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COST EFFICIENCY OF MALAYSIAN BANKS DURING FINANCIAL LIBERALISATION: A STOCHASTIC FRONTIER ANALYSIS OF THE FINANCIAL SECTOR MASTER PLAN (2001-2010)

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ABSTRACT

This study examines the cost efficiency of Malaysian banks over the decade of financial liberalisation under the Financial Sector Master Plan (FSMP) from 2000 to 2011. Using stochastic frontier analysis (SFA) with a translog cost function, the study evaluates 354 bank-year observations encompassing 32 to 39 institutions operating in Malaysia. The analysis incorporates input prices, output quantities, and environmental factors such as ownership, bank size, liquidity, and the phases of deregulation to capture the dynamic effects of structural reform and global financial turbulence. The results reveal that average cost efficiency declined from 87.6% in 2000 to 71.8% in 2011, with an overall mean of 76.5%, indicating transitional inefficiencies during the liberalisation process. Cost efficiency was negatively influenced by large-bank size, foreign ownership, Islamic specialisation, and the 2008–2010 global financial crisis; while technological progress contributed to modest recovery toward the end of the period. The findings suggest that financial liberalisation enhances long-term competitiveness but imposes short-term cost burdens as banks restructure, integrate technology, and adapt to regulatory change. Concurrently, the results could serve as a vital reference for upcoming policy.

Keywords: cost efficiency, stochastic frontier analysis, Malaysian banks, financial liberalisation, Financial Sector Master Plan

1. INTRODUCTION

The assessment of banking efficiency has long constituted a central theme in financial economics, particularly within the context of regulatory reform and market liberalisation. Cost efficiency represents a fundamental indicator of a bank's ability to minimise production costs while maintaining a given level of output. In a liberalising financial environment, cost efficiency also reflects the managerial capacity to respond effectively to new competitive pressures, technological requirements, and evolving regulatory frameworks (Berger & Mester, 1997). In Malaysia, the issue of banking efficiency gained more attention in the aftermath of the 1997–1998 Asian Financial Crisis, which revealed vulnerabilities in capital adequacy, risk management, and cost control within the domestic financial system (Sivalingam, 2008). In response, Bank Negara Malaysia (BNM) introduced the Financial Sector Master Plan (FSMP) in 2001, a ten-

year reform blueprint designed to strengthen the financial system's institutional framework, enhance competition, and improve efficiency through a sequenced process of consolidation and liberalisation. The FSMP was implemented across three distinct phases: 2001 to 2003, 2004 to 2007, and 2008 to 2010. Each phase introduced progressively higher levels of openness, market discipline, and foreign participation.

The introduction of the FSMP, it marked a pivotal shift from a protected, domestically focused banking landscape to a more competitive and market-focused system. Over the course of this plan, the Malaysian banking industry underwent extensive consolidation, reducing the number of institutions from more than fifty to nine domestic banking groups, while simultaneously expanding the Islamic banking segment and modernising its technological infrastructure (Šeho et al., 2024). These structural changes were expected to improve efficiency and productivity in the long term, but they also imposed substantial short-term adjustment costs as banks integrated systems, merged operations, and complied with evolving prudential standards. While numerous studies have examined the impact of financial liberalisation on overall banking performance, there remains limited evidence on how liberalisation specifically affected cost efficiency during the FSMP implementation period (Casu et al., 2017; Deng et al., 2014). Earlier studies such as Zulkhibri and Sufian (2007) and Abdul-Majid et al. (2011) reported mixed outcomes with short-term declines in efficiency attributed to restructuring costs, followed by gradual improvement as reforms matured. However, the mechanisms and magnitude of these changes remain underexplored within the Malaysian context, particularly when distinguishing between the effects of consolidation, regulatory phases, and global financial conditions.

