

Evaluating ASEAN and EU Banking Sector Efficiency Using DEA (Data Envelopment Analysis)

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Abstract. *This study compares ASEAN and EU banking efficiency using Data Envelopment Analysis (DEA) and an intermediary approach. Three input variables (staff expense, fixed assets, total customer deposits) and two output variables (loans to customer and operating income other than interest) are analyzed using RStudio and R. EU and ASEAN banks had efficiency scores of 0.7 and 0.65, respectively, showing opportunity for improvement. Based on cost analyses, ASEAN banks are more efficient than their EU counterparts. Inefficiencies occur when output surpasses input or is much lower than another output variable. However, both regions may improve banking efficiency to do better. The 10-year trends exhibit oscillations, showing that regulatory issues affect banking efficiency. Stricter laws, higher capital requirements, and risk management changes may have hampered ASEAN credit. The dynamics and objectives of the EU and ASEAN economic blocs shape their financial systems. ASEAN is working toward regulatory convergence, while the EU has integrated and harmonized more. To maintain a stable and efficient financial industry, the region's banks must adapt to changing economic landscapes, technological advances, and mounting challenges.*

Keywords: *ASEAN, bank performance, data envelopment analysis, efficiency, EU*

1. Introduction

Efficiency analysis is essential in determining how well banks use resources to produce desired results. It assists in identifying banks that function efficiently and those that could enhance resource allocation and operational methods. As a commonly used methodology in efficiency analysis, Data Envelopment Analysis allows for a full review by considering numerous input-output linkages, capturing the intricacies of banking sector processes.

The ASEAN and EU banking sectors have witnessed significant developments in recent years. Technological improvements, shifting client tastes, and expanding regulatory frameworks have all contributed to the

banking industry's dynamic terrain. As a result, policymakers, regulators, and banking institutions acknowledge the need to analyze and improve efficiency levels to secure long-term growth and stability. As the protectors of the banking industry, regulators have a vested interest in maintaining efficient operations. They are critical in establishing regulatory frameworks encouraging healthy competition, risk management techniques, and consumer protection. Regulators can fine-tune their regulations to reward efficient operations and remove barriers that impede efficiency gains by gaining insights into bank efficiency levels.

This research has the potential to assist banking institutions. Efficiency analysis allows them to compare their performance to

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ASEAN and the EU peers. Banks can improve operational efficiency, cut expenses, and increase profitability by identifying areas for improvement and implementing best practices. Furthermore, efficient banks are better positioned to fulfill changing client demands in an increasingly competitive and digital-driven world.

Finally, the originality of our research comes in its comparative investigation of banking efficiency between industrialized EU countries and less developed ASEAN nations, which fills a significant gap in the existing literature. We provide vital insights into future policy decisions, industry practices, and scholarly study agendas by highlighting diverse business models as a main cause of inefficiency. By doing so, we not only contribute to academic debate but also provide practical consequences that can benefit the banking sectors and economies of both ASEAN and EU countries.

Research Question

Comparing the efficiency of banking sectors in developing nations and European nations raises concerns about the potential differences between their respective banking sectors. One factor to consider is whether the efficiency of banks in developing nations is typically lower than in Europe. Developing nations are frequently confronted with unique obstacles, such as underdeveloped infrastructure, limited access to technology, and immature financial markets, which can affect the effectiveness of their banking systems. In contrast, European nations have more established financial systems, technologically advanced infrastructure, and more developed financial markets. These factors may contribute to an increase in the efficacy of banks. It is essential to observe, however, that several factors, including regulatory frameworks, governance practices, market structure, and macroeconomic conditions, influence banks' efficiency. In order to acquire a deeper understanding of the potential differences between their banking sectors, it is necessary to conduct a thorough examination and comparison of banking efficiency in

developing nations and European nations, taking into account these multifaceted factors.

Based on the issues above, the research question of the study is "Is EU banking performance higher than that of the ASEAN?" Our study uses efficiency measures for evaluating banking performance, furthermore, we use DEA (Data Envelopment Analysis) for calculating bank's efficiency. We use samples from EU banks that are categorized as developed countries and ASEAN banks that are categorized as less developed countries. Our findings reveal that banking in developed countries has a significantly different level of performance compared to less developed countries. The empirical evidence shows that EU banking sector has higher efficiency score compared to ASEAN banking sectors.

This paper is organized as follows: Section 2 briefly describes the literature related to bank performance and efficiency approach. Section 3 explains the data set used in this study and the methodology employed in this study. Section 4 presents the findings and discussions. Section 5 provides some concluding remarks.

2. Literature Review

Banking Efficiency Approaches

According to Jouadi and Zorgui (2014), efficiency summarizes the idea of producing in the best way possible, which means that efficiency is focused on the use of minimum inputs to produce the best output. In other words, efficiency requires the optimized use of resources to generate the best products at the lowest possible cost. In management, efficiency can be defined as the study of the optimal use of the firm's internal elements. The effectiveness idea, on the other hand, summarizes the yield of elements and the achievement of a goal without considering the way and optimal utilization of resources.

