \frac{\beta^2((x_0,y_0)^2)}{\beta^2((x_0,y_0)^1)}} \qquad (12)$$

MI > 1 indicates progress in the total factor productivity of the DMU from period 1 to 2, while MI = 1 and MI < 1 indicate, respectively the status quo and decay in the total factor productivity.

3.3. Conclusion

In the third section, the authors elucidate the methodology and the final model employed in the research investigation. This chapter is structured into three primary areas: the research process and the DEA technique. The research study introduces a hybrid approach that merges Super-SBM and DEA Malmquist methods to evaluate the competitiveness of Asian countries. The DEA method, a data-centric system, permits the comparative assessment of different units' relative efficiency by analyzing their inputs and outputs. The authors present a comprehensive overview of the DEA method, encompassing its origin, definition, and conventional model. Within this research study, two advanced DEA models, namely, DEA Super-SBM and DEA Malmquist, are utilized by the authors. These models serve as practical tools for gaining insights into the efficiency and productivity of various units. The subsequent chapter will provide the findings and the process of data analysis.

CHAPTER 4: FINDINGS AND ANALYSIS

4.1. Data Collection

This analysis aims to examine various Asian countries, where each DMU represents a specific country. The investigation utilizes data from 30 Asian countries and relies on the World Bank database (Worldbank, 2018; Global Innovation Index, 2023), specifically focusing on the GII and the LPI. Based on the existing literature review and experts' opinions, the study establishes total 14 input and output factors**.** Inputs are Institutions (IT), Human capital and research (HR), Infrastructure (IF), Market sophistication (MS), Business sophistication (BS), International shipments (IS) and Tracking and Tracing (TT). Besides, Knowledge and technology outputs (KT), Creative outputs (CR), Global Innovation Index (GI), Income level (IL), Customs (CS), Logistic competence and quality (LQ), and Timeliness (TL) are outputs. Furthermore, the study outlines input and output factors in **Figure 4.1** to enhance the analysis further. Besides, **Table 4.1** shows the inputs and outputs statistics for 30 Asian countries for 2012–2018.

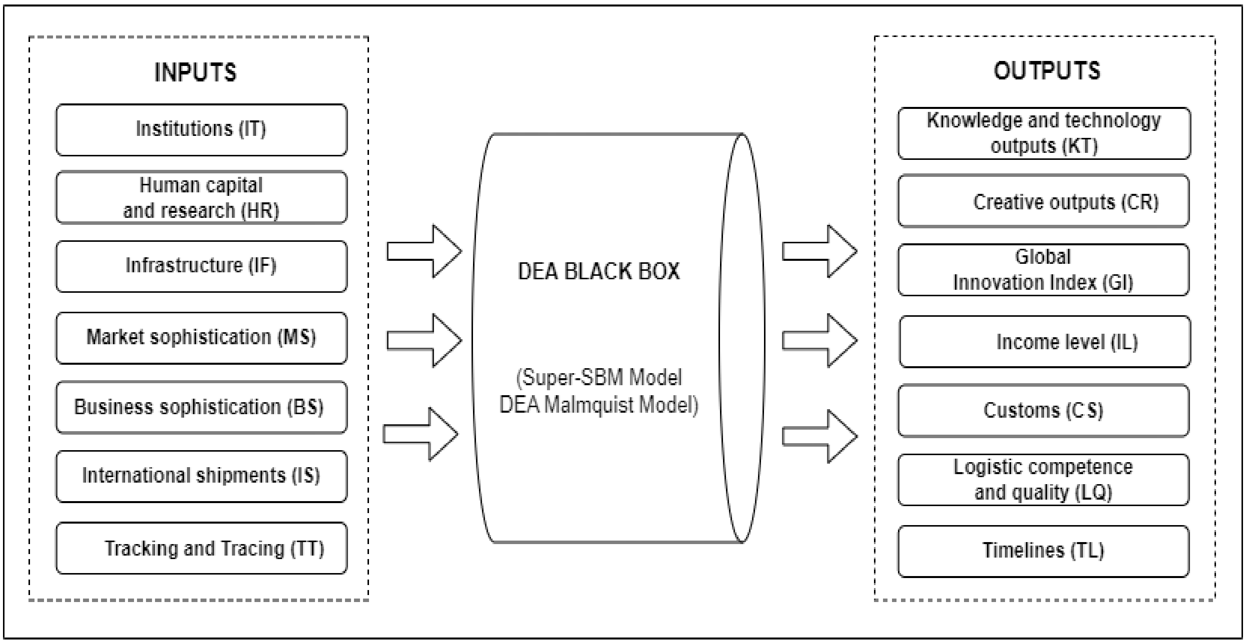

Figure 4.1: The DEA structure for evaluation of countries' competitiveness in Asia. *(Source: Thesis Team)*

Table 4.1. Statistic of inputs and outputs statistics for 30 Asian countries for 2012 – 2018

(Source: Thesis Team)

Period	Statistics	(I) IT	(I) HR	(I) IF	(I) MS	(I) BS	(I) IS	(I) TT	(O) KT	(O) CR	(O) GI	(O) IL	(O) CS	(O) LQ	(O) TL
2012	**Max**	92.600	68.300	64.200	85.500	76.900	4.175	4.090	64.900	52.600	63.500	4.000	4.099	4.076	4.394
	Min	25.400	10.000	20.900	23.400	23.300	1.995	2.130	13.200	17.000	23.100	1.000	1.983	1.883	2.507
	Average	57.430	37.953	38.690	44.983	43.310	3.015	3.108	31.830	33.013	38.463	2.967	2.859	2.982	3.464
	SD	17.222	13.848	12.077	13.409	12.226	0.490	0.538	12.963	8.737	9.836	0.948	0.534	0.567	0.490
2014	**Max**	64.900	67.400	79.700	66.700	3.703	3.952	59.000	56.800	59.200	4.000	4.007	3.967	4.250	4.394
	Min	9.800	19.600	35.400	12.600	2.316	2.130	14.300	5.000	23.700	1.000	2.032	2.132	2.362	2.507
	Average	33.700	40.147	52.933	34.037	3.072	3.138	30.957	33.487	38.373	3.033	2.908	3.085	3.381	3.464
	SD	14.174	12.514	10.713	10.786	0.374	0.482	9.898	10.233	8.943	0.912	0.494	0.460	0.516	0.490
2016	**Max**	67.100	69.100	80.000	62.100	4.055	4.047	54.100	48.600	59.200	4.000	4.179	4.094	4.395	4.394
	Min	13.000	18.000	32.000	8.600	2.103	2.022	10.600	4.200	14.600	2.000	1.800	1.960	2.039	2.507
	Average	34.617	44.220	47.717	32.510	3.146	3.109	28.840	30.260	36.830	2.967	2.899	3.036	3.501	3.464
	SD	14.148	12.923	11.180	12.315	0.539	0.559	10.717	9.684	10.289	0.875	0.600	0.584	0.509	0.490
2018	**Max**	94.700	73.300	68.900	75.700	65.100	3.847	4.080	56.500	48.400	59.800	4.000	3.994	4.100	4.376
	Min	44.000	11.500	21.300	36.200	18.700	2.215	2.100	14.300	14.800	24.100	2.000	1.923	2.208	2.663
	Average	61.703	34.887	46.047	51.297	33.387	3.046	3.083	28.467	30.613	37.497	3.033	2.838	3.020	3.471
	SD	13.866	14.295	11.464	9.072	12.071	0.456	0.555	11.285	8.795	9.706	0.836	0.507	0.546	0.448

The input factors encompass a range of variables that shed light on different dimensions of these countries' economies. The statistics reveal notable variations in the maximum and minimum values across each of these factors, indicating diversity among the countries' economic capacities. For instance, in terms of IT, we observe a substantial growth from 2012 to 2018, with the maximum value increasing from 92.600 to 94.700. This could signify a growing emphasis on technological advancements and digital infrastructure. However, the SD values, which measure the extent of dispersion from the average, suggest that there is considerable variance in these factors, highlighting the disparities in IT capabilities among these nations. Within the HR factor, the landscape of human capital investment and research unfolds. The highest value of 73.300 in 2018 signifies substantial investment in human capital and research, while the minimum value of 11.500 in the same year denotes the foundational level of investment. The average HR value of 34.887 provides a holistic perspective on human capital development, and the SD of 14.295 highlights the range of investment diversities. Focusing on IF factor we unveil the trajectory of infrastructure development. The peak value of 68.900 in 2018 represents the zenith of infrastructure advancement, contrasting with the minimum of 21.300 in the same year, underscoring the rudimentary infrastructure. The average IF value of 46.047 captures the general infrastructure landscape, while the SD of 11.464 demonstrates the scope of infrastructure disparities.

The output factors encompass various parameters that provide insights into the economic outcomes and performance of these countries. Notably, TT and KT showcase consistent increases in their maximum values over the years, indicating growing trade activities and capital investments. The minimum and average values also portray trends of growth, suggesting an overall positive trajectory in these areas. On the other hand, CR and GI exhibit less consistent trends. Among these factors, GI stands as a pivotal measure of innovation performance. The peak value of 4.394 in 2012 underscores a robust innovation landscape, whereas the nadir of 2.507 in the same year denotes comparatively subdued innovation. The average GI value of 3.464 tracks the overall trend in innovation, with the SD of 0.490 accentuating the diversity in innovation capacities. Furthermore, CS serves as a window into trade efficiency. Higher CS values, exemplified by the maximum of 4.099 in 2012, signify streamlined customs processes, while the minimum of 1.983 in the same year implies room for enhancement. The average CS value of 2.859 encapsulates the general trade efficiency trajectory, and the SD of 0.534 underscores the range in customs performance. Besides, LQ holds the essence of logistical adeptness. Elevated LQ values mirror superior logistical capabilities, with the zenith of 4.100 in 2018 symbolizing excellence and the nadir of 2.208 in the same year, capturing the foundational stage. The average LQ value of 3.020 represents the overarching trend, while the SD of 0.546 showcases the spectrum of logistical proficiency.

Across the board, the averages and standard deviations indicate that while some factors experienced steady growth or stability, others displayed more variability. The wide range between the maximum and minimum values in various factors highlights the diversity and economic inequality present among these Asian countries. The statistics help in identifying the range, trends, and variations in these factors, contributing to a comprehensive analysis of the Asian countries' competitiveness.

4.2. Pearson Correlation Coefficient

The Pearson correlation coefficient holds significance within DEA as it evaluates the connection between input and output factors. This coefficient offers insights into the linear relationship between two datasets or variables, encompassing a scale from -1 to +1. A score of +1 denotes complete positive linear correlation, signifying that an elevation in one variable corresponds to a rise in the other. Conversely, a value of 0 implies absence of linear correlation, indicating no link between the variables. In contrast, a score of -1 indicates complete negative linear correlation, suggesting that an increase in one variable relates to a decrease in the other.

In this study's context, the Pearson correlation coefficient values for all DMUs during the four-year timeframe are not only statistically significant but also consistently positive. This substantiates the appropriateness of the input and output data employed in the research. The outcomes of the Pearson correlation coefficient analysis are detailed in **Appendix A**, illustrating the correlation matrix depicting relationships between inputs and outputs for the years 2012 to 2018.

The presented table displays the correlations among different input variables and output variables for each individual year. To illustrate, in the year 2012, a robust positive correlation is observed between International Shipment and Logistic competence and quality. Likewise, various other factors exhibit diverse levels of correlation. These correlations consistently persist over the course of multiple years, exhibiting minor fluctuations in the coefficient magnitudes.

4.3. Super-SBM Results

4.3.1. Efficiency Analysis

In the initial phase of their study, the researchers employed the Super-SBM model to assess the competitiveness of 30 Asian countries from 2012 to 2018. According to the Super-SBM model, a DMU is classified as inefficient if its score is below 1, whereas it is considered efficient if it is equal to or greater than 1. The results of the Super-SMB model are provided in **Table 4.1**. The average efficiency scores obtained over the years varied from 1.009 to 1.027, suggesting significant scope for improving the competitiveness efficiency of most Asian countries.

Table 4.2: Competitiveness efficiency scores and ranking of Asian countries (2012–2018)

(Source: Thesis Team)

Country	**2012**	**2014**	**2016**	**2018**	**Average Scores**	**2012**	**2014**	**2016**	**2018**	**Average Ranking**
	Efficiency Scores					**Ranking**				
Pakistan	1.280	1.188	1.082	1.061	1.153	1	1	5	7	4
Kuwait	1.054	1.067	1.167	1.143	1.108	9	4	2	1	4
Armenia	1.008	1.073	1.134	1.117	1.083	20	3	4	2	7
Thailand	0.889	1.004	1.404	1.010	1.077	26	26	1	21	19
Tajikistan	1.054	1.122	1.070	1.059	1.076	8	2	6	8	6
China	1.112	1.050	1.026	1.095	1.071	2	8	15	3	7
Cyprus	1.008	1.047	1.139	1.049	1.061	21	11	3	10	11
Jordan	1.070	1.047	1.045	1.065	1.057	6	10	8	6	8
Mongolia	1.036	1.033	1.034	1.076	1.045	11	16	11	4	11
Turkey	1.030	1.065	1.045	1.040	1.045	12	5	9	12	10
Qatar	1.067	1.038	1.036	1.021	1.041	7	14	10	16	12
Indonesia	1.079	1.055	1.009	1.017	1.040	3	6	22	17	12
Oman	1.075	1.022	1.032	1.029	1.040	5	20	12	14	13
Russia	1.044	1.048	1.021	1.009	1.031	10	9	19	24	16
Georgia	1.030	1.040	1.022	1.013	1.026	13	12	17	20	16
South Korea	1.017	1.025	1.026	1.027	1.024	16	19	16	15	17
Egypt	1.001	1.026	1.015	1.054	1.024	25	17	21	9	18
India	1.076	1.003	1.003	1.000	1.021	4	27	25	28	21
Saudi Arabia	1.012	1.026	1.004	1.009	1.013	18	18	24	22	21
Singapore	1.024	1.012	1.002	1.009	1.012	15	23	26	22	22
Japan	1.010	1.008	1.007	1.017	1.010	19	24	23	18	21
Vietnam	0.832	1.036	1.028	1.046	0.986	29	15	14	11	17
Philippines	1.013	0.902	1.022	1.004	0.985	17	28	18	25	22
Bahrain	0.871	1.014	1.032	1.015	0.983	27	21	13	19	20
United Arab Emirates	1.001	1.055	0.861	1.004	0.980	24	6	28	26	21
Lebanon	1.007	1.005	1.020	0.841	0.968	22	25	20	30	24
Cambodia	0.680	1.039	1.051	1.068	0.960	30	13	7	5	14
Hong Kong	1.004	1.012	0.811	1.000	0.957	23	22	30	27	26
Kyrgyzstan	1.028	0.732	1.001	1.031	0.948	14	30	27	13	21

Malaysia	0.842	0.821	0.848	0.888	0.850	28	29	29	29	29
Average	**1.008**	**1.021**	**1.033**	**1.027**						

As mentioned in **Table 4.2**, five Asian countries emerge as having the highest efficiency scores out of the 30 countries: Pakistan, China, Armenia, Tajikistan, and Kuwait. Pakistan consistently ranks as one of the top-performing countries in terms of efficiency scores, with an average efficiency score of 1.153 and an average ranking of 4. The efficiency scores for Pakistan were 1.280 (2012), 1.188 (2014), 1.082 (2016), and 1.061 (2018), resulting in rankings of 1 (2012), 1 (2014), 5 (2016), and 7 (2018). Pakistan's efforts to enhance its infrastructure, improve business regulations, and attract foreign investments have significantly contributed to its high ranking (Arsalan, 2022). Its advantageous geographical position as an entryway to Central Asia (Fair, 2008) and its growing population also play a significant role in its competitive advantage.