To bridge the gap of limited research in the Malaysian context, this study employs the Stochastic Frontier Analysis (SFA) framework to estimate and analyse the cost efficiency of Malaysian banks throughout the period of FSMP implementation from 2001 to 2010. An emphasis on cost efficiency, rather than standard profit or alternative profit efficiencies, isolates operational factors that directly reflect managerial performance, technological adaptation, and policy-induced structural change (Assaf et al., 2019; Zhang & Liu, 2024). This study provides additional empirical evidence to the current literature on how a sequenced liberalisation strategy under the FSMP influences the cost efficiency of banks within a developing economy. It also offers insights for policymakers who aimed to balance financial liberalisation and prudential stability, demonstrating that efficiency gains from reform are neither automatic nor immediate. Instead, they evolve as banks adjust to competitive pressures, adopt new technologies, and internalise governance standards. Despite the FSMP concluding in 2010, revisiting the implementation period remains analytically important. The decade represents a key phase in Malaysia's financial evolution, bridging the post-crisis reconstruction era and the foundations of the modern digital banking system. An analysis of cost efficiency patterns during this period provides not only a retrospective evaluation of the FSMP's outcomes but also valuable lessons for ongoing and future reforms under the Financial Sector Blueprint (2011–2020) and beyond.

2. LITERATURE REVIEW

2.1. Financial Liberalisation and Banking Sector Reform

Financial liberalisation refers to the process of reducing government intervention and regulatory restrictions within the financial system to promote market-oriented allocation of financial resources. McKinnon (1973) and Shaw (1973) argued that financial repression, characterised by interest rate ceilings, directed credit programmes, and state intervention, constrains the mobilisation of savings and the efficient allocation of investment. Liberalisation, therefore, aims to improve financial intermediation, enhance competition, stimulate innovation, and support economic growth.

In developing economies, financial liberalisation is often introduced to strengthen the banking system and increase efficiency. Liberalisation policies include the deregulation of interest rates, the removal of entry barriers, capital account openness, and the expansion of foreign bank participation. According to McKinnon (1973), market-determined interest rates encourage savings and improve the efficiency of capital allocation. Similarly, Shaw (1973) argued that financial deepening contributes positively to economic development by enhancing investment opportunities and productivity.

Despite its potential benefits, liberalisation also introduces significant risks. Demirgüç-Kunt and Detragiache (1998) found that poorly sequenced financial liberalisation may increase banking fragility and financial crises, especially in countries with weak regulatory institutions. Increased competition may encourage excessive risk-taking, speculative lending, and deterioration in asset quality. Consequently, strong prudential supervision and institutional reforms are necessary to ensure stability during the liberalisation process.

Malaysia implemented substantial banking reforms following the Asian Financial Crisis of 1997–1998. The crisis exposed weaknesses in the domestic banking sector, including high non-performing loans, weak risk management, and excessive credit growth. In response, Bank Negara Malaysia (BNM) introduced extensive restructuring programmes involving recapitalisation, consolidation, and stronger prudential regulation. One major initiative was the consolidation programme that reduced domestic banking institutions to ten anchor banking groups.

The Financial Sector Master Plan (FSMP) 2001–2010 represented the most comprehensive financial reform framework in Malaysia. The FSMP aimed to strengthen resilience, improve competitiveness, promote Islamic banking, encourage technological innovation, and gradually liberalise the financial sector. BNM played a critical role in implementing risk-based supervision, strengthening corporate governance, improving capital adequacy standards, and facilitating banking consolidation. The FSMP also encouraged foreign participation and modernisation of banking operations through digital technologies and enhanced financial infrastructure.

Fries and Taci (2005) argued that banking reforms and liberalisation can improve cost efficiency through stronger competition and better managerial practices. However, transitional restructuring costs and organisational adjustments may initially reduce performance before long-term efficiency gains emerge. Therefore, evaluating banking efficiency during the FSMP period provides important insights into the effectiveness of financial liberalisation policies in Malaysia.

2.2. Concept of Cost Efficiency in Banking

Efficiency measures have frequently been employed to evaluate the performance and reform outcomes of the banking sector. Among these measures, cost efficiency is particularly important as it reflects how effectively banks minimise input costs while maintaining output levels. Across developing countries, cost efficiency serves as a benchmark for both managerial performance and policy effectiveness, especially during periods of structural transformation and financial liberalisation (Berger & Mester, 1997; Casu & Girardone, 2009). For Malaysia, the issue of cost efficiency became relevant following the Asian Financial Crisis of 1997–1998, which exposed weaknesses in bank capitalisation, risk management, and operational cost control (Sufian, 2010). As part of its post-crisis reform agenda, BNM launched the ten-year FSMP in 2001 as a comprehensive framework to strengthen and modernise the existing Malaysian financial system. Assessing cost efficiency over this decade of regulatory reform is therefore essential to understand how financial liberalisation and institutional restructuring influenced the operational performance of Malaysian banks.