In the banking theory literature, there are two primary approaches, namely the production

and intermediation approaches (Sealey & Lindley, 1977): The production approach implies that financial institutions serve as producers of services for account holders, i.e., that they perform transactions on deposit accounts and process documents such as loans.

According to the intermediation approach, banks are primarily financial intermediaries whose primary function is to obtain funds from depositors in exchange for their liabilities; in turn, banks provide loans to others for profit-making (Chu & Lim, 1998). The intermediation approach, also known as

the asset approach, assumes that financial institutions serve as an intermediary between investors and borrowers. Banks are perceived as procuring labor, materials, and deposit funds to generate loan and investment outputs.

This research uses banks as financial intermediaries, or institutions that act as a link between a saver who deposits money in a bank and a borrower who receives a loan from that bank. All deposited funds are combined into one large pool, which is subsequently loaned out as shown in Figure 1.

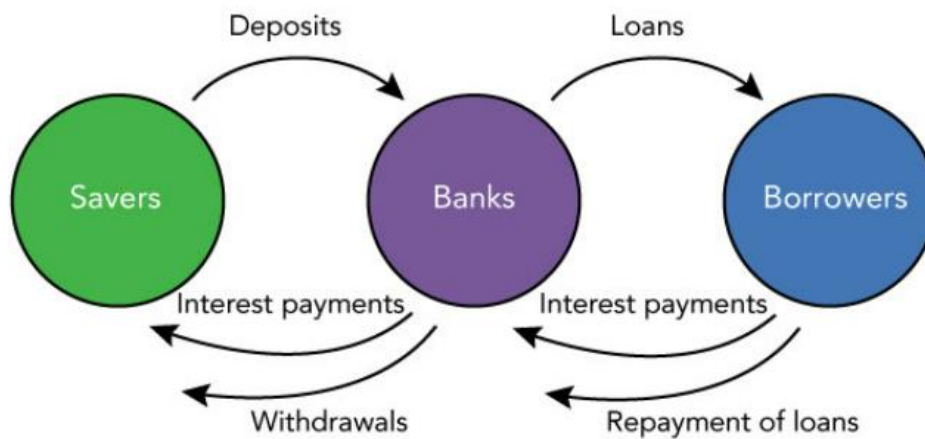


Figure 1.

Banks As Financial Intermediary

Source: <https://courses.lumenlearning.com/wm-introductiontobusiness/chapter/banks-as-financial-intermediaries/>

According to Diallo (2018), efficiency makes banks more resilient to shocks, positively and substantially influencing economic growth. During a financial crisis, bank efficiency loosens credit restrictions and increases the growth rate of financially dependent industries.

According to Alber et al (2019), another way to categorize banking efficiency is to divide it into five types:

1. Pure technical efficiency: the efficiency with which a given set of inputs is utilised to generate an output. The difference between the observed amount of input and output variables and the ideal quantity of input and output variables is defined as

the technical efficiency of banks. An efficient bank can achieve a maximum value of one compared to an inefficient bank, which can reduce to zero.

2. Scale efficiency: the bank's capacity to achieve optimal operations. When the bank works in the range of constant returns to scale (CRS), it possesses scale efficiency.
3. Allocative efficiency: a bank's success in selecting an optimal set of inputs with a given set of input prices.
4. Cost efficiency: a bank's ability to deliver services without squandering resources due to technical or allocative inefficiency.
5. Scope efficiency: arises when the bank operates in various locales.

Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is a non-parametric mathematical technique for assessing the relative efficiency of decision-making units (DMUs) such as businesses, organizations, and institutions. It evaluates the input-output relationships of several DMUs to determine efficiency and potential areas for improvement.

A collection of inputs and outputs defines each DMU in DEA. A DMU's efficiency is determined by comparing its input-output

performance to other DMUs. DEA assigns efficiency scores to each DMU based on its ability to generate the most outputs from a given set of inputs or minimize inputs for a given level of outputs compared to other DMUs in the sample.

There are two standard models in DEA which are CCR (Charnes-Cooper-Rhodes) or constant return to scale (CRS) model and BCC (Banker-Charnes-Cooper) or variable return to scale (VRS) model.