Following Pakistan, Kuwait ranks second in high-efficiency scores, primarily attributed to its oil-based solid economy. With scores of 1.054 (2012), 1.067 (2014), 1.167 (2016), and 1.143 (2018), Kuwait achieved rankings of 9 (2012), 4 (2014), 2 (2016), and 1 (2018). Consequently, Kuwait achieved an average efficiency score of 1.108 and an average ranking of 4. The country's substantial oil reserves have provided a solid economic foundation, enabling infrastructure, healthcare, and education investments (Rania and Eman, 2009). Moreover, Kuwait's efforts to diversify its economy through initiatives like the Kuwait Vision 2035 plan have further contributed to its competitiveness (Chris, 2021). Next, Armenia is ranked third among the top five countries with the highest efficiency scores, with an average efficiency score of 1.083 and an average ranking of 7. Armenia has shown an impressive rise in efficiency scores during the given Period, with scores of 1.008 (2012), 1.073 (2014), 1.134 (2016), and 1.117 (2018), resulting in rankings of 20 (2012), 3 (2014), 4 (2016), and 2 (2018). This improvement can be attributed to Armenia's focus on developing a knowledge-based economy (Ivailo Izvorski, 2023). The country has invested in education, science, and technology, leading to a vibrant tech industry and a skilled workforce. Furthermore, Armenia's favourable business environment, including simplified tax regulations and government support for startups and innovation, has enhanced competitiveness (Narine, 2021).

Behind Armenia, Tajikistan has prioritized infrastructure development and the diversification of its economy, positively impacting its efficiency scores (Development

Bank, 2016). Tajikistan achieved an average efficiency score of 1.076 and an average ranking of 6. The efficiency scores for Tajikistan were 1.054 (2012), 1.122 (2014), 1.070 (2016), and 1.059 (2018), leading to rankings of 8 (2012), 2 (2014), 6 (2016), and 8 (2018). The nation has made notable advancements in energy production, transportation, and telecommunications. Additionally, Tajikistan's strategic investments in tourism and abundant natural resources have further enhanced its competitiveness (The Government Decree of the Republic of Tajikistan, 2018). Finally, China, with an average efficiency score of 1.07075 and an average ranking of 7, has consistently demonstrated strong competitiveness. China's efficiency scores were 1.112 (2012), 1.050 (2014), 1.026 (2016), and 1.095 (2018), resulting in rankings of 2 (2012), 8 (2014), 15 (2016), and 3 (2018). The country's continuous economic growth and significant investments in various sectors have propelled its regional competitiveness. China's strong manufacturing base, technological advancements, and export-oriented policies have contributed to its high-efficiency scores (Yang, 2011; Jigang, 2020). Moreover, China's integration into global supply chains and its emphasis on innovation research and development (R&D) has played a crucial role in maintaining its competitive edge (Huang, 2023).

Next, Thailand, with an average score of 1.077, exhibited a mixed performance in terms of competitiveness efficiency. While it secured the top position in 2016, its ranking fluctuated significantly in other years. The country's performance can be attributed to factors such as political instability, fluctuations in the global economy, and challenges in enhancing innovation capabilities (Trakarnsirinont, Jitaree and Buachoom, 2023). Moreover, with an average score of 1.061, Cyprus showcased a mixed performance throughout the years. Although it achieved a high ranking in 2014, its position fluctuated in subsequent years. Economic instability, political challenges, and changes in international business dynamics have influenced Cyprus's competitiveness efficiency (International Monetary Fund, 2019). Besides, with an average score of 1.057, maintained a relatively stable performance in terms of competitiveness efficiency. Its rankings fluctuated slightly throughout the years but consistently remained within the top 10. Jordan's success can be attributed to its efforts in economic diversification, attracting foreign investments, improving infrastructure, and promoting entrepreneurship and innovation (Alawamleh, Francis and Alawamleh, 2023).

Similarly, Mongolia, with an average score of 1.045, demonstrated a consistent competitiveness efficiency performance over the years. Despite fluctuations in its rankings, it remained within the top 20. Mongolia's focus on developing its mining and natural resources sectors, promoting sustainable economic growth, and improving the business environment contributed to its competitiveness (Li, Gupta and Yu, 2017). Similarly, Turkey, with an average score of 1.045, displayed a relatively stable performance in terms of competitiveness efficiency. Its rankings remained within the top 10 throughout the years. Turkey's success can be attributed to its strategic location as a gateway between Europe and Asia, investments in infrastructure and transportation, and a dynamic private sector that drives economic growth (Raiser, Wes and Yilmaz, 2016).

In contrast, Qatar, with an average score of 1.041, showcased a fluctuating performance in competitiveness efficiency. Although it achieved a high ranking in 2014, its position dropped in subsequent years. Qatar's competitiveness is influenced by factors such as its natural gas reserves, investments in infrastructure and construction projects, and initiatives to diversify its economy beyond hydrocarbon resources (International Monetary Fund, 2022).

Shifting the focus, Indonesia, with an average score of 1.040, exhibited a mixed performance in terms of competitiveness efficiency. While it secured a high ranking in 2016, it faced challenges in other years. Indonesia's efforts to improve its business environment, invest in infrastructure development, and promote economic reforms have contributed to its competitiveness, despite obstacles such as bureaucratic inefficiencies and infrastructure gaps (Listiyanto and Pulungan, 2021). Similarly, Oman, with an average score of 1.040, maintained a relatively stable performance in competitiveness efficiency. Its rankings remained within the top 20 throughout the years. Oman's focus on economic diversification, investments in infrastructure, and enhancing its business environment have contributed to its competitiveness, particularly in sectors such as tourism, logistics, and manufacturing (Ullah, Salah and Din, 2022). Furthermore, Russia, with an average score of 1.031, displayed a mixed performance in terms of competitiveness efficiency. Its rankings fluctuated over the years, and it faced challenges such as geopolitical tensions and economic sanctions. However, Russia's strengths in areas such as natural resources, skilled labor force, and technological capabilities have contributed to its competitiveness, especially in sectors like energy, aerospace, and defense (Gokhberg, Sokolov and Chulok, 2017).

In a similar vein, Georgia, with an average score of 1.026, showcased a relatively stable performance in competitiveness efficiency. While its rankings fluctuated, it remained within the top 20. Georgia's focus on economic reforms, improving the business environment, and attracting foreign direct investment have contributed to its competitiveness, particularly in sectors such as tourism, agriculture, and logistics (Hall and Dennis, 2018). Meanwhile, South Korea, with an average score of 1.024, displayed a relatively stable performance in terms of competitiveness efficiency. Its rankings remained within the top 20 throughout the years. South Korea's success can be attributed to its strong focus on innovation, investments in research and development, a highly skilled workforce, and a robust manufacturing sector, particularly in the electronics and automotive industries (Bill Emmott, 2015).

Conversely, Egypt, with an average score of 1.024, exhibited a mixed performance in terms of competitiveness efficiency. Although it achieved a high ranking in 2018, its position fluctuated in other years. Egypt's efforts to improve its business environment, attract foreign investments, and develop its infrastructure have contributed to its competitiveness. However, political instability and social disparities have impacted its overall performance (Christopher Jarvis, 2015).

Moving on, with an average score of 1.021, India showcased a varied performance in competitiveness efficiency. While it faced challenges in specific years, India's rankings improved. The country's large domestic market, investments in information technology, reforms in business regulations, and initiatives to promote entrepreneurship have contributed to its competitiveness. However, infrastructure gaps and bureaucratic hurdles remain areas for improvement (BRINK Asia Editorial Staff, 2016). Similarly, with an average score of 1.013, Saudi Arabia demonstrated a relatively stable performance in competitiveness efficiency. Its rankings fluctuated but remained within the top 25. Saudi Arabia's focus on economic diversification through its Vision 2030 plan, investments in infrastructure, efforts to attract foreign investments, and reforms in labor market policies have contributed to its competitiveness, particularly in sectors such as energy, finance, and tourism.

In contrast (Amine Mati and Sidra Rehman, 2022), Singapore, with an average score of 1.012, consistently achieved high rankings in competitiveness efficiency. The country's success can be attributed to its strong emphasis on education and human capital development, efficient government policies, world-class infrastructure, and a favorable business environment. Singapore's strategic global financial and trading hub location also contributed to its competitiveness (Phan, 2022).

Furthermore, Japan, with an average score of 1.010, showcased a relatively stable performance in terms of competitiveness efficiency. While its rankings fluctuated, it remained within the top 25. Japan's competitiveness is driven by its technological advancements, innovation capabilities, high-quality infrastructure, and solid manufacturing base. The country's focus on research and development, particularly in sectors like automotive, electronics, and robotics, has contributed to its competitiveness (Shun Chokki et al., 2022). Similarly, with an average score of 0.986, Vietnam displayed a mixed performance in competitiveness efficiency. Although it achieved a high ranking in 2014, its position fluctuated in other years. Vietnam's competitiveness is influenced by factors such as its young and dynamic workforce, infrastructure development investments, and business environment improvements. The country's growing manufacturing sector has contributed to its competitiveness, particularly in textiles, electronics, and footwear(Choi et al., 2021).

Similarly, the Philippines, with an average score of 0.985, demonstrated a varied performance in terms of competitiveness efficiency. While it faced challenges in specific years, the Philippines' rankings improved over time. The country's strengths lie in its services sector, such as business process outsourcing and tourism, as well as its young and English-speaking workforce. Efforts to address infrastructure gaps, enhance governance, and promote inclusive economic growth have contributed to its competitiveness (International Monetary Fund, 2020).

In addition, Bahrain, with an average score of 0.983, showcased a mixed performance in competitiveness efficiency. Its rankings fluctuated, but Bahrain maintained a relatively competitive position. The country's strategic location as a financial center in the Gulf region, favorable business regulations, and investments in banking, tourism, and logistics have contributed to its competitiveness (Andreas Buelow et al., 2022). Similarly, the United Arab Emirates (UAE), with an average score of 0.980, displayed a varied performance in competitiveness efficiency. Although it achieved a high ranking in 2014, its position fluctuated in other years. The UAE's strengths lie in finance, tourism, and trade sectors supported by world-class infrastructure, business-friendly policies, and strategic investments (Mishrif and Kapetanovic, 2018). However, challenges such as economic diversification and labor market reforms remain crucial for further enhancing competitiveness.

On the other hand, from 2012 to 2018, Cambodia, Hong Kong, Lebanon, Malaysia, and Kyrgyzstan exhibited the lowest efficiency scores, indicating relatively lower competitiveness compared to other Asian nations. Based on an average efficiency score of 0.850 and an average ranking of 29, Malaysia faces challenges in education quality, productivity enhancement, and corruption (Mohammed et al., 2023). Despite ongoing initiatives, these issues continue to impact Malaysia's efficiency scores. Following Malaysia, Kyrgyzstan recorded lower efficiency scores than its counterparts, averaging 0.948 and ranking 21. Governance, institutional capacity, and infrastructure development require attention, while political instability and corruption also contribute to its lower competitiveness. Next, Hong Kong experienced a decline in efficiency scores, averaging 0.957 with a ranking of 26, due to socio-political unrest, trade disputes, and instability, adversely affecting investor confidence (Li, 2019; Research Office Legislative Council Secretariat, 2019).

Moreover, with an average efficiency score of 0.960 and an average ranking of 14, Cambodia faces infrastructure limitations, bureaucratic obstacles, and governance issues (Mono, 2021). However, recent progress in improving the business environment and attracting investments showcases positive developments. Lastly, with an average efficiency score of 0.968 and a ranking of 24, Lebanon grapples with high public debt, political instability, and regional conflicts, hindering its business environment and competitiveness (Warsaw Institute Org, 2023). These factors impede investment attraction and slow economic growth prospects.

4.3.2. Slack Analysis

Table 4.3: Average Slack of Asian Countries (2012 – 2018) (Source: Thesis Team)

Country	Average Score	Average Rank	(I) IT	(I) HR	(I) IF	(I) MS	(I) BS	(I) IS	(I) TT	(O) KT	(O) CR	(O) GI	(O) IL	(O) CS	(O) LQ	(O) TL
Russia	1.031	16	0.000	0.000	0.000	0.109	0.071	0.039	0.217	1.849	2.034	0.084	0.276	0.248	0.030	0.052
China	1.071	7	6.101	0.000	0.671	0.973	0.000	0.000	0.000	1.475	2.026	0.089	0.197	0.059	0.118	0.195
India	1.021	21	0.462	0.000	0.000	0.000	0.000	0.052	0.000	1.519	2.093	0.596	0.220	0.107	0.048	0.079
Saudi Arabia	1.013	21	0.631	0.000	0.000	0.000	0.078	0.004	3.430	7.014	2.427	1.009	0.168	0.121	0.107	0.032
Mongolia	1.045	11	0.000	0.000	0.000	0.000	0.042	0.087	2.800	0.948	0.000	0.152	0.448	0.226	0.250	0.045
Indonesia	1.040	12	3.487	0.000	0.000	0.000	0.058	0.013	1.121	3.544	0.264	0.973	0.151	0.081	0.000	0.000
Pakistan	1.153	4	1.775	1.876	1.667	3.052	0.000	0.000	0.404	1.384	1.411	0.504	0.001	0.000	0.000	0.064
Turkey	1.045	10	1.018	1.110	0.748	0.800	1.225	0.000	0.000	1.881	0.000	0.000	0.049	0.095	0.171	0.018
Thailand	1.077	19	0.535	1.744	1.172	2.710	1.562	0.000	1.082	4.719	1.932	0.000	0.000	0.069	0.061	0.078
Japan	1.010	21	0.000	0.000	0.000	0.000	0.024	0.095	0.000	1.965	2.960	0.000	0.023	0.000	0.046	0.150