Cost efficiency in banking measures how closely a bank's observed cost aligns with the optimal (minimum) cost for producing its outputs, given its input prices and production technology (Aigner et al., 1977). It serves as an indicator of managerial effectiveness in controlling operating costs while maintaining service quality. Studies typically estimate cost efficiency using Stochastic Frontier Analysis (SFA) or Data Envelopment Analysis (DEA). The stochastic frontier method, introduced by Aigner et al. (1977) and Meeusen and van Den Broeck (1977), has been widely applied in banking research because it distinguishes inefficiency from random error, thereby allowing for robust statistical inference (Battese & Coelli, 1995). In the context of financial reform, SFA provides a suitable framework for assessing how banks respond to deregulation, technological change, and macroeconomic shocks. As shown in the current body of knowledge, the literature generally suggests that financial liberalisation can improve efficiency over time but may initially result in cost increases due to restructuring, learning costs, and competitive pressures (Fries & Taci, 2005; Kumbhakar & Sarkar, 2003; Leightner & Lovell, 1998). For example, studies in India, Thailand, and some other transition economies found that efficiency tends to fall during the early stages of financial liberalisation as banks invest heavily in technology and governance systems, and they could only recover once reforms stabilised (Fries & Taci, 2005; Wonglimpiyarat, 2008). Similarly, Malaysia's experience under the FSMP reflected a phased approach that combined consolidation with gradual deregulation to prevent abrupt destabilisation in the existing financial system. Empirical evidence on Malaysian banking efficiency reflects these transitional effects. Sufian (2010) and Zulkhibri and Sufian (2007) found that cost efficiency declined during the early liberalisation period, largely because of merger-related integration costs and investments in information systems. Abdul-Majid et al. (2011) reported similar patterns, explaining that Islamic banks, in particular, faced temporary inefficiencies as they expanded and diversified at the outset. Mohd Tahir et al. (2010) showed that domestic banks were generally more cost-efficient than foreign banks, partly due to regulatory limitations placed on foreign banks. Meanwhile, Hasan et al. (2012) observed that although average efficiency remained relatively high, differences across ownership types and bank sizes persisted throughout the FSMP decade.

These findings were consistent with international banking evidence that structural and regulatory change can generate short-term inefficiency even when long-term competitiveness improves. During the FSMP implementation period, Malaysian banks faced multiple simultaneous adjustments, including post-merger integration, adoption of the New Interest Rate Framework (NIRF), growing competition from foreign entrants, and compliance with new risk-based capital standards. Each of these developments changed existing cost structures and required significant resource reallocation. Hence, the resulting short-term inefficiencies were a natural by-product of transformation rather than an indication of declining performance (Dadzie & Ferrari, 2019). Therefore, examining cost efficiency during the FSMP period could offer additional insight into how Malaysian banking institutions respond to these adjustments. The FSMP was not merely a deregulation exercise. Rather, it represented a prudently sequenced reform designed to balance financial liberalisation with stability. As such, assessing cost efficiency outcomes helps determine whether the policy accomplished its intended objectives of strengthening competitiveness while maintaining systemic soundness. It also provides important lessons for other emerging countries, where the success of financial liberalisation hinges on the careful timing and sequencing of regulatory reforms. (Nasim et al., 2025). In addition, the FSMP period coincided with the emergence of digital banking, automation, and electronic payment systems, all of which required substantial capital investment and affected banks' overall cost efficiency (Naveed et al., 2025). The significant technological progress observed in later years, as evident from the negative time trend in stochastic frontier estimates, suggests that these investments gradually yielded efficiency gains after 2010. Thus, understanding the dynamics of cost efficiency over this period helps explain how the sector evolved from a protected, domestically focused industry into a modern, competitive, and innovation-driven financial system (Tarawneh et al., 2024).

In summary, the literature offers a coherent understanding of Malaysia's experience with financial liberalisation, highlighting the balance between reform costs and long-term gains. In this context, cost efficiency is a critical indicator of both operational soundness and the effectiveness of policy implementation. Although the FSMP initially increased transitional inefficiencies associated with structural reforms and regulatory realignment, these were subsequently offset by improvements in technological capacity, managerial practices and institutional resilience. Therefore, investigating cost efficiency during the FSMP implementation period offers not only empirical insight into the performance of Malaysian banks but also broader policy lessons on how emerging economies can balance financial liberalisation and stability in the pursuit of sustainable financial development (Duygun et al., 2015).