The input-oriented CRS DEA model is shown below. (Zhang, et al 2020)

$$\max \frac{\sum_{r=1}^q u_r \gamma_{rk}}{\sum_{i=1}^m v_i x_{ik}} \quad \text{subject to} \quad \left\{ \begin{array}{l} \frac{\sum_{r=1}^q u_r \gamma_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad (j = 1, \dots, n) \\ \mu_r \geq 0 (r = 1, \dots, q), v_i \geq 0 (i = 1, \dots, m); \end{array} \right.$$

The output-oriented CRS DEA model is shown below.

$$\max \frac{\sum_{i=1}^m v_i x_{ik}}{\sum_{r=1}^q u_r \gamma_{rk}} \quad \text{subject to} \quad \left\{ \begin{array}{l} \frac{\sum_{i=1}^m v_i x_{ij}}{\sum_{r=1}^q u_r \gamma_{rj}} \geq 1 \quad (j = 1, \dots, n) \\ u_r \geq 0 (r = 1, \dots, q), v_i \geq 0 (i = 1, \dots, m); \end{array} \right.$$

The input-oriented VRS DEA model is shown below.

$$\max \sum_{r=1}^q \mu_r \gamma_{rj} + \mu_0 \quad \text{subject to} \quad \left\{ \begin{array}{l} \sum_{r=1}^q \mu_r \gamma_{rj} - \sum_{i=1}^m v_i x_{ij} + \mu_0 \leq 0 (j = 1, \dots, n), \\ \sum_{i=1}^m v_i x_{ik} = 1, \\ \mu_r \geq 0 (r = 1, \dots, q), v_i \geq 0 (i = 1, \dots, m), \mu_0 \in \mathbb{R} \end{array} \right.$$

The output-oriented VRS DEA model is shown below.

$$\max \sum_{i=1}^m v_i x_{ik} + v_0 \quad \text{subject to} \quad \left\{ \begin{array}{l} \sum_{r=1}^q \mu_r \gamma_{rj} - \sum_{i=1}^m v_i x_{ij} + v_0 \leq 0 (j = 1, \dots, n), \\ \sum_{r=1}^q \mu_r \gamma_{rk} = 1, \\ \mu_r \geq 0 (r = 1, \dots, q), v_i \geq 0 (i = 1, \dots, m), v_0 \in \mathbb{R}, \end{array} \right.$$

Where:

- X_{ij} : input variables
- V_i : input weight vector
- γ_j : output vector
- μ_j : output weight vector

- z : amount of input
- r : amount of output
- μ_0 and v_0 are two free variables.

DEA offers various advantages, including the ability to handle multiple inputs and outputs simultaneously, its non-parametric character, which does not require explicit functional forms or assumptions, and its ability to discover peer groups from which inefficient DMUs can learn from efficient ones.

According to Bogetoft et al., (2010) there are several strengths of DEA, which are:

Non-parametric approach: Because DEA does not require specific functional form assumptions, it is adaptable and appropriate to various data kinds and sectors. **Relative efficiency comparison:** DEA ranks decision-making units (DMUs) in terms of relative efficiency, enabling benchmarking and identifying best practices. There is no need for a priori efficiency assumptions with DEA because it does not presume a specific production function or distribution, making it appropriate when the underlying production process is unknown or complex. **Handles numerous inputs and outputs:** Due to the multidimensional nature of efficiency analysis, DEA may handle various inputs and outputs at the same time. **Useful for decision support:** Decision-makers can benefit from DEA insights in resource allocation, performance evaluation, and strategic planning.

Generally, two scale assumptions are used: constant returns to scale (CRS) and variable returns to scale (VRS), including both increasing and decreasing returns to scale. CRS reflects that output changes proportionately to input changes (e.g., doubling all inputs doubles output); VRS reflects the reality that production technology might display growing, constant, or falling returns to scale. Cooper, Seiford, and Tone (2000) present approaches for calculating returns to scale. In essence, the researcher studies technical efficiency under various returns to scale and assesses whether or not the observed levels are along the frontier corresponding to a specific return to scale.

3. Data and Methodology

Data

The data used in this study were from year 2012 to year 2019 and obtained from bankscope. This study is limited to all banks in the European Union and ASEAN countries. These are the sample selection criteria:

1. Banks that have loans of less than 0 were eliminated.
2. Banks with less than zero equity were eliminated.
3. Banks having a non-interest income of less than zero were eliminated.
4. Banks with an overall asset ratio was less than one million dollars were discarded.

The observation was discarded if the variable input (customer deposit, fixed assets, staff expenses) exceeded the variable output (loans, operating income other than interest).

In territorial managed by local governments, such as Guadeloupe (France), Martinique (France), and Reunion (France), the observations were dropped. Banks from Germany and England were dropped due to the diversity of their bank business models.

After filtering the data, there are 920 banks from 19 countries that matched the research criteria. Among those 19 countries, there are 13 countries from EU which are Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, and Sweden and 6 countries from ASEAN region which are Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

Methodology

This research's objectives are evaluating the banking efficiency in ASEAN and EU areas and identifying the factors behind. This research started by obtaining data from bankscope. Next, we define the variable that will be used for efficiency measurement. After define the variable, we winsored the data to ensure that the efficiency scores are not distorted by extreme values or outliers.