Vietnam	0.986	17	0.611	3.447	2.855	1.069	1.050	0.000	0.010	0.674	1.471	0.302	0.416	0.123	0.132	0.000
Malaysia	0.850	29	9.724	8.277	0.000	5.693	2.149	0.125	2.129	4.823	0.806	0.433	0.242	0.075	0.140	0.175
Oman	1.040	13	0.000	0.000	0.346	1.206	0.087	0.052	4.138	3.171	1.361	0.709	0.015	0.007	0.043	0.070
Philippines	0.985	22	0.270	0.788	0.840	0.594	0.000	0.008	0.000	1.875	2.592	0.176	0.172	0.105	0.024	0.058
Kyrgyzstan	0.948	21	2.652	0.982	3.294	0.000	0.041	0.110	1.289	8.280	4.141	0.648	0.364	0.090	0.077	0.000
Cambodia	0.960	14	1.731	3.345	1.013	1.854	0.629	0.000	0.279	4.124	1.474	0.846	0.269	0.077	0.106	0.057
Tajikistan	1.076	6	0.000	1.929	1.594	1.247	1.281	0.043	0.023	3.977	1.254	0.096	0.102	0.065	0.161	0.063
South Korea	1.024	17	0.000	0.000	0.538	0.263	0.692	0.099	0.027	0.633	0.885	0.000	0.000	0.037	0.160	0.188
Jordan	1.057	8	0.000	0.124	2.269	1.338	0.873	0.101	0.000	2.152	0.000	0.033	0.076	0.034	0.105	0.182
UAE	0.980	21	1.441	0.000	1.854	3.320	0.058	0.034	3.843	5.059	1.784	0.533	0.000	0.034	0.041	0.200
Georgia	1.026	16	0.000	0.000	0.241	0.160	0.029	0.045	0.074	2.268	2.351	0.000	0.025	0.076	0.038	0.103
Egypt	1.024	18	0.000	0.000	1.294	0.234	0.010	0.000	0.001	1.416	2.881	0.408	0.220	0.073	0.026	0.000
Armenia	1.083	7	1.668	1.392	0.310	0.000	0.006	0.083	0.000	0.832	1.787	0.151	0.095	0.018	0.116	0.025
Kuwait	1.108	4	1.539	0.000	0.474	1.770	3.272	0.084	0.057	0.660	0.438	0.000	0.031	0.118	0.040	0.098
Qatar	1.041	12	0.000	0.000	2.138	2.301	0.029	0.168	3.827	0.000	1.209	0.210	0.029	0.125	0.082	0.047
Lebanon	0.968	24	0.000	0.071	0.704	0.000	2.304	0.053	2.536	3.126	1.602	0.345	0.083	0.203	0.253	0.000
Cyprus	1.061	11	0.000	0.733	0.755	0.000	0.042	0.097	0.035	0.033	0.491	0.000	0.024	0.123	0.115	0.032
Bahrain	0.983	20	2.737	2.519	1.515	1.274	0.046	0.000	0.786	6.719	2.329	0.645	0.019	0.074	0.252	0.070
Singapore	1.012	22	0.000	0.000	0.000	0.000	0.022	0.085	1.359	3.588	2.597	0.273	0.154	0.000	0.137	0.137
Hong Kong	0.957	26	3.591	1.117	1.407	0.000	0.056	0.068	5.656	5.984	1.094	0.389	0.000	0.035	0.241	0.589

In **Table 4.3,** the countries ranked as the top three in the efficiency index are Pakistan, Kuwait, and Armenia. More specifically, the average scores obtained from the results of the Slack analysis conducted from 2012 to 2018 are 1.153, 1.108, and 1.083, respectively. Pakistan has demonstrated significant efficiency in utilizing BS and IS inputs. It is worth noting that Pakistan has a diversified economy, with industries, agriculture, and services contributing to its GDP. Throughout this period, Pakistan has achieved steady and progressive economic growth across various sectors, benefiting from its favorable geographical position in Central Asia (Fair, 2008) and contributing significantly to its high ranking. Following Pakistan, Kuwait occupies the second position. Kuwait's efficient utilization is primarily observed in the HF input. The country's substantial oil reserves contribute significantly to its GDP (Rania and Eman, 2009).

Moreover, efforts towards promoting economic diversification have enhanced Kuwait's competitive value. In the third spot is Armenia, distinguished by its optimal employment of MS and TT inputs. Armenia boasts a developed information technology industry, attracting investments and creating employment opportunities (Sargis, 2017). Additionally, its strategic geographic location between Europe and Asia provides advantageous international trade and cooperation conditions (Bedirian et al., 2022). Notably, all three countries exhibit outputs close to or greater than 0, ranging between 0.000 and 1.411. This signifies that the inputs effectively contribute to the desired outcomes, albeit with some degree of overuse (Le and Umetsu, 2022). Despite achieving positive results, their overall performance remains room for improvement. Notably, these countries should focus on enhancing their efficiency levels to meet the growing demand for output. Recognizing the pivotal role of the input-output relationship in economic efficiency and productivity, they ought to strive to minimize stagnation and consider increasing inputs when necessary. By doing so, these countries can maximize their output and overall performance. Moreover, scaling can be a viable strategy for them to pursue (Atta Mills et al., 2021).

Behind Armenia, Thailand emerges with a score of 1.077. According to **Table 4.3,** Thailand used the IS input well. During the study period, Thailand witnessed steady economic growth and industrial diversification, which contributed significantly to the country's high ranking. Thailand has strived for comprehensive economic development of the country by promoting tourism, exports, industrial production, and foreign investment. However, this country still faces political instability, global economic volatility, and innovation capacity challenges (Trakarnsirinont, Jitaree and Buachoom, 2023). Next in line is Tajikistan, with a mean score of 1.076, demonstrating a fair use of IT input. Tajikistan has experienced noteworthy economic growth by augmenting public investment and developing key industries such as energy, mining, and construction. These efforts have facilitated the expansion and diversification of the economy, consequently enhancing the country's competitive advantage. Behind Tajikistan lies China, showcasing an efficiency score of 1.071. China has efficiently utilised HR, BS, IS, and TT inputs. Over the past few decades, China has emerged as the world's largest economy, characterized by consistent growth and rapid development. Its robust manufacturing base, technological advancements, and export-oriented policies have all contributed to its commendable efficiency scores (Yang, 2011; Jigang, 2020). However, it is worth noting that these countries have majority outputs exceeding 0, falling within the range of 0.000 to 4.719. This suggests an overutilization of inputs (Le and Umetsu, 2022). These countries could consider increasing their inputs or expanding their operations to maximize output.

Cyprus effectively utilised its IT and MS inputs, as indicated by an average efficiency score of 1.061. Following the 2013 financial crisis, Cyprus has made an economic recovery and diversification efforts (George, 2013). The country's tourism, financial, and service sectors have been strengthened, attracting foreign investment and contributing to sustained economic growth and improved competitive positioning. Similarly, Jordan achieved an average score of 1.057, reflecting moderate IT and TT inputs utilisation. This country has prioritized attracting foreign investment, implementing expedited economic reform measures, and diversifying its economy, all of which have contributed to sustainable growth and development (Alawamleh, Francis and Alawamleh, 2023). With a score of 1.045, Turkey effectively employed the IS and TT inputs, as indicated by **Table 4.3**. To enhance its competitiveness, this country has focused on public investment, building infrastructure, diversifying industries, and expanding exports, contributing to increased productivity and economic growth (Raiser, Wes and Yilmaz, 2016). However, it is noteworthy that all these countries exhibit outputs more significant than 0, indicating the potential overutilization of input factors (Le and Umetsu, 2022). To meet the rising demand, these nations must enhance their efficiency levels. They should minimize stagnation and consider increasing input as needed (Atta Mills et al., 2021).

In the subsequent rankings, Mongolia, Qatar, Indonesia, Oman, Russia, and Georgia attained scores of 1.045, 1.041, 1.040, 1.040, 1.031, and 1.026, respectively. Mongolia displayed prudent utilization of IT, HR, IF, and MS inputs. However, it is essential to note that six out of seven outputs in Mongolia surpassed zero, indicating room for improvement. Furthermore, Qatar, Oman, and Georgia employed IT and HR inputs effectively. Indonesia demonstrated reasonable utilization of HR, IF, and MS inputs, while Russia exhibited reasonable utilization of IT, HR, and IF inputs.

Nonetheless, all these countries registered outputs above 0, ranging from 0.000 to 3.544. These findings suggest that these countries may be overutilizing inputs, and considering their competitive strengths, they could explore opportunities to maximize output by augmenting inputs or expanding their operational scale (Atta Mills et al., 2021). By implementing these strategies, these countries can enhance efficiency, foster economic growth, and achieve sustainable international competitiveness.

According to the table, the six countries, namely South Korea, Egypt, India, Saudi Arabia, Singapore, and Japan, have Average Slack results of 1.024, 1.024, 1.021, 1.013, 1.012, and 1.010, respectively. It indicates that these countries utilize their resources relatively efficiently to generate desired outcomes. All six countries have input values close to 0, approximately 4 out of 7 inputs or approaching 0, except for the TT factor in Saudi

Arabia, which is not effectively utilized and has the potential for optimization. This means that these countries are using the input factors quite well.

Looking at the outputs of the six countries, we observe a high proportion of output indices more significant than 0. Notably, the KT of Saudi Arabia and Singapore shows that the output in KT has reached its highest point of inefficiency, with values of 7.014 and 3.588, respectively. Additionally, the CR of five out of six countries, namely Egypt, India, Saudi Arabia, Singapore, and Japan, all have slack results more significant than 2. This indicates that the generation CR has reached its high-efficiency point. Promoting and supporting innovative activities to enhance CR may be necessary.

The solution for these six countries is to increase research and development (R&D) investment, which can enhance innovation capabilities and technological output. The countries can enhance public-private collaboration in funding research and development projects and encourage businesses to invest in research and innovation. Furthermore, innovation in technology and technology transfer can create a favorable environment for technological innovation and transfer, thus enhancing technological output. The countries can create favorable conditions to promote technology transfer from foreign organizations and encourage public-private collaboration in applying new technologies and creating value-added results.

According to the Slack result table, six countries, namely Vietnam, Philippines, Bahrain, UAE, Lebanon, and Cambodia, have high Slack values in the KT and CR. In particular, Bahrain, UAE, Lebanon, and Cambodia have slack values for KT greater than 3. This indicates that there is room for improvement in these countries. They have the potential to achieve better performance and efficiency in KT. Additionally, all six countries have CR with values greater than 1, which suggests their potential for better performance and efficiency in CR.

Specifically, for Vietnam, the slack results for input such as HR, IF, MS, and BS are 3.447, 2.855, 1.069, and 1.050, respectively, exceeding 1. This indicates that Vietnam is not effectively utilizing its HR, IF, MS, and BS inputs. It requires efforts from Vietnam to improve its policies and strategies for the country's development. Vietnam has a strong and determined policy to promote investment and boost the logistics-driven economy. According to the Ministry of Planning and Investment, the total planned capital allocation 2023 is more than 33.9 billion dollars (Lan, 2023). This reflects the country's commitment to enhance its economic growth and development.

Each country must enhance institutional frameworks and policies to address these challenges and improve performance. Implementing effective governance structures, safeguarding intellectual property rights, and enacting supportive policies can foster an environment conducive to knowledge-based activities. Clear regulations and transparent processes will attract investments and facilitate the transfer and dissemination of knowledge. Furthermore, implementing a robust monitoring and evaluation framework aimed at regularly assessing performance, tracking progress, and identifying areas for improvement, is crucial. Such an approach provides valuable insights into the effectiveness of interventions and guides future strategies.

From 2012 to 2018, Hong Kong, Malaysia, and Kyrgyzstan displayed the lowest average slack scores, indicating relatively lower competitiveness than other Asian countries. With an average slack score of 0.850 and an efficiency ranking of 29, Malaysia faces several challenges in education quality, productivity enhancement, and corruption. Despite ongoing initiatives, these issues persist and impact Malaysia's overall scores.

Following Malaysia, Kyrgyzstan recorded lower average slack scores than its counterparts, averaging 0.948 and ranking 21. The country requires attention regarding governance, institutional capacity, and infrastructure development. Additionally, political instability and corruption contribute to Kyrgyzstan's lower level of competitiveness.

Hong Kong experienced a decline in average slack scores, averaging 0.957 with a ranking of 26. This decline can be attributed to socio-political unrest, trade disputes, and overall instability, all of which have adversely affected investor confidence. These factors have played a significant role in Hong Kong's diminished competitiveness compared to previous years.

Malaysia must address the issues surrounding education quality, productivity enhancement, and corruption. Implementing measures to improve the quality of education and increase productivity levels can enhance Malaysia's competitiveness. Additionally, combating corruption through stricter regulations and enforcement will create a more favorable business environment. In the case of Kyrgyzstan, focused efforts are required to strengthen governance structures, enhance institutional capacity, and develop infrastructure. Addressing political instability and corruption issues will be pivotal in improving the country's competitiveness and attracting investments. For Hong Kong, resolving socio-political unrest, resolving trade disputes, and restoring stability are essential. By doing so, investor confidence can be regained, improving competitiveness in the global market. These countries should prioritize policy reforms, resource allocation, and strategic planning to address the underlying challenges and create an environment conducive to competitiveness and economic growth.

4.4. Malmquist Results

4.4.1. The Efficiency Change

Table 4.4: Catch-up of Asian countries (2012 - 2018) (Source: Thesis Team)

Country	2012=>2016	2014=>2018	Average
Vietnam	1.143	1.025	1.084
United Arab Emirates	0.921	0.952	0.937
Turkey	1.084	0.995	1.039
Thailand	1.651	0.995	1.323
Tajikistan	1.010	0.941	0.976
South Korea	1.014	1.002	1.008
Singapore	0.974	0.995	0.985
Saudi Arabia	1.013	0.935	0.974
Russia	0.919	0.932	0.926
Qatar	0.984	0.988	0.986
Philippines	1.000	1.040	1.020
Pakistan	0.781	0.941	0.861
Oman	0.976	1.028	1.002
Mongolia	1.026	1.083	1.054
Malaysia	1.026	1.027	1.026
Lebanon	1.027	0.926	0.977
Kyrgyzstan	0.853	1.301	1.077
Kuwait	1.122	1.055	1.088
Jordan	0.861	1.014	0.937
Japan	0.995	1.015	1.005
Indonesia	0.930	0.885	0.907
India	0.829	0.991	0.910

Hong Kong	0.910	0.986	0.948
Georgia	0.989	0.969	0.979
Egypt	1.047	1.061	1.054
Cyprus	1.141	0.983	1.062
China	0.775	0.867	0.821
Cambodia	1.246	1.071	1.159
Bahrain	1.145	0.978	1.062
Armenia	1.149	1.087	1.118
Average	**1.018**	**1.002**	**1.010**

Catch-up	2012=>2016	2014=>2018	Average
Russia	0.919727085	0.93253	0.926128
China	0.775981866	0.867909	0.821946
India	0.829958024	0.991095	0.910526
Saudi Arabia	1.013486815	0.935219	0.974353
Mongolia	1.026112689	1.083501	1.054807
Indonesia	0.930936128	0.885013	0.907974
Pakistan	0.781635964	0.941559	0.861597

In the preceding phase, the researchers used the Super SBM model to evaluate the relative competitiveness and performance of Asian countries from 2012 to 2018. In contrast, the Malmquist model was employed to analyze the competitiveness performance of 30 nations. Specifically, this model analyses the overall productivity change concerning competitiveness over the specified period.

According to the findings in **Table 4.4**, there is a notable disparity in efficiency changes between the two periods. Regarding the catching-up index, most countries have values greater than 1. Upon analyzing individual countries, it becomes evident that the majority of them have experienced an improvement in their efficiency change. Specifically, out of the countries assessed, 17 have achieved an efficiency change score of 1 or higher. Thailand, Cambodia, and Armenia are in the top 3 of the average efficiency score. Specifically, Thailand is in the first position average efficiency change score of 1.323, followed by Cambodia with a score of 1.159.

Thailand, Cambodia, and other countries in Southeast Asia like Vietnam, Singapore, Malaysia, Philippines, … have achieved a high-efficiency change compared to other regions. This outcome is a product of integrating a comprehensive approach to resource development that aims to foster overall economic growth. The shared development trajectory arises from implementing mutual policies in Southeast Asia aimed at attaining sustainable development and economic cooperation objectives. These include removing trade barriers, both tariff and non-tariff, within ASEAN member nations to facilitate trade liberalization (Nguyen S, 2018). Moreover, the establishment of the ASEAN Economic Community (AEC) is set to streamline the unrestricted movement of goods, services, capital, investment, and skilled labor across the ten member states. ASEAN remains committed to upholding its pivotal role within regional frameworks and further integrating into the global economy (Nguyen S, 2018). In addition, Southeast Asia has made significant investments in infrastructure development, including transportation, energy, telecommunications, and technical infrastructure. The goal is to enhance regional connectivity and create favorable trade and economic cooperation conditions. These nations are making significant strides in catching up to their more developed counterparts. This highlights their potential for future economic advancement and suggests they effectively implement policies and strategies to stimulate growth.