2.3. Stochastic Frontier Analysis (SFA) Theory and Methodology

Stochastic Frontier Analysis (SFA) is one of the most widely used approaches for measuring efficiency in banking and financial institutions. The methodology was independently developed by Aigner, Lovell, and Schmidt (1977), and Meeusen and van den Broeck (1977). SFA estimates an efficient frontier while separating random statistical noise from inefficiency effects.

The central concept of SFA is the frontier production or cost function. Banks operating on the frontier are considered fully efficient, while those below the frontier are regarded as inefficient. Unlike deterministic frontier methods, SFA recognises that deviations from the frontier may result not only from managerial inefficiency but also from random shocks, measurement errors, and external economic conditions.

The stochastic frontier model decomposes the error term into two components: a symmetric random error term and a non-negative inefficiency term. The random error captures external influences beyond managerial control, while the inefficiency component reflects operational shortcomings. This distinction represents a major advantage of SFA compared with non-parametric approaches such as Data Envelopment Analysis (DEA).

DEA constructs an efficiency frontier using linear programming techniques without specifying a functional form. Although DEA is flexible and does not require distributional assumptions, it assumes that all deviations from the frontier are due to inefficiency. As a result, DEA is highly sensitive to measurement errors and outliers. In contrast, SFA incorporates statistical noise and allows formal hypothesis testing, making it more suitable for banking studies where macroeconomic fluctuations and regulatory changes influence performance.

Battese and Coelli (1995) extended the stochastic frontier framework by introducing models that allow inefficiency effects to vary over time and depend on explanatory variables. Their one-stage panel data approach has become widely used in banking efficiency research because it simultaneously estimates frontier parameters and determinants of inefficiency. Time-varying inefficiency models are particularly useful for analysing banking reforms because they capture dynamic changes in efficiency during periods of liberalisation and restructuring.

SFA has therefore become an important methodological tool in banking studies examining the effects of deregulation, mergers, foreign bank participation, technological change, and financial sector reforms. Its ability to distinguish random disturbances from inefficiency makes it well-suited to evaluating Malaysian banking performance during the FSMP period.

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2.4. Empirical Studies on Banking Efficiency

A substantial body of empirical literature has examined banking efficiency across developed and developing economies. In developed countries such as the United States and European economies, deregulation and technological innovation have generally improved banking productivity and operational performance. Berger and Mester (1997) found that efficiency differences among US banks were strongly associated with managerial practices, technological capabilities, and risk management quality.

Studies in European banking sectors similarly reported that liberalisation and integration increased competitive pressures and encouraged efficiency improvements. However, consolidation and mergers produced mixed outcomes because some banks experienced economies of scale while others faced integration challenges and increased operational complexity.

In Japan, banking reforms following financial instability during the 1990s also emphasised restructuring and recapitalisation. Empirical evidence suggests that technological modernisation and stronger regulatory frameworks contributed to improved banking performance, although efficiency gains varied across institutions.

In developing and transition economies, banking liberalisation has produced diverse outcomes depending on institutional quality and regulatory capacity. Fries and Taci (2005) examined banking efficiency in transition economies and found that competitive banking environments and foreign ownership positively influenced cost efficiency. Foreign banks often introduced superior managerial practices, advanced technologies, and stronger governance systems.

Studies on Asian banking sectors following the Asian Financial Crisis highlighted the importance of restructuring and consolidation. In Thailand and Indonesia, post-crisis reforms focused on recapitalisation, prudential regulation, and foreign participation. Although efficiency improved in the long run, short-term restructuring costs and non-performing loans reduced performance during the transition period.

Research in China and India has also demonstrated that banking reforms and market-oriented policies contributed to greater operational efficiency. Technology adoption, digital banking expansion, and competition reforms improved service delivery and cost management. Nevertheless, state ownership and regulatory constraints continued to influence efficiency performance in many developing banking systems.

Overall, empirical evidence suggests that financial liberalisation and banking reforms can improve efficiency, but outcomes depend heavily on regulatory quality, institutional development, and the sequencing of reform policies.

2.5. Empirical Studies on Malaysian Banking Efficiency

Numerous studies have examined banking efficiency in Malaysia, particularly in relation to financial liberalisation, mergers, Islamic banking, and foreign bank participation. Malaysian banking reforms after the Asian Financial Crisis created an important context for evaluating changes in efficiency.