Efficiency measurement is calculated by using Data Envelopment Analysis (DEA). An output-oriented approach in DEA recognises the importance of external factors on the performance of banks. These external elements include market demand, economic conditions, and regulatory frameworks. By centring its attention on outputs, DEA paves the way for a more in-depth analysis of the capacity of financial institutions to respond to changing conditions and make the most of opportunities presented by the environment. Because it is directly relevant to the goals and preoccupations of decision-makers, such as bank managers and regulators, output-oriented DEA provides helpful insights for these individuals. An evaluation of efficiency based on output measurements helps to inform decisions relating to the allocation of

resources, the development of performance, and the creation of policy by highlighting areas in which financial institutions have the potential to increase their output generation capabilities. A strategy focused on the DEA output makes it easier to make meaningful comparisons between banks operating in various markets or areas. The DEA can facilitate comparisons based on the amount to which banks transform their inputs into the desired outputs by evaluating the efficiency of their outputs. DEA, with its output-oriented approach, makes it possible to do benchmarking among countries or across industries, which helps establish policies and identifies areas that could use some improvement. These are the variables that are used in DEA calculation as shown in Table 1.

Table 1.
Input and Output Selections – Financial Intermediary Approach

No.	Inputs	Outputs
1	Customer deposit	Loans to customer
2	Staff expense	Operating income other than interest
3	Fixed asset	

Source: Faturohman, et.al (2019)

4. Findings and Discussion

The following table (Table 2) summarises the descriptive statistics for the input and output

variables utilized in ASEAN and EU institutions' Data Envelopment Analysis (DEA). The variables are measured in ratio to total assets.

Table 2
Descriptive Statistics of DEA Input and Output Variables

Variables	Sector	Obs.	Mean	St. Dev	Min	Max
Customer deposit	Both	5,202	0.670	0.375	0.000	1.714
	ASEAN	1,492	0.787	0.316	0.001	1,714
	EU	3,610	0.623	0.386	0.000	1.714
Staff expense	Both	5,202	0.01	0.008	0.000	0.054
	ASEAN	1,492	0.01	0.008	0.000	0.054
	EU	3,610	0.01	0.009	0.000	0.054
Fixed assets	Both	5,202	0.009	0.026	0.000	0.491
	ASEAN	1,492	0.009	0.013	0.000	0.259
	EU	3,610	0.009	0.03	0.000	0.491

Table 2 (Continued)
Descriptive Statistics of DEA Input and Output Variables

Variables	Sector	Obs.	Mean	St. Dev	Min	Max
Loans to customer	Both	5,202	0.569	0.231	0.003	0.968
	ASEAN	1,492	0.593	0.169	0.003	0.948
	EU	3,610	0.560	0.252	0.003	0.968
Operating income other than interest	Both	5,202	43.821	25.109	0.001	114.33
	ASEAN	1,492	33.673	24.56	0.001	114.33
	EU	3,610	47.901	24.156	0.037	114.33

Source: Author's Calculation (2023).

The study compares the efficiency of banks in ASEAN and EU regions using descriptive statistics. The EU dataset exhibits a broader dispersion among its data points, indicating a higher level of heterogeneity or disparity among the observed data points compared to the ASEAN region. The study finds that banks in both regions are cutting costs or transitioning to a digital business model. The efficiency scores of banks are presented in Table as a percentage from 0 to 100%, and banking efficiency refers to the ability of banks to utilize their resources effectively to achieve objectives while minimizing costs and maximizing output or services provided to customers.

The study identifies several key indicators of bank efficiency, including high customer deposits, low staff expense, low fixed assets, a substantial number of loans made to customers, and low operational income other than interest. High customer deposits indicate that the bank has attracted a significant amount of customer funds, which can be used for various banking activities such as lending and investing. The low staff expense shows that the bank's expenditure on employee pay

and benefits is comparatively minimal, which could imply that the bank employs efficient personnel procedures, operates at a low cost, or relies on automation and technology to streamline processes. The low fixed asset indicates that the bank may have made only a minor investment in physical assets such as buildings, equipment, or infrastructure, which could imply a preference for leasing or outsourcing specific assets, as well as a focus on efficiency. Alternatively, it could mean that the bank uses a digital or online banking strategy with few physical assets. The enormous number of loans made to customers implies that the bank has a substantial lending portfolio, which reflects its confidence in its customers' creditworthiness or a strategic concentration on producing interest income through lending activities. The bank's small operational income other than interest shows that non-interest revenue, such as fees, commissions, or other non-lending operations, is relatively low, which could imply that the bank's revenue is mostly derived from interest income generated by lending activities. This also implies that banks' function is intermediary agent.