Oppositely, nations with an average Catch-Up (CU) index of less than 1 are Saudi Arabia, Georgia, Oman, Qatar, Lebanon, Russia, Jordan, India, China, and Pakistan. The countries with a CU index below 1 indicate a concentration on optimizing resources perceived as strengths. For instance, Qatar is known for its abundant natural gas reserves. The country has invested heavily in developing and extracting natural gas, making it one of the world's leading exporters of liquefied natural gas (LNG). By leveraging this resource, Qatar has created a significant source of revenue and diversified its economy.

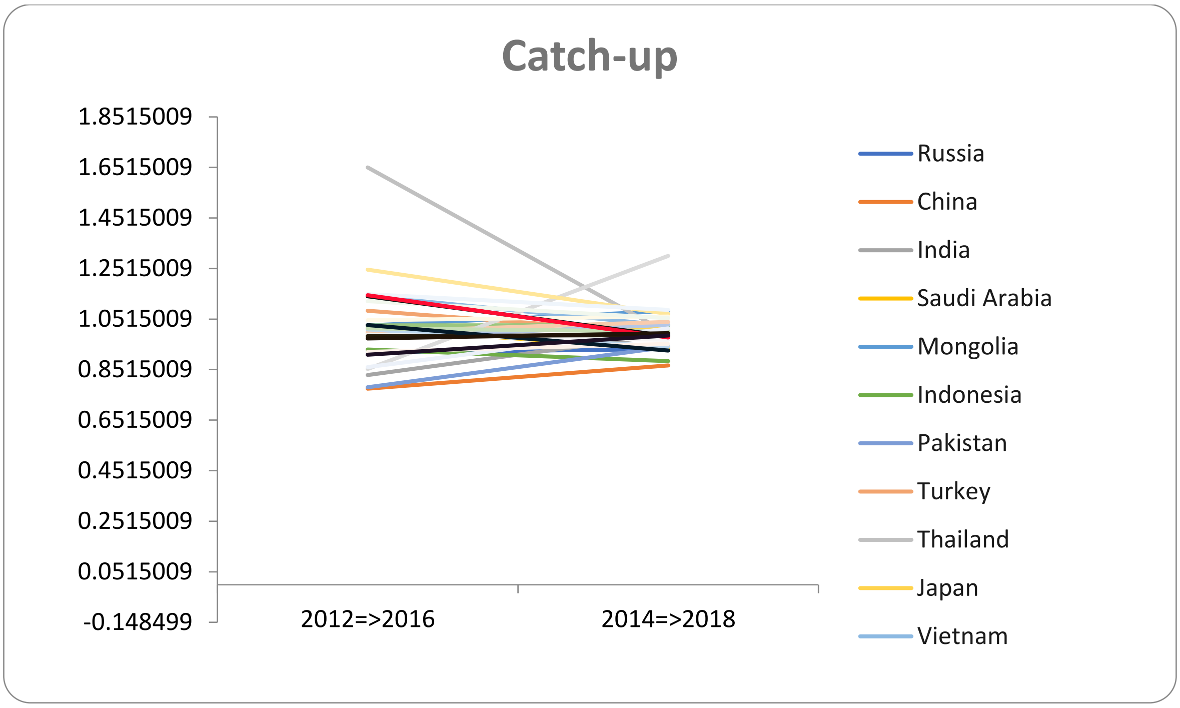

Chart 4.1: Catch-up Effect

4.4.2. The Technical Change

The technical change, known as the Frontier-Shift (FS) effect, represents the shift or fluctuation in the efficient frontier itself.

Table 4.5: Frontier-shift of Asian countries (2012 – 2018) (Source: Thesis Team)

Country	2012=>2016	2014=>2018	Average
Russia	0.967	0.993	0.980
China	0.962	1.003	0.982
India	0.970	0.901	0.936
Saudi Arabia	0.971	1.005	0.988
Mongolia	1.024	0.996	1.010
Indonesia	0.969	0.951	0.960
Pakistan	0.978	0.879	0.928
Turkey	0.950	0.928	0.939
Thailand	0.932	0.927	0.930
Japan	0.996	0.997	0.996
Vietnam	0.913	0.902	0.907
Malaysia	0.939	0.928	0.933
Oman	1.032	1.018	1.025

Philippines	0.951	0.829	0.890
Kyrgyzstan	1.077	0.967	1.022
Cambodia	0.883	0.921	0.902
Tajikistan	0.989	0.963	0.976
South Korea	0.995	0.999	0.997
Jordan	1.003	0.984	0.993
United Arab Emirates	0.939	0.961	0.950
Georgia	1.041	0.993	1.017
Egypt	1.004	0.941	0.973
Armenia	0.988	0.966	0.977
Kuwait	1.022	0.980	1.001
Qatar	0.962	1.008	0.985
Lebanon	0.961	1.019	0.990
Cyprus	0.981	0.981	0.981
Bahrain	0.948	1.010	0.979
Singapore	1.001	1.002	1.001
Hong Kong	1.103	0.975	1.039
Average	**0.982**	**0.964**	**0.973**

Table 4.5 shows 11 nations with an average FS index above 1: Kyrgyzstan, Hong Kong, Georgia, Mongolia, Kuwait, Oman, Singapore, and Mongolia. Notably, Hong Kong received the highest average FS position with 1.038 score. This is the effect of Hong Kong's investment promotion in high-tech businesses. The head of finance of the Hong Kong Special Administrative Region (China) Paul Chan on February 28 announced an expanded budget to stimulate economic growth, in which the policy of promoting investment is prominent. into high-tech industries to contribute to improving the competitiveness of this special zone. The second position is Oman, with 1.024 score. Other nations with FS lower than 1 are Saudi Arabia, Tajikistan, Bahrain, Cyprus, Jordan, Russia, Malaysia, China, and Pakistan. The value of FS lower than 1 suggests that these nations have experienced a shift away from the frontier, indicating a decline in their performance or a loss of efficiency.

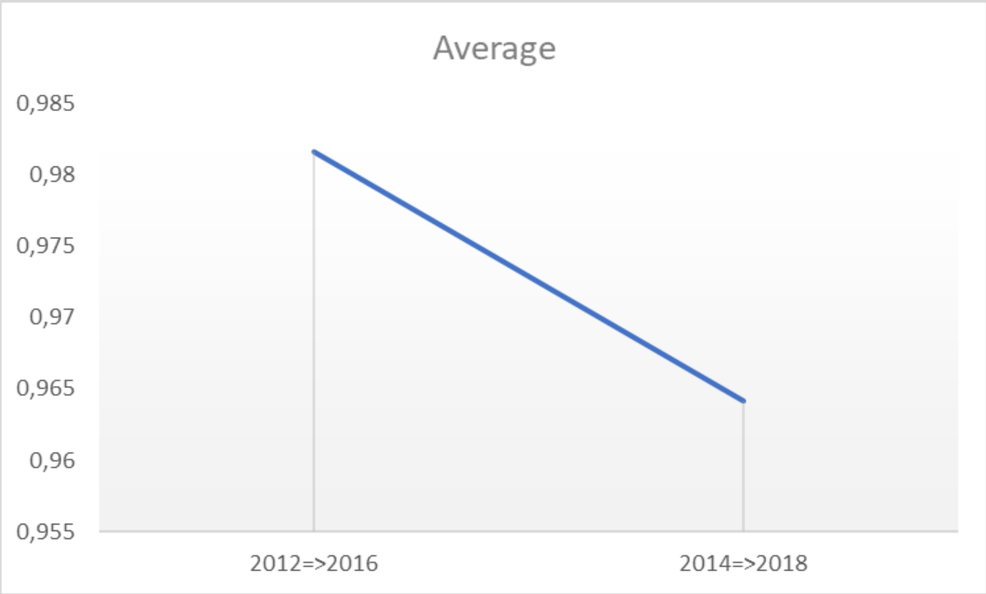

Chart 4.2: The Average Frontier Shift score in 2 period

Following **Chart 4.2**, the average score slightly decreased in the study period. In the first period, the average FS index was 0.981; this score dropped 1.75% in 2014 – 2018. It can occur when nations have reached the optimal limits of performance. This means there is no more extended room for improving performance advancement when units have reached the maximum point of accessing performance.

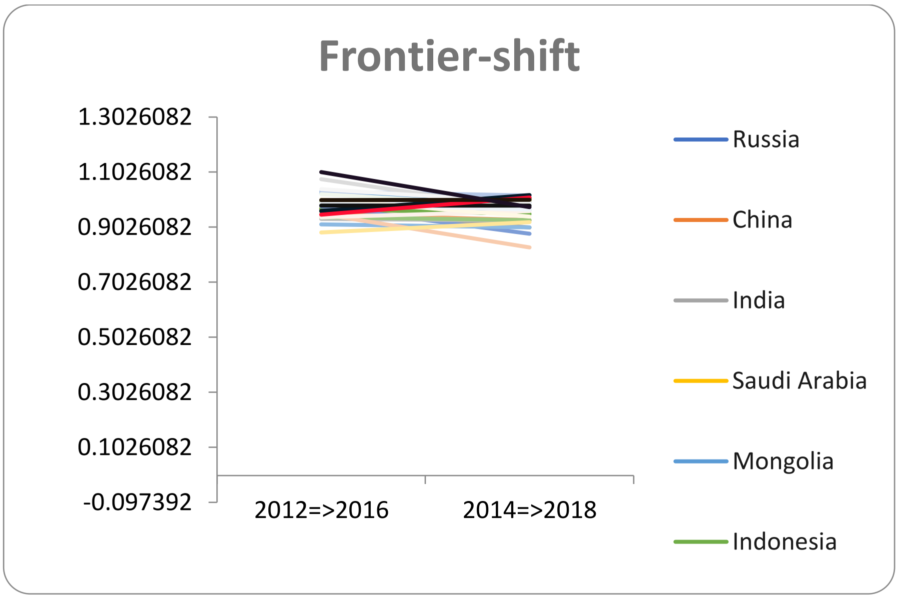

Chart 4.3: The Frontier Shift Effect

Chart 4.3 exhibits fewer shifting patterns of DMUs than **Chart 4.1** (catch-up effect), indicating that FS does not play a significant role in driving change in their effectiveness.

4.4.3. Total Productivity Change

Table 4.6: Malmquist Productivity Index (2012–2018) (Source: Thesis Team)

Country	2012-2016	2014-2018	Average
Russia	0.890	0.926	0.908
China	0.746	0.870	0.808
India	0.805	0.893	0.849
Saudi Arabia	0.984	0.939	0.962
Mongolia	1.051	1.079	1.065
Indonesia	0.902	0.841	0.872
Pakistan	0.765	0.827	0.796
Turkey	1.030	0.924	0.977
Thailand	1.540	0.923	1.232
Japan	0.992	1.012	1.002
Vietnam	1.044	0.925	0.985
Malaysia	0.964	0.953	0.959
Oman	1.007	1.047	1.027
Philippines	0.951	0.862	0.907
Kyrgyzstan	0.920	1.258	1.089
Cambodia	1.101	0.987	1.044
Tajikistan	0.999	0.907	0.953
South Korea	1.009	1.002	1.006
Jordan	0.864	0.999	0.932
United Arab Emirates	0.865	0.916	0.891
Georgia	1.030	0.962	0.996
Egypt	1.052	0.999	1.026
Armenia	1.137	1.051	1.094
Kuwait	1.148	1.034	1.091
Qatar	0.947	0.996	0.972
Lebanon	0.987	0.945	0.966
Cyprus	1.120	0.965	1.043
Bahrain	1.086	0.989	1.038
Singapore	0.976	0.997	0.987

Hong Kong	1.004	0.962	0.983
Average	**0,997**	**0,966**	**0,981**

Table 4.6 presents the average outcomes of the MPI, indicating changes in productivity levels from 2012 to 2028. The data reveals that, among the 30 countries, 12 countries exhibit an average MPI greater than 1, indicating positive productivity levels during the specified period. Conversely, 18 countries demonstrate an average MPI below 1, suggesting lower productivity levels. Notably, Thailand stands out as the country with the highest average MPI (1,232), highlighting the efficiency of its production. However, Thailand experienced a significant decline in MPI from 1,540 to 0.923 during this period, indicating substantial variations in its manufacturing performance.

On the other hand, Pakistan holds the lowest average MPI (0.796). Although there was a slight increase in MPI from 0.765 to 0.827, Pakistan's average value remains relatively low compared to other countries in the Asia region. It is plausible that several factors, such as infrastructure deficiencies, education, technology, and economic policies, contribute to the unfavorable manufacturing performance in Pakistan.

Several countries have demonstrated noteworthy growth and improvements in their production performance. For instance, Kyrgyzstan experienced a substantial increase in its MPI from 0.920 (2012-2016) to 1,258 (2014-2018), indicating robust progress in production efficiency and highlighting the potential for growth and development in its manufacturing sectors and technology. Likewise, Jordan saw an increase from 0.864 to 0.999, while China increased from 0.746 to 0.870 during the same period. Besides, countries such as Japan, South Korea, Malaysia, and Singapore with stable MPI show almost no significant change in productivity throughout the given time frame.

4.4.4. Comparative Analysis

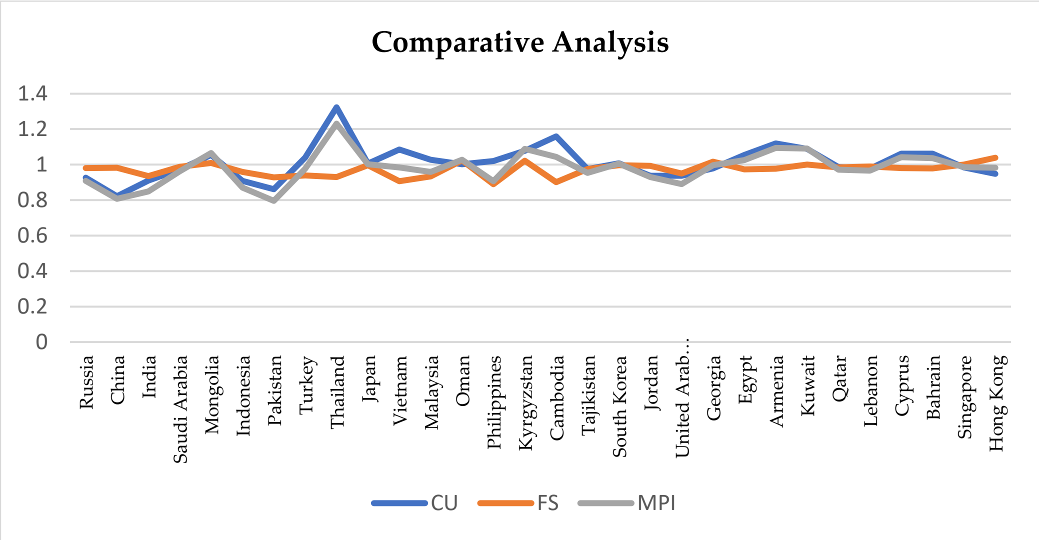

Chart 4.4: Comparison of CU, FS, and MPI

Chart 4.4 depicts the average FS, CU, and MPI values for the DMUs. The analysis examined the relationship between these variables and their contribution to productivity improvement. The analysis findings revealed an intriguing pattern, highlighting the significance of efficiency change compared to technical change in driving productivity improvements, particularly in Southeast Asian countries such as Thailand, Vietnam, Cambodia, and the Philippines. This suggests a positive adjustment in efficiency levels, indicating improved resource utilization, productivity, and overall performance.