Sufian (2010) analysed the efficiency performance of Malaysian banks and found that consolidation and restructuring programmes contributed positively to operational efficiency. Larger banking institutions generally benefited from economies of scale, improved technology adoption, and stronger managerial capabilities. However, some banks experienced adjustment difficulties following mergers and restructuring exercises.

Zulkhibri and Sufian (2007) compared domestic and foreign Islamic banks in Malaysia and reported significant differences in efficiency levels. Foreign banks tended to demonstrate higher managerial efficiency due to advanced technologies, international expertise, and superior governance systems. Domestic banks, however, benefited from stronger local market knowledge and government support.

Abdul-Majid, Saal, and Battisti (2011) examined efficiency differences between Islamic and conventional banks. Their findings indicated that Islamic banks faced unique operational and compliance costs associated with Shariah governance structures, although some Islamic institutions achieved high efficiency through product innovation and market expansion.

Hasan and Dridi (2012) investigated the resilience of Islamic and conventional banks during financial crises and found that Islamic banks were relatively stable due to lower exposure to speculative financial instruments. Nevertheless, efficiency performance varied depending on management quality and operational scale.

Several Malaysian studies also examined the impact of the FSMP on banking performance. The liberalisation of interest rates, increased competition, foreign bank entry, and technological modernisation improved operational efficiency across many banking institutions. Banks invested heavily in information technology, internet banking platforms, ATM networks, and electronic payment systems to reduce operating costs and improve customer service delivery.

Research further indicates that mergers and consolidations enhanced scale efficiency in Malaysian banking. The reduction of numerous small banking institutions into larger anchor banks strengthened capital adequacy and improved operational resilience. However, integration costs and organisational restructuring initially reduced efficiency for some institutions during the adjustment phase.

Overall, the Malaysian banking literature suggests that post-crisis reforms and FSMP initiatives contributed significantly to improvements in banking efficiency, competitiveness, and financial stability.

2.6. Financial Sector Master Plan (FSMP) and Banking Transformation

The Financial Sector Master Plan (FSMP) 2001–2010 represented a major transformation strategy for Malaysia's financial sector. Introduced by Bank Negara Malaysia, the FSMP aimed to create a resilient, efficient, competitive, and dynamic financial system to support long-term economic growth.

One of the primary objectives of the FSMP was banking consolidation. The consolidation programme reduced the number of domestic banking institutions and created stronger banking groups with improved capital strength and operational capabilities. Larger banking institutions were expected to achieve economies of scale, improve cost efficiency, and strengthen risk management systems.

The FSMP also promoted gradual liberalisation and foreign participation in the Malaysian banking sector. Foreign banks introduced new technologies, innovative products, and advanced management techniques, thereby increasing competitive pressure within the industry. This encouraged domestic banks to modernise operations and improve service quality.

Prudential regulation and risk-based supervision constituted another major component of the FSMP. Bank Negara Malaysia strengthened supervisory frameworks, corporate governance standards, and capital adequacy requirements to improve financial stability. Risk management practices became increasingly important following lessons from the Asian Financial Crisis.

The FSMP further introduced the New Interest Rate Framework (NIRF), which enhanced market-based pricing mechanisms and improved the transmission of monetary policy. The framework encouraged greater flexibility in interest rate determination while promoting efficient allocation of financial resources.

Technological development also became a critical focus of the FSMP. Banks expanded electronic banking services, digital payment systems, and internet banking platforms to improve operational efficiency and customer accessibility. Technological innovation reduced transaction costs and enhanced competitiveness within the banking sector.

The FSMP therefore represented a comprehensive reform agenda integrating liberalisation, prudential regulation,

technological modernisation, and institutional restructuring. Evaluating banking efficiency during this period provides important evidence regarding the effectiveness of Malaysia's financial sector transformation policies.

2.7. Research Gap

Although extensive literature exists on banking efficiency and financial liberalisation, several important gaps remain in the Malaysian context. First, many previous studies focus only on specific aspects of banking efficiency, such as Islamic banking, mergers, or foreign bank participation, rather than examining the broader impact of financial sector reforms.

Second, relatively few studies analyse the entire FSMP period from 2001 to 2010. Most research examines shorter sub-periods or focuses on immediate post-crisis restructuring effects. Consequently, limited evidence exists regarding long-term efficiency dynamics throughout the full implementation of the FSMP.