Table 3.
Average Cost Efficiency Values By Countries In ASEAN And EU

EU		ASEAN	
Country	DEA Efficiency	Country	DEA Efficiency
Austria	0.695	Indonesia	0.683
Belgium	0.704	Malaysia	0.697
Denmark	0.598	Philippines	0.546
Finland	0.765	Singapore	0.665
France	0.750	Thailand	0.696
Greece	0.681	Vietnam	0.589
Ireland	0.701	Mean	0.659
Italy	0.836		
Luxembourg	0.657		
Netherlands	0.672		
Portugal	0.621		
Spain	0.649		
Sweden	0.730		
Mean	0.702		

Source: Author's Calculation (2023)

Based on the Table 3 most efficiency scores are around 60 to 70 percent. There were fluctuations in the observation variables that happened because of several challenges that changed the region's banking policy. The change can decrease the performance or increase the efficiency value. In 2016, both the ASEAN and EU economic sectors exhibited considerable activity and growth as shown in Figure 2. The following are noteworthy highlights derived from the search results:

The ASEAN region presently ranks as the world's fifth-largest economy, boasting a population of over 660 million consumers (Binder, 2020).

On January 1, 2016, the Association of Southeast Asian Nations (ASEAN) introduced the ASEAN Economic Community (AEC). This initiative's objective is to establish a unified marketplace and production base to facilitate the unrestricted movement of goods, services, investment, capital, and skilled labor within the ASEAN region (Jones Day, 2016).

ASEAN consistently maintained a trade surplus with the EU since 1998, reaching its peak at US\$ 54.6 billion in 2017. Additionally, the EU held the position of being the third-largest contributor of Foreign Direct Investment (FDI) to ASEAN in 2016.

The EU has a significant stake in ASEAN's prosperity and is dedicated to supporting regional integration in Southeast Asia through community development cooperation (European Commission, 2017).

Commencing negotiations for a region-to-region free trade agreement (FTA) with ASEAN in 2007, the EU initially suspended these discussions in 2009. Subsequently, the EU chose to pursue separate bilateral trade agreements with individual ASEAN member states. By 2016, six ASEAN member states had initiated talks regarding bilateral FTAs with the EU (Binder, 2020).

The EU holds the position of being ASEAN's third-largest trade partner, trailing only China and the US. In 2022, the trade in goods between the two entities exceeded €271.8

billion. Furthermore, bilateral trade in services reached €82.4 billion in 2020 (European Commission, 2023).

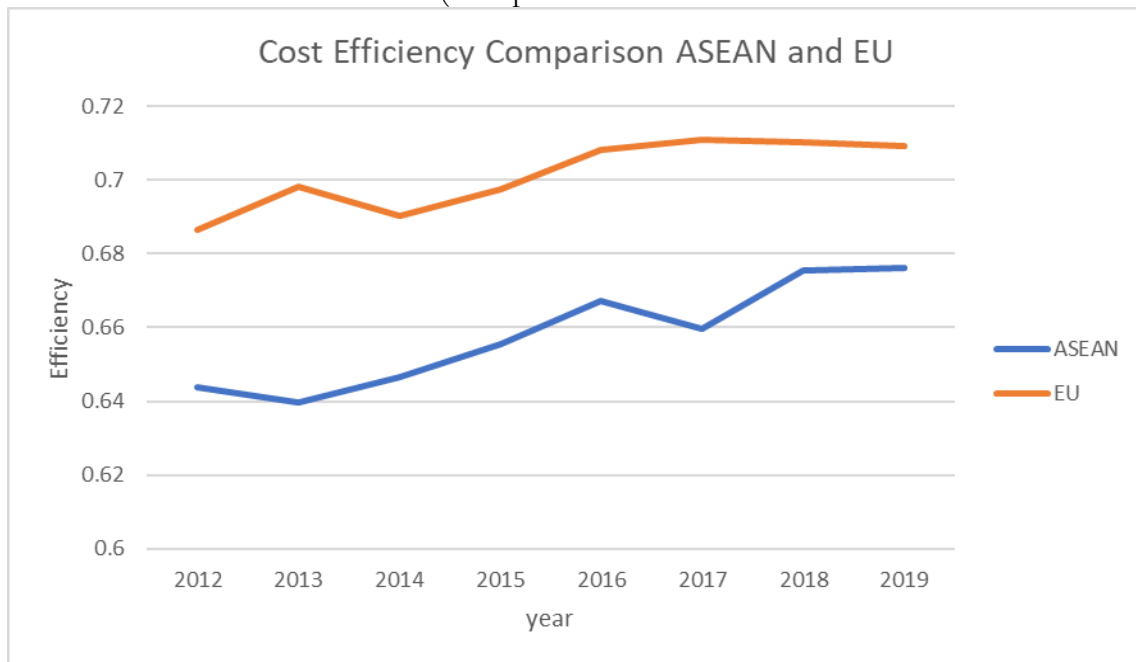


Figure 2. EU Countries Banking Efficiency (Author, 2023)

As it shown on Figure 2. , there was a slight downfall of efficiency scores in ASEAN from 2012, then started to increase from 2013. The banking landscape in the ASEAN region underwent significant changes between 2010 and 2014, most notably in the area of regulatory compliance. The adoption of tougher regulatory frameworks, such as Basel III regulations, had the potential to considerably increase compliance costs for ASEAN banks. This spike in regulatory-related expenditures may have had a short-term impact on profitability, particularly for smaller banks with fewer resources to quickly adjust to new and more stringent regulatory norms. Such a regulatory environment could have temporarily hampered the efficiency of major financial institutions, forcing them to commit resources to assure compliance, hurting their overall profitability dynamics.