Of particular importance is Thailand, which exhibited the highest average MPI and experienced significant fluctuations over the research period. Notably, Thailand had the highest CU index from 2012 to 2016. However, a substantial decrease of 39.7% was observed in the country's CU index from 2016 to 2018. Although the FS scores fluctuated marginally between 0.930 and 0.920 during these two periods, the high CU index primarily influenced Thailand's position in the MPI results.

On the other hand, the observations indicate that most nations cluster around an FS value of 1, with an average slightly below 1. This suggests limited progress in FS, which could be a significant contributing factor to the lower efficiency levels in competitiveness. While there are variations in competitiveness levels among different regions across the examined years, the overall trend reflects a decline in efficiency. However, notable differences in the results are observed among these regions. Analysis of the efficiency change and technical change indicators reveals that the key variables driving these changes do not effectively enhance the competitiveness of Asian countries. Consequently, there is a pressing need to advocate for policies prioritizing improving efficiency by emphasizing the appropriate and effective utilization of resources, including institutions, human capital, research, infrastructure, and expenditure, to enhance competitiveness performance.

The analysis underscores the importance of efficiency change in driving productivity improvements. It highlights the need for Asian countries, particularly Southeast Asia, to focus on enhancing resource utilization and efficiency to enhance competitiveness. Policy initiatives targeting the effective utilization of resources and emphasizing areas such as institutions, human capital, research, and infrastructure can play a pivotal role in improving regional competitiveness performance.

4.5. Discussion

In the realm of exploring competitiveness, prior research has predominantly centered on analyzing competitiveness at the firm level. Numerous studies have delved into this domain, including seminal works such as Liu et al. (2023), which examined the competitiveness of firms in post-COVID-19 China, as well as the influential study by Rentschler et al. (2017), investigated the firm competitiveness in Indonesia. These studies have provided invaluable insights into the intricacies of competition within individual firms, contributing significantly to the existing body of knowledge. However, in light of the evolving global landscape, this research takes a divergent approach by concentrating on competitiveness at the country level. The significance of understanding the competitiveness of nations has gained traction in recent years due to the interdependence of economies and the complex dynamics of international trade. Focusing on the broader context of competitiveness, this study aims to shed light on the factors driving a nation's economic strength, innovation capacity, and overall prosperity in a highly interconnected world. In undertaking this investigation, this study draws inspiration from previous works that have utilized the DEA method. Notably, Almeida et al. (2020) employed DEA to evaluate the relative efficiency of various industries within a country in the EU. Bresciani et al. (2021) applied the DEA technique to assess the competitiveness of different regions within a nation. These studies have demonstrated the efficacy of DEA as a robust analytical tool for evaluating complex systems and have paved the way for the application of this method in this research.

The findings derived from the Super-SBM model align with previous research (Maji and Laha, 2021; Sahakyan, 2021; Shuai et al., 2021; Hasan, Shengyong and Kemi, 2022), enhancing the study's validation and credibility. The analysis demonstrates considerable variations in the rankings of countries across the observed years, underscoring the dynamic and ever-changing nature of assessing global competitiveness. Consistent with Sahakyan's research (2021), it reveals that certain countries in Central Asia, like Pakistan and Tajikistan, are emerging as new players in the region and hold substantial potential for collaboration in energy, trade, political, and security sectors, contributing to enhanced competitiveness. The Super-SBM results of this study illustrated that Pakistan, China, and Tajikistan had demonstrated high competitiveness due to favorable geographical locations, abundant mineral resources, and significant government investments in energy (Sahakyan, 2021). In addition, the Super-SBM analysis also emphasizes the opportunity for less efficient nations to improve their competitiveness by optimizing resource allocation and operational processes, reinforcing practical recommendations for overall performance enhancement on the global stage.

Furthermore, examining competitiveness performance among the top Asian countries provides valuable insights. Central Asian countries, situated at a strategic crossroads where major economic corridors from various regions intersect, play a crucial role in connecting the East with the West and the North with the South (Sahakyan, 2021). The region's vast energy resources further enhance its global significance. Moreover, in the context of the "Belt and Road" initiative (BRI), China has made remarkable progress in renewable energy production and trade while also strengthening economic, logistical, and political ties in the resource-rich and volatile region, intensifying great power competition (Jing et al., 2020; Sahakyan, 2021; Hasan, Shengyong and Kemi, 2022). These findings not only align with previous findings (Maji and Laha, 2021; Sahakyan, 2021; Shuai et al., 2021; Hasan, Shengyong and Kemi, 2022) but also offer specific and comprehensive insights into the competitiveness performance of Asian countries, shedding light on the opportunities and challenges they face in an increasingly interconnected world.

The results obtained from the Malmquist model align with the findings reported by Nguyen et al. (2023), which highlight the significance of taking efficiency change into account when assessing overall performance change. Significantly this study indicated that efficiency change played a significant role and may be the main reason for total productivity change. However, previous studies have also found that technical change plays a more significant and influential role when using this method. According to a study by Moirangthem & Nag (2020) about competitiveness in India, catching up allows states are experiencing advantages from improved knowledge and expertise across the entire national economy, particularly in resource application and utilization. However, individual inefficiencies compared to other states are not adequately addressed, preventing further productivity growth. This difference will depend on the scope and subject of the study and the approaches adopted by DMUs to enhance overall performance.

The result of this study aligns with previous research about the effect of GII and LPI on the competitiveness level. This article, like Ebru's research (2016), suggested that a nation's competitiveness is primarily determined by its ability to invest in research, expertise, technology, and skills, enabling the optimal utilization of these resources to create new products or services. Innovation, the foundation for growth and vitality in all economies, is crucial in determining competitiveness. Competitiveness is characterized as the aggregate of institutions, policies, and production factors that contribute to a country's level of productivity. Also, Miranda et al.'s study (2021) indicated that the connection between competitiveness indicators and the level of innovation in a country is bidirectional, meaning that innovation and competitiveness interact with each other rather than being a one-way relationship. The two-way relationship between LPI and competitiveness is also mentioned in Özgür et al.'s research (2019). The study shows that global economies that are more competitive exhibit a greater need for highly skilled logistics professionals.

In addition to the mentioned strategies, several other potential approaches can be utilized to elevate the level of competitiveness. According to the study by Özgür et al. (2019), countries can be classified based on their LPI values, allowing the proposed methodology to be tailored specifically for each category. This tailored approach could result in more accurate action plans customized for individual countries. To optimize output, the government should adopt comprehensive policies to improve input resources. Policymakers can foster a supportive environment for research and innovation by investing in R&D and fostering collaboration between academia, industry, and research institutions. Encouraging the development and commercialization of new technologies and innovations is also crucial.

Additionally, embracing technological innovation in logistics and supply chain management can be led by the nation's leaders. Digitalization can achieve better data-driven decision-making and enhanced efficiency in logistics operations. Moreover, countries can enhance logistics performance by investing in Business Sophistication, Financial Market Development, Infrastructure, Market Efficiency, and Higher Education and Training. As a result, this improvement will positively influence the competitiveness level.

CHAPTER 5: CONCLUSION

5.1. Summary Of Findings & Answer the Research Questions

To Assess Asian Countries' Competitiveness, the research has answered the following questions, which were given in chapter one. The research questions are addressed as follows:

Question 1: Are the GII and the LPI appropriate sets of indexes to assess the competitiveness of Asian countries?

The competitiveness of countries plays a pivotal role in establishing their position in the global arena. It is of utmost significance as it dramatically influences a nation's economic performance, determining its ability to achieve sustainable growth and improve the well-being of its citizens. A competitive economy is characterized by its agility in adapting to changing market conditions, embracing technological advancements, fostering research and development, and cultivating a skilled workforce. Placing a strong emphasis on competitiveness allows countries to create an enabling environment for economic growth, job creation, and enhanced living standards for their populations. Various indicators can be employed to measure competitiveness. Ülengin et al. (2011) explored the correlation between national competitiveness and the human development index (HDI), while Sergi et al. (2021) investigated the interrelationship between the LPI and the GCI. Previous research has also demonstrated the suitability of these indicators. Notably, global innovation serves as an indicator of national competitiveness (Pudelko and Mendenhall, 2009). Moreover, the GII was collaboratively developed by Cornell University's SC Johnson College of Business, INSEAD, and the WIPO (2020) to assess multiple dimensions of a country's innovation ecosystem.

Therefore, the GII and LPI are appropriate indicators to evaluate the competitiveness of Asian countries. The GII focuses on a country's innovation capacity, while the LPI evaluates logistics performance encompassing infrastructure, transportation, and customs efficiency. The GII is vital for assisting businesses and investors in pinpointing potential markets and innovation hubs. By offering insights into countries' innovation capabilities, it empowers informed decisions on investment, collaboration, and R&D establishment. It aids companies in utilizing other nations' expertise and resources, fostering knowledge exchange that drives competitiveness. By examining and analyzing GII sub-indicators, policymakers and stakeholders can gain valuable insights into the areas where countries excel or require further attention, thus informing strategies and policies to enhance innovation-driven growth and competitiveness. The LPI greatly assesses and enhances global logistics. It's vital for nations to gauge their logistics, identify improvements, and compare performance. The LPI fosters transparency and collaboration in the sector, providing reliable data for competitiveness assessment. This transparency encourages knowledge sharing and international partnerships for improved logistics. Insights into LPI sub-indices can empower policymakers, researchers, and stakeholders to develop targeted strategies, policies, and interventions that enhance logistics performance, foster trade promotion, and drive sustainable economic growth at national and regional levels. Considering both indices, this study comprehensively explains the factors driving competitiveness. It represents a groundbreaking effort to assess the competitive landscape of Asian countries and holds significant value in competitiveness assessment.

Question 2: Are Asian countries effective in using resources to improve competitiveness?

This thesis employs the Super-SBM model to calculate efficiency scores and rank the efficiency of 30 Asian countries from 2012 to 2018. Utilizing the slack's objective function, the super-SBM model ascertained the excess inputs and insufficient outputs for individual units, enabling a granular efficiency assessment. By incorporating scores, rankings, and slack indicators, the Super-SBM methodology evaluates and offers insights for inefficient and efficient DMUs, further enhancing its evaluative capabilities. The obtained scores and rankings are presented in **Table 4.1**. The table reveals that the competitive efficiency of Asian countries during the period 2012-2018 is generally high. Of the 30 countries, 21 have efficiency scores above 1, indicating their effective utilization of resources to improve competitiveness. However, nine countries have efficiency scores below 1, suggesting they are inefficient in utilizing resources to enhance competitive efficiency. The average efficiency scores obtained over the years ranged from 1.009 to 1.027, highlighting a significant potential for improving competitiveness efficiency across most Asian countries.

Throughout the study period, Pakistan, Kuwait, Armenia, Thailand, and Tajikistan emerged as the top five countries with the highest performance scores. Pakistan consistently maintained a high rank in efficiency scores, with an average score of 1.153 and an average rating of 4. The country's efforts to enhance infrastructure, improve business regulations, and attract foreign investment have significantly contributed to its strong position. Additionally, its favorable geographic location as an entryway to Central Asia and its growing population have played a crucial role in its competitive advantage. Conversely, Malaysia, Kyrgyzstan, Hong Kong, Cambodia, and Lebanon exhibited the lowest efficiency scores from 2012 to 2018, indicating relatively lower competitiveness than other Asian nations. In economics, policymakers in less efficient countries should learn from prosperous nations in enhancing competitiveness. It is crucial for Asian countries to continuously adapt their output and overall competitive performance to maintain efficiency. Implementing policy initiatives that effectively utilize innovation inputs can stimulate competitiveness in Asian countries.

Question 3: How has there been a change in optimizing the resources of Asian countries?

The MPI facilitates a comparative analysis of the incremental productivity growth during two distinct temporal intervals. This approach engenders a more dynamic scrutiny that accommodates the temporal evolution of productivity. The MPI proves instrumental in assessing productivity's relative advancement or progression across disparate timeframes. The CU index, as displayed in **Table 4.3,** evaluates the performance of 30 Asian countries based on the Technical Efficiency Change of DMUs from 2012 to 2018. During this period, 16 countries had an average CU score exceeding 1, which was also a crucial part of making MPI more productive. These nations are making significant strides in catching up to their more developed counterparts. This demonstrates their potential for future economic advancement and indicates their effective implementation of policies and strategies to stimulate growth. Notably, Thailand exhibited the highest average level of CU performance. It displayed consistent improvement in technical efficiency from 2012 to 2018, with an average CU index of 1.324. On the contrary, 14 countries displayed below-average efficiency, with CU indexes below 1.

The technological FS index examines the performance of DMUs in terms of their technology frontiers (efficiency frontiers) from 2012 to 2018, as presented in **Table 4.4**. Overall, the average FS indexes of most countries cluster around FS = 1, with an average FS slightly below 1, indicating that FS does not significantly contribute to promoting changes in their effectiveness. During 2012-2018, most countries failed to surpass the advancement FS indexes, as evidenced by indexes below 1. Only seven countries achieved indexes exceeding 1. It indicates that most DMUs fell short of meeting the advancement FS indexes; only 7 DMUs had FS indexes of more than 1 with constant technological efficiency change.

Several countries in Asia have made notable progress in competitiveness, with some achieving significant advancements in FS and CU. However, the slow rate of improvement in CU aligns with that of the MPI, suggesting that efficiency change plays a crucial role and may be the primary driver of competitiveness changes across countries. Furthermore, observations reveal that most nations are clustered around an FS value of 1, with an average FS slightly below 1. This indicates that FS does not substantially impact enhancing effectiveness in terms of competitiveness. While competitiveness levels may vary among regions in the examined years, there is an overall decline in efficiency. When considering the indicators of efficiency change and technical change, it becomes evident that the key variables influencing these changes do not effectively enhance the competitiveness of Asian countries.

Consequently, there is a pressing need to advocate for policies that improve efficiency. These policies should emphasize the appropriate and effective utilization of resources, including institutions, human capital, research, infrastructure, and expenditure, to enhance competitiveness performance. By prioritizing efficiency and optimizing resource allocation, Asian countries can strive to bolster their competitiveness in the global arena.

5.2. Conclusion

Competitiveness is pivotal in ensuring a nation's economic health and vitality. It drives market competition, fosters sustainable growth, stimulates innovation, enhances productivity, promotes development, and ultimately leads to improved living standards for the population. By prioritizing competitiveness, countries can create an environment conducive to thriving businesses, attracting investments, and generating abundant economic opportunities. In conclusion, fostering competitiveness is not merely an economic strategy; it's a holistic approach that influences the very fabric of a nation's progress.

This study employed the Super-SBM and MPI models to assess the competitiveness of 30 Asian nations relative to GII and LPI between 2012 and 2018. The Super-SBM model evaluated the effectiveness and inefficiency of the countries, while the DEA Malmquist model measured productivity changes for each DMU over the study period. The Super-SBM methodology evaluates and furnishes recommendations pertaining to both inefficient and efficient DMUs, incorporating an assessment of their scores, rankings, and slack indicators.

Conversely, the Malmquist model computes scores indicative of efficiency changes by analyzing output factors and input variables.