Third, while various methodologies have been applied in banking efficiency research, fewer Malaysian studies employ stochastic frontier analysis to measure cost efficiency during the liberalisation period. Since SFA distinguishes random shocks from inefficiency effects, it provides a more appropriate framework for evaluating banking performance during periods of economic and regulatory transition.

Fourth, limited empirical research examines changes in dynamic efficiency during the sequential implementation of reforms. Banking reforms often produce short-term adjustment costs followed by long-term efficiency gains. Existing studies rarely examine these transitional dynamics comprehensively.

Therefore, this study contributes to the literature by examining the evolution of cost efficiency in Malaysian banks during the FSMP period using stochastic frontier analysis. The study integrates financial liberalisation theory, banking sector reforms, and efficiency measurement within a unified analytical framework to provide a deeper understanding of banking transformation in Malaysia.

3. METHODOLOGY

This study employs the Stochastic Frontier Analysis (SFA) approach to estimate the cost efficiency of Malaysian banks during the Financial Sector Master Plan (FSMP) period. SFA is widely used in banking efficiency studies because it distinguishes inefficiency from random statistical noise, allowing a more accurate assessment of bank performance under varying economic and regulatory conditions. Following Berger and Mester (1997), cost efficiency measures the extent to which a bank minimises total costs relative to a best-practice bank that produces the same level of output under similar operating conditions.

The stochastic cost frontier model is specified as follows:

$$\mathbf{lnTC\_it = f(w\_it, y\_it, c\_it, z\_it, \beta) + v\_it + u\_it}$$

where lnTC_it represents the natural logarithm of total cost for bank i at time t. The function f(.) denotes the translog cost frontier, while w_it represents the vector of input prices, y_it denotes the vector of outputs, c_it represents control variables, and z_it denotes environmental variables. The parameter vector β captures the coefficients to be estimated.

The composite error term consists of two components. The first component, v_it, represents random statistical noise arising from measurement errors, external shocks, and other uncontrollable factors. It is assumed to follow a normal distribution with mean zero and variance σ^2_v. The second component, u_it, represents cost inefficiency and is assumed to be non-negative and one-sided. This term captures deviations from the efficient frontier attributable to managerial inefficiency and operational shortcomings.

Cost efficiency is estimated as the ratio of the minimum possible cost to the actual observed cost. The efficiency score ranges from 0 to 1, with values closer to 1 indicating higher efficiency. A bank with a score of one is considered fully efficient relative to the best-practice frontier.

To estimate the cost frontier, this study adopts the translog functional form due to its flexibility and widespread application

in banking efficiency literature. The translog specification allows for interaction effects among outputs, input prices, and control variables without imposing restrictive assumptions regarding production technology. The estimated translog cost function is expressed as:

$$\ln(TC\_it / W3\_it) = \alpha 0 + \Sigma \beta\_n \ln(W\_nit / W3\_it) + \Sigma \delta\_k \ln Y\_kit + 1/2\ \Sigma\Sigma \beta\_nj \ln(W\_nit / W3\_it) \ln(W\_jit / W3\_it) + 1/2\ \Sigma\Sigma \delta\_km \ln Y\_kit \ln Y\_mit + \Sigma\Sigma \eta\_nk \ln(W\_nit / W3\_it) \ln Y\_kit + \Sigma \chi\_r \ln C\_rit + \text{interaction and time trend terms} + v\_it + u\_it$$

The model incorporates time trend variables to capture technological progress and structural changes over the sample period. In addition, interaction terms between inputs, outputs, and control variables are included to account for non-linear relationships within banking operations.

This study applies the one-stage estimation procedure developed by Battese and Coelli (1995). Under this framework, inefficiency effects are estimated simultaneously with the stochastic frontier model, allowing environmental factors to directly influence inefficiency levels. This approach is preferred because it avoids inconsistency problems associated with two-stage estimation methods.

Control variables are incorporated into the deterministic component of the frontier to capture heterogeneity across banks. These variables directly influence banking operations and production technology. Environmental variables are included within the inefficiency component to explain variations in cost efficiency across institutions.

3.1. Data and Variables

The study utilises an unbalanced panel dataset comprising Malaysian commercial and Islamic banks from 2000 to 2011. The sample period covers the implementation of the Financial Sector Master Plan (FSMP) and includes the Global Financial Crisis, thereby providing a comprehensive context for examining banking efficiency under financial liberalisation and economic restructuring
.
Financial data were obtained from proprietary banking databases and annual reports. Investment banks were excluded because their operational characteristics differ significantly from commercial and Islamic banking institutions. Observations with incomplete financial information, zero non-performing loans, or missing fixed asset data were also excluded. The final sample consists of 354 bank-year observations representing between 32 and 39 banking institutions across the study period.