Between 2012 and 2019, the ASEAN banking sector encountered various difficulties, encompassing:

Advancements in Financial Integration: The ASEAN banking sector was progressively moving towards enhanced financial integration. Nevertheless, this transition was

not devoid of hurdles (Aziz, 2012).

Emphasis on Financial Stability: A study conducted in 2021 underscored the criticality of stability within the ASEAN banking sector. To bolster financial stability across the region, ASEAN nations undertook initiatives such as establishing a financial safety net (Ariyasajjakorn, 2020).

Impact of Financial Globalization: The surge in the integration of capital markets and international financial dealings, referred to as financial globalization, heightened the challenges and risks confronted by the ASEAN banking sector (Ariyasajjakorn, 2020).

Restructuring and Reforms in the Financial Sector: The restructuring and reforms implemented in the financial sector in 2012 underscored ASEAN's evolving role as a substantial consumer market. However, they also illuminated the challenges confronting the banking sector (Aziz, 2012).

Climate and Environmental Hazards: Central banks within ASEAN assumed pivotal roles in

addressing risks associated with climate and the environment, aligning with their mandate to uphold price and financial stability (Ariyasajjakorn, 2020).

Significant changes and advances occurred in the banking landscapes of many Southeast Asian countries as shown in Figure 3. In the Philippines, the economy witnessed significant expansion, as seen by robust GDP growth of 6.9% year on year in 2016 (Business wire, 2016). Simultaneously, the banking system has remained stable, with proper capitalization and provisioning levels, thereby supporting the country's economic growth. However, incumbent Philippine banks were acknowledged to be underinvesting in digital offerings, indicating a preference for digitalization as a way of expansion. Similarly, Vietnam experienced low banking penetration, with only about 30% of the population having bank accounts, indicating significant development potential

in this sector. Another important trend was the rapid expansion of credit in Vietnam's banking sector in recent years (Worldbank, 2017).

According to BNM Report in 2016, Malaysia's economy grew by 4.5% in 2016, fueled by local demand and government spending, although important policy shifts abroad deviated from conventional wisdom in global development. Thailand's banking sector grew steadily from 2012 to 2019, thanks to modernization and government programs promoting financial inclusion and digitalization (Statista, 2019). Meanwhile, according to IMF, cash usage remained deeply established in Singapore, owing in part to interoperability difficulties across various e-payment systems, necessitating the need for improved e-payment infrastructure to support a move toward digital payments and unlock productivity gains.

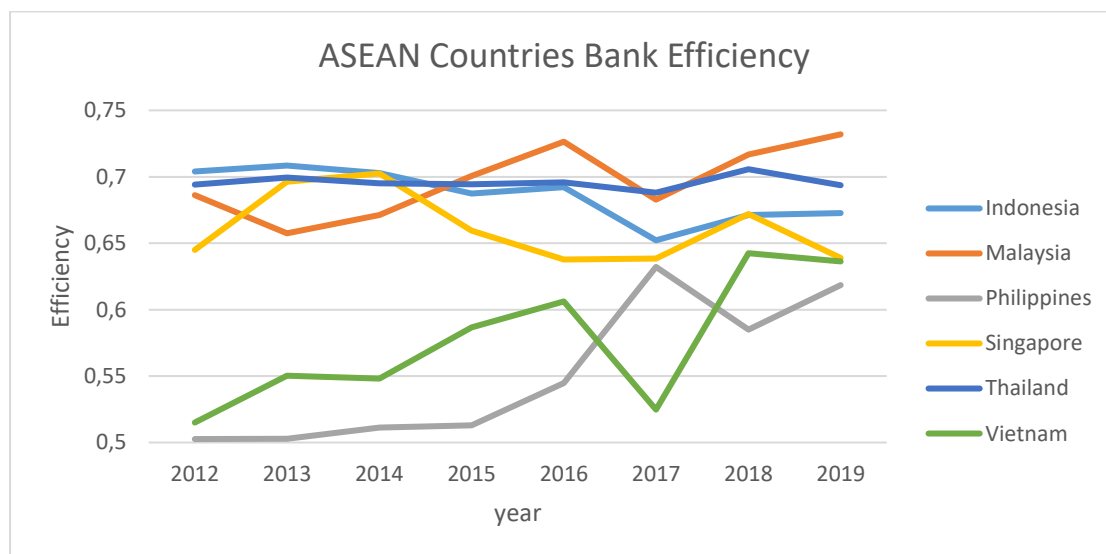


Figure 3
ASEAN Countries Banking Efficiency (Author, 2023)

Figure 3 shows the banking performance efficiency in European Union. The fluctuation of chart happened due to challenges and major events that affected the macroeconomy. Based on the information gathered from the search results, here are some significant challenges that confronted the EU banking sector from 2012 to 2019: Vulnerabilities in the Banking System and

Regulatory Framework: The crisis brought to light significant vulnerabilities within the banking system and the regulatory framework. This led to a surge in lending and risk-taking activities that were not adequately supported by regulations.