The findings of this research hold significant implications for policymakers and stakeholders in Asian countries. The GII and LPI provide valuable insights into a country's innovation and logistics capabilities and critical competitiveness drivers. By gaining insights into their competitive strengths and weaknesses through the relationship between GII and LPI with national competitiveness, governments can formulate targeted policies and strategies to foster innovation, enhance logistics capabilities, and improve global competitiveness. The region's commitment to enhancing national competitiveness has contributed to these achievements. Policymakers can draw valuable insights from successful models and identify potential innovations for sustainable development. In conclusion, this study provides valuable insights into the competitiveness of Asian countries by using a two-stage DEA model, offering guidance for policymakers in formulating effective strategies to enhance competitiveness and stimulate economic development. By prioritizing competitiveness and implementing targeted measures, Asian nations can position themselves for sustained growth, increased competitiveness, and improved socio-economic outcomes for their citizens.

5.3. Implications

5.3.1. Theoretical Implications

The study holds significant theoretical implications concerning competitiveness assessment and policy-making. In the first place, the study introduces a pioneering approach to evaluating the competitive strength of Asian countries by integrating the GII and the LPI. This integration is noteworthy as it combines two distinct yet interconnected dimensions of competitiveness: Innovation and logistics. While the GII measures a country's innovation capacity, the LPI assesses logistics performance, including infrastructure, transportation, and customs efficiency. By incorporating both indices, this study offers a comprehensive understanding of the factors driving competitiveness. It establishes itself as a groundbreaking effort to assess the competitive landscape of Asian countries. Next, the research findings have broad applicability beyond Asia, providing a basis for assessing competitiveness globally. This study offers insights into the key determinants of competitiveness across different contexts by validating and identifying seven critical factors from the GII and the LPI that significantly influence competitiveness. These factors can serve as benchmarks and reference points for policymakers and researchers worldwide, enabling them to evaluate and compare the competitiveness of their respective countries. The integration of GII and LPI in this study establishes a robust framework that can be replicated and extended to assess competitiveness in other regions and economies, thereby advancing the field.

Finally, this study's focus on Asian countries contributes a valuable perspective to the existing literature on competitiveness. While previous research has primarily centered around larger economies and global competitiveness rankings (Capobianco-Uriarte et al., 2019), this study highlights the competitive strength of Asian nations. Notably, countries such as China, Pakistan, and Kuwait emerge as high performers in terms of competitiveness indicators, underscoring their potential as emerging economic powerhouses. These findings offer valuable insights to policymakers and investors, shedding light on the untapped potential and investment opportunities in Asian countries. As a result, policymakers and investors may consider these nations viable destinations for economic cooperation and growth.

5.3.2. Managerial Implications

The discoveries arising from this study bear substantial managerial implications for governments and policymakers in Asian countries. They offer invaluable insights that can steer strategic decision-making and policy formulation. To begin with, the identification and validation of seven pivotal factors derived from the GII and LPI, which exert influence on competitiveness, furnish policymakers with a roadmap for prioritizing areas necessitating improvement. Policymakers can channel their efforts and allocate resources with greater efficacy by comprehending the factors contributing to competitiveness. For instance, if infrastructure and transportation emerge as critical determinants, governments can invest in upgrading transportation networks and enhancing logistics efficiency, fortifying their countries' competitive standing.

Moreover, assessing competitiveness efficiency across 30 Asian countries during the specified timeframe enables policymakers to gauge their countries' performance relative to regional counterparts. Countries such as China, Pakistan, and Kuwait, demonstrating elevated competitiveness indicators, can be exemplars for others to emulate. Policymakers can delve into the policies and strategies implemented by these countries to identify best practices and adapt them to their contexts. Additionally, these findings provide crucial insights for policymakers and investors, who can consider these countries as promising prospects for collaboration and economic advancement. Furthermore, the analysis of the overall evolution in countries' competitiveness productivity across Asia presents a longitudinal view of competitiveness trends. Policymakers can identify countries that have enhanced competitiveness and study the factors underpinning their progress. Conversely, countries exhibiting relatively lower competitiveness indicators can leverage this information to pinpoint areas of weakness and devise targeted interventions to heighten their competitive edge.

The super SBM results clearly demonstrate the effectiveness in utilizing inputs and outputs, enabling strategic planners to make overall assessments and redistribute resources efficiently. The Malmquist results also provide a basis for emphasizing the improvement of efficiency changes rather than technical changes. Specifically, governments should promote a balanced adjustment of both output and input to enhance overall competitiveness.

5.4. Limitations And Suggestions for Further Research

While integrating the GII and the LPI through a two-stage DEA analysis provides a comprehensive evaluation of competitiveness in Asian countries, it is essential to acknowledge the limitations associated with this approach. Firstly, the GII and the LPI have inherent limitations that may require further consideration. Factors such as market size and government policies, which are not fully captured by these indices, could influence competitiveness and should be considered for a more accurate assessment.

Moreover, the assumption of a linear relationship between innovation and logistics performance in the two-stage DEA analysis may not always hold in practice. Real-world dynamics and complexities can deviate from this assumption, potentially impacting the results. Additionally, the subjective selection of variables and assignment of weights in the DEA model may introduce bias and affect the outcomes. Another limitation of this study is the potential lack of up-to-date datasets. The use of outdated information can hinder the accuracy and relevance of the findings, given the rapidly changing nature of innovation and logistics performance in Asian countries.

To overcome the above limitations and expand the understanding of competitiveness in Asian countries, future research should explore alternative frameworks that incorporate a broader range of variables and utilize advanced statistical techniques. A more comprehensive assessment of competitiveness can be achieved by incorporating additional factors such as market dynamics, government policies, globalization, and sustainability. Conducting in-depth case studies focusing on specific Asian countries can provide valuable insights into their unique challenges and opportunities. Furthermore, it is crucial to ensure the availability of up-to-date and reliable data sources for a more accurate analysis. This would involve continuous data collection efforts and incorporating the latest information into the research.

By addressing these limitations through further research, our understanding of competitiveness in Asian countries can be enhanced. This knowledge can guide policymakers and stakeholders in formulating effective strategies to foster innovation, improve logistics capabilities, and enhance regional competitiveness. A comprehensive and up-to-date assessment will enable informed decision-making and promote sustainable economic development in the region.

Appendices A

Table A1: Correlation (Time period = 2012)

	IT	HR	IF	MS	BS	IS	TT	KT	CR	GI	IL	CS	LQ	TL
IT	1.000	0.843	0.744	0.706	0.697	0.501	0.506	0.438	0.576	0.839	0.746	0.623	0.497	0.484
HR	0.843	1.000	0.835	0.571	0.759	0.500	0.582	0.495	0.597	0.858	0.834	0.569	0.525	0.567
IF	0.744	0.835	1.000	0.719	0.875	0.792	0.858	0.639	0.630	0.926	0.780	0.806	0.832	0.844
MS	0.706	0.571	0.719	1.000	0.698	0.620	0.611	0.599	0.423	0.805	0.465	0.667	0.594	0.586
BS	0.697	0.759	0.875	0.698	1.000	0.746	0.790	0.608	0.667	0.902	0.687	0.736	0.742	0.815
IS	0.501	0.500	0.792	0.620	0.746	1.000	0.909	0.597	0.613	0.763	0.500	0.870	0.920	0.906
TT	0.506	0.582	0.858	0.611	0.790	0.909	1.000	0.555	0.611	0.773	0.593	0.845	0.949	0.951
KT	0.438	0.495	0.639	0.599	0.608	0.597	0.555	1.000	0.179	0.751	0.462	0.560	0.585	0.514
CR	0.576	0.597	0.630	0.423	0.667	0.613	0.611	0.179	1.000	0.681	0.567	0.545	0.533	0.681
GI	0.839	0.858	0.926	0.805	0.902	0.763	0.773	0.751	0.681	1.000	0.769	0.775	0.745	0.767
IL	0.746	0.834	0.780	0.465	0.687	0.500	0.593	0.462	0.567	0.769	1.000	0.602	0.585	0.555
CS	0.623	0.569	0.806	0.667	0.736	0.870	0.845	0.560	0.545	0.775	0.602	1.000	0.925	0.836
LQ	0.497	0.525	0.832	0.594	0.742	0.920	0.949	0.585	0.533	0.745	0.585	0.925	1.000	0.913
TL	0.484	0.567	0.844	0.586	0.815	0.906	0.951	0.514	0.681	0.767	0.555	0.836	0.913	1.000

Table A2: Correlation (Time period = 2014)

	IT	HR	IF	MS	BS	IS	TT	KT	CR	Gl	IL	CS	LQ	TL
IT	1.000	0.690	0.790	0.671	0.737	0.417	0.433	0.279	0.598	0.800	0.770	0.531	0.501	0.523
HR	0.690	1.000	0.851	0.573	0.780	0.501	0.666	0.516	0.616	0.871	0.671	0.632	0.696	0.719
IF	0.790	0.851	1.000	0.576	0.858	0.592	0.700	0.431	0.718	0.901	0.789	0.727	0.747	0.704
MS	0.671	0.573	0.576	1.000	0.566	0.383	0.374	0.452	0.407	0.710	0.393	0.487	0.409	0.444
BS	0.737	0.780	0.858	0.566	1.000	0.615	0.677	0.488	0.719	0.893	0.584	0.699	0.733	0.698
IS	0.417	0.501	0.592	0.383	0.615	1.000	0.762	0.436	0.560	0.631	0.328	0.868	0.836	0.789
TT	0.433	0.666	0.700	0.374	0.677	0.762	1.000	0.478	0.637	0.715	0.460	0.892	0.956	0.855
KT	0.279	0.516	0.431	0.452	0.488	0.436	0.478	1.000	0.302	0.664	0.285	0.461	0.505	0.532
CR	0.598	0.616	0.718	0.407	0.719	0.560	0.637	0.302	1.000	0.800	0.565	0.643	0.727	0.746
GI	0.800	0.871	0.901	0.710	0.893	0.631	0.715	0.664	0.800	1.000	0.700	0.743	0.782	0.796
IL	0.770	0.671	0.789	0.393	0.584	0.328	0.460	0.285	0.565	0.700	1.000	0.433	0.478	0.496
CS	0.531	0.632	0.727	0.487	0.699	0.868	0.892	0.461	0.643	0.743	0.433	1.000	0.934	0.818
LQ	0.501	0.696	0.747	0.409	0.733	0.836	0.956	0.505	0.727	0.782	0.478	0.934	1.000	0.922
TL	0.523	0.719	0.704	0.444	0.698	0.789	0.855	0.532	0.746	0.796	0.496	0.818	0.922	1.000

Table A3: Correlation (Time period = 2016)

	IT	HR	IF	MS	BS	IS	TT	KT	CR	GI	IL	CS	LQ	TL
IT	1.000	0.703	0.834	0.717	0.703	0.429	0.468	0.552	0.710	0.828	0.770	0.603	0.515	0.529
HR	0.703	1.000	0.821	0.779	0.790	0.530	0.661	0.768	0.746	0.904	0.682	0.620	0.677	0.613
IF	0.834	0.821	1.000	0.649	0.702	0.652	0.731	0.594	0.745	0.852	0.817	0.714	0.736	0.696
MS	0.717	0.779	0.649	1.000	0.805	0.446	0.541	0.746	0.726	0.869	0.476	0.613	0.541	0.540
BS	0.703	0.790	0.702	0.805	1.000	0.455	0.564	0.813	0.706	0.890	0.458	0.626	0.599	0.578
IS	0.429	0.530	0.652	0.446	0.455	1.000	0.939	0.338	0.350	0.495	0.589	0.913	0.925	0.883
TT	0.468	0.661	0.731	0.541	0.564	0.939	1.000	0.417	0.393	0.583	0.578	0.922	0.962	0.901
KT	0.552	0.768	0.594	0.746	0.813	0.338	0.417	1.000	0.746	0.879	0.388	0.467	0.455	0.449
CR	0.710	0.746	0.745	0.726	0.706	0.350	0.393	0.746	1.000	0.898	0.572	0.464	0.429	0.437
GI	0.828	0.904	0.852	0.869	0.890	0.495	0.583	0.879	0.898	1.000	0.658	0.641	0.616	0.602
IL	0.770	0.682	0.817	0.476	0.458	0.589	0.578	0.388	0.572	0.658	1.000	0.623	0.588	0.562
CS	0.603	0.620	0.714	0.613	0.626	0.913	0.922	0.467	0.464	0.641	0.623	1.000	0.927	0.911
LQ	0.515	0.677	0.736	0.541	0.599	0.925	0.962	0.455	0.429	0.616	0.588	0.927	1.000	0.907
TL	0.529	0.613	0.696	0.540	0.578	0.883	0.901	0.449	0.437	0.602	0.562	0.911	0.907	1.000

Table A4: Correlation (Time period = 2018)

	IT	HR	IF	MS	BS	IS	TT	KT	CR	Gl	IL	CS	LQ	TL
IT	1.000	0.739	0.775	0.770	0.761	0.582	0.646	0.672	0.737	0.871	0.643	0.814	0.700	0.724
HR	0.739	1.000	0.815	0.666	0.817	0.573	0.735	0.721	0.598	0.857	0.643	0.760	0.743	0.753
IF	0.775	0.815	1.000	0.599	0.731	0.738	0.798	0.655	0.702	0.845	0.791	0.848	0.806	0.798
MS	0.770	0.666	0.599	1.000	0.775	0.522	0.614	0.689	0.681	0.822	0.396	0.727	0.660	0.689
BS	0.761	0.817	0.731	0.775	1.000	0.659	0.762	0.852	0.658	0.909	0.479	0.807	0.779	0.722
IS	0.582	0.573	0.738	0.522	0.659	1.000	0.904	0.536	0.542	0.664	0.506	0.810	0.907	0.854
TT	0.646	0.735	0.798	0.614	0.762	0.904	1.000	0.660	0.582	0.771	0.538	0.920	0.961	0.919
KT	0.672	0.721	0.655	0.689	0.852	0.536	0.660	1.000	0.751	0.910	0.395	0.734	0.709	0.624
CR	0.737	0.598	0.702	0.681	0.658	0.542	0.582	0.751	1.000	0.866	0.485	0.665	0.632	0.663
GI	0.871	0.857	0.845	0.822	0.909	0.664	0.771	0.910	0.866	1.000	0.601	0.861	0.812	0.794
IL	0.643	0.643	0.791	0.396	0.479	0.506	0.538	0.395	0.485	0.601	1.000	0.611	0.547	0.609
CS	0.814	0.760	0.848	0.727	0.807	0.810	0.920	0.734	0.665	0.861	0.611	1.000	0.935	0.912
LQ	0.700	0.743	0.806	0.660	0.779	0.907	0.961	0.709	0.632	0.812	0.547	0.935	1.000	0.935
TL	0.724	0.753	0.798	0.689	0.722	0.854	0.919	0.624	0.663	0.794	0.609	0.912	0.935	1.000

GLOBAL CONFERENCE ON BUSINESS AND SOCIAL SCIENCES SERIES

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LETTER OF ACCEPTANCE

15th Global Conference on Business & Social Sciences

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Date: 9th June 2023

Authors: Phi-Hung Nguyen, Dieu-Vi Thi Dao, Ha-Anh Vu, Duong-Dang Pham, Viet-Phuong Vu Nguyen,
Affiliation: Faculty of Business, FPT University, 100000, Hanoi, Vietnam
Paper Title: Assessing Asian Countries' Competitiveness: Two-Stage DEA Analysis Of Global Innovation Index And Logistics Performance Index Integration.

Dear Phi-Hung Nguyen,

Congratulations! We are pleased to confirm that the GCBSS committee has accepted your submitted paper abstract based on a double-blind peer review for an oral presentation at the 15th Global Conference on Business and Social Sciences in Novotel Bangkok Platinum Pratunam, Bangkok, Thailand.

Please note the following important guidelines:

1. Your paper abstract number is **CIMSSR-00370,** and please quote this number for all future correspondence. Please double-check the accuracy of the abstract title, address, and spelling of the author's name and name of the university and send us the corrected abstract, if necessary, by **10th June 2023**.

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Yours sincerely
Prof Abd Rahim
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Figure A1: Letter of Acceptance

REFERENCES

Alawamleh, M., Francis, Y.H. and Alawamleh, K.J. (2023) ‘Entrepreneurship challenges: the case of Jordanian start-ups’, Journal of Innovation and Entrepreneurship, 12(1), pp. 1–14. Available at: https://doi.org/10.1186/S13731-023-00286-Z/METRICS.

Aldamak, Abdullah and Zolfaghari, S. (2017) ‘Review of efficiency ranking methods in data envelopment analysis’, Measurement, 106, pp. 161–172. Available at: https://doi.org/10.1016/J.MEASUREMENT.2017.04.028.

Aldamak, A. and Zolfaghari, S. (2017) ‘Review of efficiency ranking methods in data envelopment analyses. Available at: https://doi.org/https://doi.org/10.1016/j.measurement.2017.04.028.

Almeida Neves, S., Cardoso Marques, A. and Moutinho, V. (2020) ‘Two-stage DEA model to evaluate technical efficiency on deployment of battery electric vehicles in the EU countries’, Transportation Research Part D: Transport and Environment, 86, p. 102489. Available at: https://doi.org/10.1016/J.TRD.2020.102489.

Amine Mati and Sidra Rehman (2022) Saudi Arabia to Grow at Fastest Pace in a Decade. Available at: https://www.imf.org/en/News/Articles/2022/08/09/CF-Saudi-Arabia-to-grow-at-fastest-pace (Accessed: 10 July 2023).

Andreas Buelow et al. (2022) Situating Bahrain in a future world: Opportunities for foreign investment | Arthur D. Little. Available at: https://www.adlittle.com/sa-en/insights/report/situating-bahrain-future-world-opportunities-foreign-investment (Accessed: 10 July 2023).

Anwer AL-Shboul, M. (2022) ‘An investigation of transportation logistics strategy on manufacturing supply chain responsiveness in developing countries: the mediating role of delivery reliability and delivery speed’, Heliyon. Available at: https://doi.org/10.1016/j.heliyon.2022.e11283.

Apak, S. and Atay, E. (2015) ‘Global Competitiveness in the EU Through Green Innovation Technologies and Knowledge Production’, Procedia - Social and Behavioral Sciences, 181, pp. 207–217. Available at: https://doi.org/10.1016/J.SBSPRO.2015.04.882.

Arsalan, K. (2022) ‘Munich Personal RePEc Archive Is the Physical Infrastructure in Pakistan Enough to Attract Foreign Direct Investment’.

Atta Mills, E.F.E. et al. (2021) ‘Dynamic operating efficiency and its determining factors of listed real-estate companies in China: A hierarchical slack-based DEA-OLS approach’, International Journal of Finance & Economics, 26(3), pp. 3352–3376. Available at: https://doi.org/10.1002/IJFE.1965.

Aytekin, A. et al. (2022) ‘Global innovation efficiency assessment of EU member and candidate countries via DEA-EATWIOS multi-criteria methodology’, Technology in Society, 68, p. 101896. Available at: https://doi.org/10.1016/J.TECHSOC.2022.101896.

Banker, Charnes and Cooper (1984) ‘Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis’, 30, pp. 1078–1092.

Bedirian, K. et al. (2022) ‘Overview of Cancer Control in Armenia and Policy Implications’, Frontiers in Oncology, 11, p. 782581. Available at: https://doi.org/10.3389/FONC.2021.782581/BIBTEX.

Bill Emmott (2015) South Korea: Finding its place on the world stage | McKinsey. Available at: https://www.mckinsey.com/featured-insights/asia-pacific/south-korea-finding-its-place-on-the-world-stage (Accessed: 10 July 2023).

Bresciani, S. et al. (2021) 'Innovation, environmental sustainability and economic development: DEA-Bootstrap and multilevel analysis to compare two regions', Technological Forecasting and Social Change, 172, p. 121040. Available at: https://doi.org/10.1016/J.TECHFORE.2021.121040.

BRINK Asia Editorial Staff (2016) India's Infrastructure Gap: A Drag On Growth? – BRINK – Conversations and Insights on Global Business. Available at: https://www.brinknews.com/indias-infrastructure-gap-a-drag-on-growth/ (Accessed: 10 July 2023).

Capobianco-Uriarte, M. de las M. et al. (2019) 'A Bibliometric Analysis of International Competitiveness (1983–2017)', Sustainability 2019, Vol. 11, Page 1877, 11(7), p. 1877. Available at: https://doi.org/10.3390/SU11071877.

Carpita, M. and Ciavolino, E. (2017) 'A generalized maximum entropy estimator to simple linear measurement error model with a composite indicator', Advances in Data Analysis and Classification, 11(1). Available at: https://doi.org/10.1007/s11634-016-0237-y.

Caves, D.W., Christensen, L.R. and Diewert, W.E. (1982) 'The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity', Econometrica, 50(6). Available at: https://doi.org/10.2307/1913388.

Charles V and Zegarra L.F (2014) "Measuring regional competitiveness through Data Envelopment Analysis: A Peruvian case", Expert Systems with Applications', 41, pp. 5371–5381.

Charnes, A., Cooper, W.W. and Rhodes, E. (1978) 'Measuring the efficiency of decision-making units', European Journal of Operational Research, 2(6), pp. 429–444. Available at: https://doi.org/10.1016/0377-2217(78)90138-8.

Chen, J., Chen, D. and Yao, A. (2020) 'Trade development between China and countries along the Belt and Road: A spatial econometric analysis based on trade competitiveness and complementarity', Pacific Economic Review, 25(2), pp. 205–227. Available at: https://doi.org/10.1111/1468-0106.12329.

Choi, J. et al. (2021) 'The Role of Vietnam's FDI Inflows in Global Value Chains Participation and Economic Growth'.

Chris, M. (2021) Vision 2035 and Kuwait's banks: a match made in heaven. Available at: https://www.exus.co.uk/blog/vision-2035-the-bold-plan-to-transform-kuwait-and-what-that-means-for-banks-1 (Accessed: 7 June 2023).

Christopher Jarvis (2015) How Can Egypt Achieve Economic Stability and Better Living Standards Together? Available at: https://www.imf.org/en/Blogs/Articles/2015/02/11/how-can-egypt-achieve-economic-stability-and-better-living-standards-together (Accessed: 10 July 2023).

Cook, W.D. and Zhu, J. (2010) 'Output deterioration with input reduction in data envelopment analysis', http://dx.doi.org/10.1080/07408170304361, 35(3), pp. 309–320. Available at: https://doi.org/10.1080/07408170304361.

Cornell University, INSEAD and WIPO (2020) Global innovation Index 2020: Who will finance inovation? Ithaca, Fontainebleau, and Geneva, Economy Reports & Analysis.

Delgado, M. et al. (2012) ‘The Determinants of National Competitiveness’. Available at: https://doi.org/10.3386/W18249.

Development Bank, A. (2016) ‘Tajikistan Promoting Export Diversification and Growth Country Diagnostic Study’.

Do, E. (2016) ‘the Effect of Innovation on Competitiveness’, Ekonometri ve İstatistik e-Dergisi, 0(24).

European Commission (2004) A pro-active Competition Policy for a Competitive Europe. Brussels.

Fair, C.C. (2008) ‘Pakistan’s Relations with Central Asia: Is Past Prologue?’, http://dx.doi.org/10.1080/01402390801940344, 31(2), pp. 201–227. Available at: https://doi.org/10.1080/01402390801940344.

Färe, R., Grosskopf, S. and Roos, P. (1998) ‘Malmquist Productivity Indexes: A Survey of Theory and Practice’, in Index Numbers: Essays in Honour of Sten Malmquist. Available at: https://doi.org/10.1007/978-94-011-4858-0_4.

Farrell, M.J. (1957) ‘The Measurement of Productive Efficiency’, Journal of the Royal Statistical Society. Series A (General), 120(3). Available at: https://doi.org/10.2307/2343100.

Fried, H.O., Schmidt, S.S. and Yaisawarng, S. (1999) ‘Incorporating the Operating Environment into a Nonparametric Measure of Technical Efficiency’, Journal of Productivity Analysis, 12(3). Available at: https://doi.org/10.1023/A:1007800306752.

George, C.G. (2013) ‘Cyprus’s Financial Crisis and the Threat to the Euro’. Available at: https://muse.jhu.edu/pub/4/article/522080/summary (Accessed: 11 July 2023).

Giacalone, M., Nissi, E. and Cusatelli, C. (2020) ‘Dynamic efficiency evaluation of Italian judicial system using DEA based Malmquist productivity indexes’, Socio-Economic Planning Sciences, 72. Available at: https://doi.org/10.1016/j.seps.2020.100952.

Global Innovation Index (2023) Global Innovation Index 2022, Global Innovation Index. Available at: https://www.globalinnovationindex.org/ (Accessed: 29 May 2023).

Global Innovation Index (GII) (2022) World Intellectual Property Organization. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2022-en-main-report-global-innovation-index-2022-15th-edition.pdf (Accessed: 29 May 2023).

Göçer, A., Özpeynirci, Ö. and Semiz, M. (2022) ‘Logistics performance index-driven policy development: An application to Turkey’, Transport Policy, 124, pp. 20–32. Available at: https://doi.org/10.1016/J.TRANPOL.2021.03.007.

Gokhberg, L., Sokolov, A. and Chulok, A. (2017) ‘Russian S&T Foresight 2030: identifying new drivers of growth’, Foresight, 19(5), pp. 441–456. Available at: https://doi.org/10.1108/FS-07-2017-0029/FULL/HTML.

Guan, J.C. et al. (2006) ‘A study of the relationship between competitiveness and technological innovation capability based on DEA models’, European Journal of Operational Research, 170(3). Available at: https://doi.org/10.1016/j.ejor.2004.07.054.

Halkos, G.E. and Tzeremes, N.G. (2007) ‘International competitiveness in the ICT industry: Evaluating the performance of the top 50 companies’, Global Economic Review, 36(2). Available at: https://doi.org/10.1080/12265080701374115.

Hall and Dennis (2018) ‘Competitiveness Of Georgian Agriculture: Investment Case Studies’.

Hasan, M.K., Shengyong, Y. and Kemi, A.P. (2022) ‘Article in Operations and Supply Chain Management An International Journal’. Available at: https://doi.org/10.31387/oscm0480334.

Hassan, M. (2020) ‘Africa and the WTO Trade Facilitation Agreement: State of Play, Implementation Challenges, and Policy Recommendations in the Digital Era’, Advances in African Economic, Social and Political Development, pp. 5–38. Available at: https://doi.org/10.1007/978-3-030-36632-2_2/COVER.

Hoekman, B. and Shepherd, B. (2015) ‘Who profits from trade facilitation initiatives? Implications for African countries’, Journal of African Trade, 2(1–2), pp. 51–70. Available at: https://doi.org/10.1016/J.JOAT.2015.08.001.

Huang, X. (2023) ‘The roles of competition on innovation efficiency and firm performance: Evidence from the Chinese manufacturing industry’, European Research on Management and Business Economics, 29(1), p. 100201. Available at: https://doi.org/10.1016/J.IEDEEN.2022.100201.

Huarng, K.H. and Yu, T.H.K. (2022) ‘Analysis of Global Innovation Index by structural qualitative association’, Technological Forecasting and Social Change, 182. Available at: https://doi.org/10.1016/j.techfore.2022.121850.

International Monetary Fund (2019) 'Cyprus: Selected Issues', IMF Staff Country Reports, 2019(363). Available at: https://doi.org/10.5089/9781513522067.002.A001.

International Monetary Fund (2020) The Philippines: A Good Time to Expand the Infrastructure Push. Available at: https://www.imf.org/en/News/Articles/2020/02/06/na020620the-philippines-a-good-time-to-expand-the-infrastructure-push (Accessed: 10 July 2023).

International Monetary Fund (2022) 'Qatar: 2022 Article IV Consultation-Press Release; and Staff Report', IMF Staff Country Reports, 2022(175). Available at: https://doi.org/10.5089/9798400213342.002.A001.

Ivailo Izvorski (2023) Education: Armenia's Path to Stronger Economic Growth. Available at: https://www.worldbank.org/en/news/opinion/2023/03/22/education-and-innovation-at-the-core-of-armenia-economic-growth (Accessed: 7 June 2023).

Jigang, W. (2020) 'South-South Integration and the SDGs: Enhancing Structural Transformation in Key Partner Countries of the Belt and Road Initiatives China's Industrial Policy: Evolution and Experience'.

Jing, S. et al. (2020) 'China's renewable energy trade potential in the "Belt-and-Road" countries: A gravity model analysis', Renewable Energy, 161, pp. 1025–1035. Available at: https://doi.org/10.1016/J.RENENE.2020.06.134.

Jungsberg, L. et al. (2020) 'Key actors in community-driven social innovation in rural areas in the Nordic countries', Journal of Rural Studies, 79, pp. 276–285. Available at: https://doi.org/10.1016/J.JRURSTUD.2020.08.004.

Kabak, Ö., Önsel Ekici, Ş. and Ülengin, F. (2020) 'Analyzing two-way interaction between the competitiveness and logistics performance of countries', Transport Policy, 98, pp. 238–246. Available at: https://doi.org/10.1016/J.TRANPOL.2019.10.007.

Kaliszewski, A. et al. (2020) 'Key factors of container port competitiveness: A global shipping lines perspective', Marine Policy, 117, p. 103896. Available at: https://doi.org/10.1016/J.MARPOL.2020.103896.

Khan, S.A.R. et al. (2019) 'Environmental, Social and Economic Growth Indicators Spur Logistics Performance: From the Perspective of South Asian Association for Regional Cooperation countries', Journal of Cleaner Production, 214, pp. 1011–1023. Available at: https://doi.org/10.1016/J.JCLEPRO.2018.12.322.

Kuo, K.C., Lu, W.M. and Le, M.H. (2020) 'Exploring the performance and competitiveness of Vietnam port industry using DEA', Asian Journal of Shipping and Logistics, 36(3). Available at: https://doi.org/10.1016/j.ajsl.2020.01.002.

Lan, P. (no date) Disbursement of public investment capital in the first 6 months of 2023 increased significantly compared to the same period last year. Available at: https://baochinhphu.vn/giai-ngan-von-dau-tu-cong-6-thang-dau-nam-2023-tang-kha-nhieu-so-cung-ky-nam-truoc-102230705172532582.htm (Accessed: 11 July 2023).

Le, C.B.T. and Umetsu, C. (2022) 'Sustainable farming techniques and farm size for rice smallholders in the Vietnamese Mekong Delta: A slack-based technical efficiency approach', Agriculture, Ecosystems & Environment, 326, p. 107775. Available at: https://doi.org/10.1016/J.AGEE.2021.107775.