Revitalization of the EU Banking Sector: The revitalization of the EU banking sector

emerged as a prominent challenge during this timeframe. Substantial progress was achieved through regulatory reforms and the adjustment of banks' balance sheets.

Profitability Constraints: The European banking sector grappled with low profitability, characterized by escalating pressure on profit margins, default rates, and non-performing loan ratios.

Escalating Credit Losses: Banks in Europe faced a period marked by elevated credit losses across corporate and retail portfolios. This was compounded by a slowdown in new business and increased competition.

Lingering Effects of the Global Financial Crisis: The repercussions of the global financial crisis of 2008-2009 persisted throughout the European banking sector during this period.

Issues of Excess Capacity: Excess capacity emerged as a significant concern within the European banking sector, prompting discussions regarding consolidation and potential mergers and acquisitions (KPMG, 2021).

Throughout 2012 to 2019 period, the European banking sector experienced diverse trajectories in different countries as shown in Figure 4. Portugal successfully recapitalized its banking sector, ensuring stability in liquidity buffers by 2013. However, weak loan demand was evident due to the economic downturn (Andreeva, et al, 2019). In 2014, Portugal's banks struggled to recover from the crisis, as reflected in an average return on equity of minus 10.2 percent, in stark contrast to Europe's 30 largest banks, which recorded a positive 6.6 percent return (Noonan et al, 2014).

Conversely, the Irish and Greek banking sectors grappled with government bailouts and financial instability during the European debt crisis. In 2013, Ireland decided to liquidate the Irish Bank Resolution Corporation, while Greece faced challenges in

repaying government debt and rescuing over-indebted banks (CGFS, 2018).

Austria's banking sector remained stable and well-capitalized, thanks to high liquidity levels and low non-performing loans. The nation actively participated in the Vienna Initiative, a multilateral effort aimed at addressing banking challenges in Central, Eastern, and Southeastern Europe during the global financial crisis. Belgian banks experienced steady asset growth until 2013, followed by slight declines in 2014 and 2015. However, concerns were raised about IT spending in a 2016 report, potentially reflecting earlier underinvestment. In 2015, the European Commission identified macroeconomic imbalances in Belgium, emphasizing the need for policy actions. The labor market remained robust with an 8.5% unemployment rate (OENB, 2023).

The European debt crisis, which commenced in 2010, cast a long shadow, affecting banking sectors across the continent, including Belgium (Wikipedia, 2023). The Finnish banking sector, tightly linked with the Nordic/Baltic region, balanced diversification with heightened risks. In 2015, Finland's central bank warned of additional vulnerabilities due to exceptional market conditions. Nordea's relocation to Helsinki in 2018 heightened concerns about the Finnish banking sector's vulnerability (Reuters, 2015).

Italy faced economic challenges with recessions in 2012 and 2013, but signs of recovery emerged in 2014. However, the banking sector grappled with high non-performing loans, necessitating recapitalization and government intervention.

The Italian economy showed growth in 2017 but faced challenges in 2018 amidst a global economic slowdown. In 2019, the Italian banking sector appeared well-prepared to weather economic slowdown effects (OECD, 2021).

The Danish banking sector displayed fluctuations in return on equity from 2011 to

2019, ranging from a low of 4.2% in 2018 to a high of 10.3% in 2013 (Statista, 2020). Foreign ownership levels in the Danish banking system also fluctuated during this period, with a low of 17.7% in 2015 and a high of 23.1% in 2011 (Statista, 2022). The Danish financial sector maintained its significant size by international standards,

boasting a total-assets-to-GDP ratio of more than 500% and being dominated by a few large banks. Notably, there were no major events or crises recorded in the Danish banking sector from 2012 to 2019, as indicated by available search results.