Lee, J., Jun, S.P. and Lee, C. (2022) 'Does demand-side innovation policy drive lock-in? Global evidence from solar energy in 155 countries', Energy Research & Social Science, 89, p. 102539. Available at: https://doi.org/10.1016/J.ERSS.2022.102539.

Li, B.G., Gupta, P. and Yu, J. (2017) 'From natural resource boom to sustainable economic growth: Lessons from Mongolia', International Economics, 151, pp. 7–25. Available at: https://doi.org/10.1016/J.INTECO.2017.03.001.

Li, K. (2019) As Protesters Fill Hong Kong's Streets, Businesses Are Alarmed, Too - The New York Times. Available at: https://www.nytimes.com/2019/06/12/business/hong-kong-china-protests-business.html (Accessed: 7 June 2023).

Listiyanto, E. and Pulungan, A.M. (2021) 'A P R I L 2 0 2 1 Indonesia's Macroeconomic and Finance Policy Framework for Structural Transformation'.

Liu, J. et al. (2018) 'A DEA-based approach for competitive environment analysis in global operations strategies', International Journal of Production Economics, 203. Available at: https://doi.org/10.1016/j.ijpe.2018.05.029.

Liu, S., Cai, H. and Cai, X. (2023) 'The paradox of digitalization, competitiveness, and sustainability: A firm-level study of natural resources exploitation in post Covid-19 for China', Resources Policy, 85, p. 103773. Available at: https://doi.org/10.1016/J.RESOURPOL.2023.103773.

Magazzino, C., Alola, A.A. and Schneider, N. (2021) 'The trilemma of innovation, logistics performance, and environmental quality in 25 topmost logistics countries: A quantile regression evidence', Journal of Cleaner Production, 322, p. 129050. Available at: https://doi.org/10.1016/J.JCLEPRO.2021.129050.

Maji, S.K. and Laha, A. (2021) ‘The role of digital skill in mitigating digital divide: evidences from Asia-Pacific region’, Rajagiri Management Journal, 16(3), pp. 260–271. Available at: https://doi.org/10.1108/RAMJ-05-2021-0035.

Melecky, L. (2013) ‘Use of DEA Approach to Measuring Efficiency Trend in old EU Member States’, Proceedings of the 11th International conference Liberec economic forum 2013, pp. 381–391.

Mešić, A. et al. (2022) ‘Hybrid MCDM Solutions for Evaluation of the Logistics Performance Index of the Western Balkan Countries’, ECONOMICS, 10(1), pp. 13–34. Available at: https://doi.org/10.2478/EOIK-2022-0004.

De Miranda, R.L. et al. (2021) ‘Competitiveness influence on global innovation of nations: a cross-sectional analysis’, Independent Journal of Management & Production, 12(4). Available at: https://doi.org/10.14807/ijmp.v12i4.1338.

Mishrif, A. and Kapetanovic, H. (2018) ‘Dubai’s Model of Economic Diversification’, pp. 89–111. Available at: https://doi.org/10.1007/978-981-10-5786-1_5.

Mohammed, N.F. et al. (2023) ‘Exploring anti-corruption education in Malaysian educational institutions’, Journal of Money Laundering Control [Preprint]. Available at: https://doi.org/10.1108/JMLC-02-2023-0037.

Moirangthem, N.S. and Nag, B. (2020) ‘Developing a Framework of Regional Competitiveness Using Macro and Microeconomic Factors and Evaluating Sources of Change in Regional Competitiveness in India Using Malmquist Productivity Index’, International Journal of Global Business and Competitiveness, 15(2). Available at: https://doi.org/10.1007/s42943-020-00016-2.

Mono, O.C. (2021) ‘E-Government in Cambodia: Challenges and Practical Paths to Achieve a Functional E-Government’, 3. Available at: www.cd-center.org (Accessed: 7 June 2023).

Nakagaki, P., Aber, J. and Fetterhoff, T. (2015) ‘The Challenges in Implementing Open Innovation in a Global Innovation-Driven Corporation’, https://doi.org/10.5437/08956308X5504079, 55(4), pp. 32–38. Available at: https://doi.org/10.5437/08956308X5504079.

Narine, P. (2021) Favorable business environment is a primary condition for SME development in Armenia - Strategeast. Available at: https://www.strategeast.org/favorable-business-environment-is-a-primary-condition-for-sme-development-in-armenia/ (Accessed: 7 June 2023).

Nguyen, P.H. et al. (2022) ‘A cross-country European efficiency measurement of maritime transport: A data envelopment analysis approach’, Axioms 2022, Vol. 11, Page 206, 11(5), p. 206. Available at: https://doi.org/10.3390/AXIOMS11050206.

Nguyen, P.H. et al. (2023) ‘How Does the Competitiveness Index Promote Foreign Direct Investment at the Provincial Level in Vietnam? An Integrated Grey Delphi–DEA Model Approach’.

Nguyen S (2018) ‘Enhancing Vietnam’s Position In The ASEAN Economic Community’. Available at: https://mof.gov.vn/webcenter/portal/vclvcstc/pages_r/l/chi-tiet-tin?dDocName=MOFUCM087266 (Accessed: 11 July 2023).

Önsel Ekici, Ş., Kabak, Ö. and Ülengin, F. (2016) 'Linking to compete: Logistics and global competitiveness interaction', Transport Policy, 48, pp. 117–128. Available at: https://doi.org/10.1016/J.TRANPOL.2016.01.015.

Önsel, E.Ş., Kabak, Ö. and Ülengin, F. (2019) 'Improving Logistics Performance by Reforming the Pillars of Global Competitiveness Index', Transport Policy, 81, pp. 197–207. Available at: https://doi.org/10.1016/J.TRANPOL.2019.06.014.

Özgür Kabak, Şule Önsel Ekici and Füsun Ülengin (2019) 'Analizing two-way interaction between the competitiveness and logistics performance of countries'.

Pan, Z. et al. (2020) 'Analysis of the water use efficiency using super-efficiency data envelopment analysis', Applied Water Science, 10(6). Available at: https://doi.org/10.1007/s13201-020-01223-1.

Phan, M.N. (2022) What makes Singapore a leading international financial center - The Saigon Times. Available at: https://english.thesaigontimes.vn/what-makes-singapore-a-leading-international-financial-center/ (Accessed: 10 July 2023).

Porter, M.E. (2001) 'National Innovative Capacity', The global competitiveness report [Preprint]. Available at: https://www.academia.edu/2917930/National_innovative_capacity (Accessed: 6 June 2023).

Pudelko, M. and Mendenhall, M.E. (2009) 'The contingent nature of best practices in national competitiveness: The case of American and Japanese innovation processes', European Management Journal, 27(6). Available at: https://doi.org/10.1016/j.emj.2008.10.002.

Qazi, A. (2022) ‘Adoption of a Probabilistic Network Model Investigating Country Risk Drivers that Influence Logistics Performance Indicators’, Environmental Impact Assessment Review, 94, p. 106760. Available at: https://doi.org/10.1016/J.EIAR.2022.106760.

Raiser, M., Wes, M. and Yilmaz, A. (2016) ‘Beyond convergence: Poland and Turkey en route to high income’, Central Bank Review, 16(1), pp. 7–17. Available at: https://doi.org/10.1016/J.CBREV.2016.03.001.

Rania, E.G. and Eman, G. (2009) Kuwait sovereign fund cuts stocks, shifts to cash | Reuters. Available at: https://www.reuters.com/article/kuwait-kia-idINLP574120090125 (Accessed: 7 June 2023).

Rehman, F.U. and Noman, A.A. (2020) ‘Does infrastructure promote exports and foreign direct investment in selected Southeast Asian economies? An application of global infrastructure index’, Journal of Economic Studies, 48(7), pp. 1346–1370. Available at: https://doi.org/10.1108/JES-03-2020-0123/FULL/XML.

Rentschler, J. and Kornejew, M. (2017) ‘Energy price variation and competitiveness: Firm level evidence from Indonesia’, Energy Economics, 67, pp. 242–254. Available at: https://doi.org/10.1016/J.ENECO.2017.08.015.

Research Office Legislative Council Secretariat (2019) ‘The impact of the recent social incidents and enactment of the Hong Kong Human Rights and Democracy Act of 2019 in the United States on Hong Kong’s economy’.

Rezaei, J., van Roekel, W.S. and Tavasszy, L. (2018) ‘Measuring the Relative Importance of the Logistics Performance Index Indicators Using Best Worst Method’, Transport Policy, 68. Available at: https://doi.org/10.1016/j.tranpol.2018.05.007.

Sahakyan, M. (2021) ‘The New Great Power Competition in Central Asia: Opportunities and Challenges for the Gulf’, SSRN Electronic Journal [Preprint]. Available at: https://doi.org/10.2139/SSRN.4338973.

Sargis, H. (2017) Armenian IT Growth Hits Record High. Available at: https://www.azatutyun.am/a/28631299.html (Accessed: 11 July 2023).

Sener, S. and Delican, D. (2019) ‘The causal relationship between innovation, competitiveness and foreign trade in developed and developing countries’, Procedia Computer Science, 158, pp. 533–540. Available at: https://doi.org/10.1016/J.PROCS.2019.09.085.

Sergi, B.S. et al. (2021) ‘Competitiveness and the Logistics Performance Index: The ANOVA method application for Africa, Asia, and the EU regions’, Sustainable Cities and Society, 69, p. 102845. Available at: https://doi.org/10.1016/J.SCS.2021.102845.

Shepherd, B. and Wilson, J.S. (2009) ‘Trade facilitation in ASEAN member countries: Measuring progress and assessing priorities’, Journal of Asian Economics, 20(4), pp. 367–383. Available at: https://doi.org/10.1016/J.ASIECO.2009.03.001.

Shuai, J. et al. (2021) ‘Renewable Energy Product Competitiveness: Evidence from China and the Belt and Road Countries’, SSRN Electronic Journal [Preprint]. Available at: https://doi.org/10.2139/SSRN.3920296.

Shun Chokki et al. (2022) A new era for industrial R&D in Japan | McKinsey. Available at: https://www.mckinsey.com/capabilities/operations/our-insights/a-new-era-for-industrial-rnd-in-japan (Accessed: 10 July 2023).

Smallbone, D., Saridakis, G. and Abubakar, Y.A. (2022) 'Internationalisation as a stimulus for SME innovation in developing economies: Comparing SMEs in factor-driven and efficiency-driven economies', Journal of Business Research, 144, pp. 1305–1319. Available at: https://doi.org/10.1016/J.JBUSRES.2022.01.045.

Song, M.J. and Lee, H.Y. (2022) 'The Relationship Between International Trade and Logistics Performance: A Focus on the South Korean Industrial Sector', Research in Transportation Business & Management, 44, p. 100786. Available at: https://doi.org/10.1016/J.RTBM.2022.100786.

Staníčková, M. and Skokan, K. (2012) 'Evaluation of the EU Member States efficiency by Data Envelopment Analysis method', International Journal of Mathematical Models and Methods in Applied Sciences, 6(2).

Su, L. and Ji, X. (2021) 'Spatial-temporal differences and evolution of eco-efficiency in China's forest park', Urban Forestry and Urban Greening, 57. Available at: https://doi.org/10.1016/j.ufug.2020.126894.

Tachega, M.A. et al. (2021) 'Energy efficiency evaluation of oil producing economies in Africa: DEA, malmquist and multiple regression approaches', Cleaner Environmental Systems, 2. Available at: https://doi.org/10.1016/j.cesys.2021.100025.

Tan, R. et al. (2021) 'How will innovation-driven development policy affect sustainable urban land use: Evidence from 230 Chinese cities', Sustainable Cities and Society, 72, p. 103021. Available at: https://doi.org/10.1016/J.SCS.2021.103021.

Tang, C.F. and Abosedra, S. (2019) 'Logistics performance, exports, and growth: Evidence from Asian economies', Research in Transportation Economics, 78, p. 100743. Available at: https://doi.org/10.1016/J.RETREC.2019.100743.

The Government Decree of the Republic of Tajikistan (2018) Tourism Development Strategy in the Republic of Tajikistan for the period up to 2030 - Committee of Tourism Development under the Government of the Republic of Tajikistan. Available at: https://ctd.tj/en/legislative-acts/tourism-development-strategy-in-the-republic-of-tajikistan-for-the-period-up-to-2030 (Accessed: 7 June 2023).

Tone, K. (2001) 'A slacks-based measure of efficiency in data envelopment analysis', European Journal of Operational Research, 130(3), pp. 498–509. Available at: https://doi.org/10.1016/S0377-2217(99)00407-5.

Trade Facilitation in Asean Member Countries: Measuring Progress and Assessing Priorities by Ben Shepherd, John S. Wilson :: SSRN (no date). Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1149118 (Accessed: 6 June 2023).

Trakarnsirinont, W., Jitaree, W. and Buachoom, W.W. (2023) 'Political Uncertainty and Financial Firm Performance: Evidence from the Thai Economy as an Emerging Market in Asia', Economies 2023, Vol. 11, Page 18, 11(1), p. 18. Available at: https://doi.org/10.3390/ECONOMIES11010018.

Ülengin, F. et al. (2011) 'The Competitiveness of Nations and Implications for Human Development', Socio-Economic Planning Sciences, 45(1). Available at: https://doi.org/10.1016/j.seps.2010.10.001.

Ullah, A., Salah, M. and Din, E. (2022) 'International Journal of Economics, Commerce and Management United Kingdom Licensed under Creative Common LOGISTICS CLUSTERS DEVELOPMENT IN OMAN', 5. Available at: http://ijecm.co.uk/ (Accessed: 10 July 2023).

Warsaw Institute Org (2023) The Deteriorating Economic Situation in Lebanon | Warsaw Institute. Available at: https://warsawinstitute.org/the-deteriorating-economic-situation-in-lebanon/ (Accessed: 7 June 2023).

Wei-Wen, W. (2011) 'Beyond Travel and Tourism competitiveness ranking using DEA, GST, ANN and Borda count', 38, pp. 12974–12982.

Wilson, J.S. (2003) 'Trade facilitation: new issues in a development context'. World Bank Group.

Worldbank (2018) 2018 | Logistics Performance Index (LPI). Available at: https://lpi.worldbank.org/2018 (Accessed: 28 June 2023).

Worldbank (2023) About | Logistics Performance Index (LPI). Available at: https://lpi.worldbank.org/about (Accessed: 28 June 2023).

Wuni, I.Y. and Shen, G.Q. (2023) 'Exploring the critical success determinants for supply chain management in modular integrated construction projects', Smart and Sustainable Built Environment, 12(2), pp. 258–276. Available at: https://doi.org/10.1108/SASBE-03-2021-0051/FULL/XML.

Y. Jafari (2014) 'Malmquist Productivity Index for Multi Time Periods', International Journal of Data Envelopment Analysis, 2. Available at: Available online at http://ijdea.srbiau.ac.ir (Accessed: 30 May 2023).

Yang, Y. (2011) China's export-led growth model | East Asia Forum. Available at: https://www.eastasiaforum.org/2011/02/27/chinas-export-led-growth-model/ (Accessed: 7 June 2023).

Yu, T.H.K., Huarng, K.H. and Huang, D.H. (2021) 'Causal complexity analysis of the Global Innovation Index', Journal of Business Research, 137. Available at: https://doi.org/10.1016/j.jbusres.2021.08.013.

Zheng, Z. (2021) 'Energy efficiency evaluation model based on DEA-SBM-Malmquist index', Energy Reports, 7. Available at: https://doi.org/10.1016/j.egyr.2021.10.020.