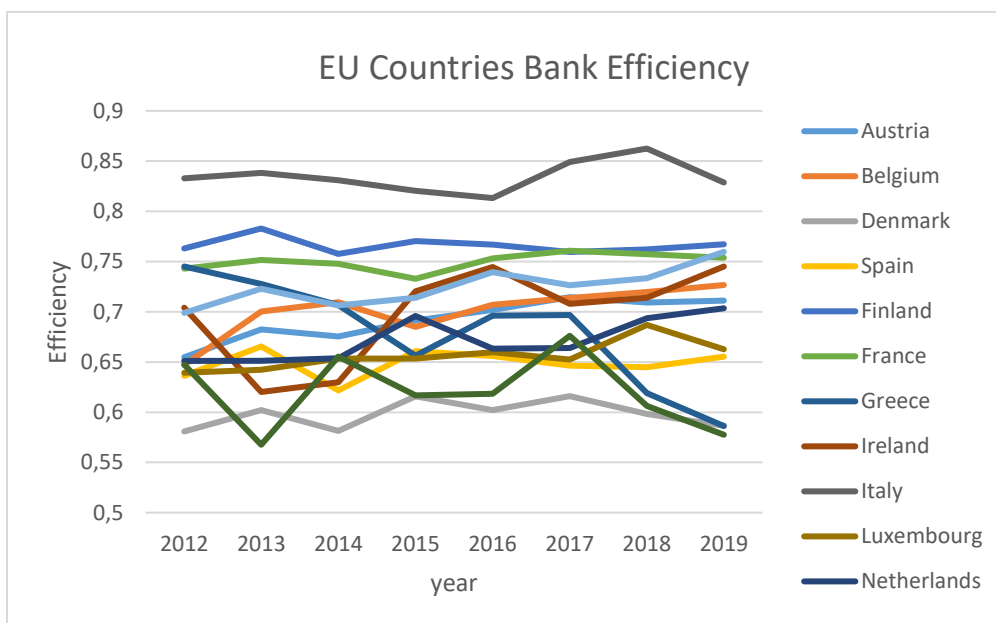


Figure 4. EU Countries Banking Efficiency (Author, 2023)

Yuen T-Test

The t-test was conducted to test the research hypothesis regarding the effect of each independent variable partially on the dependent variable. To counter the effects of nonnormality and variance heterogeneity, Yuen (1974) suggested that applied researchers use trimmed means and Winsorized variances with Welch's two-sample test.

In fact, Yuen discovered that one can achieve better Type I error control with her method, and numerous statisticians have indicated that the power to detect effects is greater with her method than with Student's t test or Welch's test based on least squares means and variances (e.g., Wilcox, 1997).

The standard deviation quantifies the data's spread or dispersion. Greater variability is

indicated by a higher standard deviation. In this situation, the standard deviation for the EU is significantly larger (0.1584) than for ASEAN (0.1375), indicating that the data from the EU is slightly more variable.

Skewness is a measure of the asymmetry of a data distribution. Negative skewness (-0.421) in ASEAN and -0.5342 in the EU implies that the data is skewed to the left, implying that the tail on the left side of the distribution is longer or fatter than the tail on the right side. In other words, there are more data points at the top of the parameter scale and fewer at the bottom.

Table 4. summarizes the descriptive statistics for the efficiency of banking performance in ASEAN and EU.

Table 4.
Descriptive Statistic of Banking Efficiency of Banks in ASEAN and EU

Parameter	ASEAN	EU	t-stat (p-value)
Mean	0.659	0.7024	10.325 (0.000)
Median	0.67	0.718	
Maximum	1	1	
Minimum	0.0988	0.003	
Standard Deviation	0.1375	0.1584	
Skewness	-0.421	-0.5342	

Source: Author's Calculation (2023)

The t-test results are displayed in the to illustrate whether there is a significant difference between the means of the two groups. The means of the two groups being compared differ statistically significantly, as shown by the t-stat value of 10.325 and the p-value of 1.8e-24. Therefore, we may say that there is a statistically significant difference between the means of the two groups.

5. Conclusions

The study concludes that the efficiency of banking in EU countries tends to be higher than that of ASEAN countries. Inefficiency occurs when the output surpasses the input or is substantially lower than the other output variables. The impact of macroeconomic conditions on the performance of banks in both regions is significant, with fluctuations significantly influencing businesses' operations and overall profitability in interest rates and adjustments in monetary policies.

The performance of banks in the ASEAN region may have been affected by regulatory reforms and alterations in supervisory frameworks throughout the study, leading to temporary impacts on profitability or constraints on lending activity. The analysis has major policy implications for ASEAN and EU banking sectors, helping policymakers and regulators assess current policies and regulations. Policymakers may reconsider regulatory frameworks if EU banks are less

efficient on average, streamlining bureaucratic processes, stimulating innovation, and enabling digitalization. Efficiency analysis can help bank executives and managers identify areas for improvement, involving resource optimization, cost reduction, or customer service improvement. Bank managers can also study the tactics and practices of efficient banks in both regions, driving others to adopt similar strategies and innovations, boosting efficiency.

Further research is required to gain a deeper and more comprehensive knowledge of the dynamics of efficiency in both regions. Future investigations incorporate the use of stochastic frontier analysis (SFA) as an additional tool for assessing the effectiveness of banking operations. This method will contribute to an evaluation of banking performance that is more rigorous and accurate, making it easier to make relevant comparisons between the various banking sectors. Further research should conduct a digital maturity assessment of EU and ASEAN banks to identify the factors that contribute to higher efficiency, including investigating their progress in digital transformation, adoption of digital channels, advanced analytics, automation, and AI technologies, and determining the correlation between digital maturity and efficiency while highlighting critical success factors for achieving high levels of efficiency through digitalization.

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