The study adopts the intermediation approach introduced by Sealey and Lindley (1977), which views banks as financial intermediaries transforming deposits, labour, and capital into loans and earning assets. This approach is widely used in banking efficiency studies because it incorporates interest expenses as a major component of banking costs.

Total cost (TC) is used as the dependent variable and includes interest expenses, personnel expenses, depreciation, provisions, and other operating costs. Three input price variables are included in the model: the price of funds (W1), measured as interest expenses divided by total deposits and borrowings; the price of labour (W2), measured as personnel expenses divided by total assets; and the price of physical capital (W3), measured as operating and administrative expenses divided by fixed assets.

The output variables consist of loans (Y1), investments (Y2), and other earning assets (Y3). To account for differences in banking operations and financial conditions, the model also incorporates control variables, including asset quality, capital adequacy, liquidity, and time trends.

In addition, several environmental variables are included to explain variations in inefficiency across banks. These variables include ownership structure, banking specialisation, stages of financial liberalisation under the FSMP, the Global Financial Crisis, bank size, market concentration, and market share.

The inclusion of these variables enables the model to capture the effects of financial liberalisation, banking consolidation, technological development, and regulatory reforms on the cost efficiency of Malaysian banks. Consequently, the methodology provides a comprehensive framework for evaluating the dynamic efficiency performance of Malaysian banking institutions throughout the FSMP reform period.

Table 1: Descriptive Statistics for Inputs, Outputs, Control, and Environmental Variables, 2000–2011

Variables		Description	Mean	Std Dev.	Min.	Max.
Dependent variables						
TC	Total Cost (MYR million)	Variable operating costs of deposits, personnel and investments	1,438.86	97.97	17.05	12,413.74
Independent variables/output prices						
Y1	Loans (MYR million)	Total loans, net of interest in suspense and NPL	15,273.20	19,496.82	19.85	99,506.07
Y2	Investments (MYR million)	Dealing securities, investment securities, government and private debt securities	3,393.27	4,349.12	0.05	27,420.31
Y3	Other earning assets (MYR million)	Interbank deposits in other banks	4,473.50	5.374.63	25.04	30,884.64
Independent variables/input prices						
W1	Price of funds (%)	Interest expenses on deposits/deposits	2.41	0.81	0.25	10.06
W2	Price of labour (%)	Personnel expenses/total assets	0.64	0.25	0.03	1.85
W3	Price of physical capital (%)	Other operating expenses/physical assets	11.50	13.89	0.00	121.02
Control Variables						
C1	Capital adequacy (%)	Capital/total assets	10.43	6.38	1.19	36.85
C2	Asset quality (%)	Non-performing loans/loans	8.00	7.72	0.07	54.23
C3	Liquidity (%)	Loans/deposits	66.79	22.55	0.63	120.34
T	Time trend	T1 = 2000, T2 = 2001,…, T12 = 2011	6.95	3.51	1.00	12.00
Environmental Variable						
Z1	Ownership	Foreign = 1, domestic = 0 (dummy)	0.47	0.50	0.00	1.00
Z2	Specialisation	Islamic banks = 1, conventional banks = 0 (dummy)	0.25	0.43	0.00	1.00
Z3	Deregulation FSMP phase 2	Dummy for 2004 – 2007 = 1, otherwise = 0	0.31	0.46	0.00	1.00
Z4	Deregulation FSMP phase 3	Dummy for 2008 – 2011 = 1, otherwise = 0	0.40	0.49	0.00	1.00
Z5	Effect of global financial crisis on Malaysia	Dummy for 2008 – 2010 = 1, otherwise = 0	0.31	0.46	0.00	1.00
Z6	Bank size (MYR million)	Total assets	32,320.00	41,679.13	721.17	229,504.17
Z7	Market concentration (%)	Herfindahl–Hirschman index (concentration of banks' assets)	7.79	0.81	6.58	8.73
Z8	Market share (%)	Bank deposits/total banking deposits	3.39	3.98	0.08	19.69

4. FINDINGS AND DISCUSSION

Based on the estimated cost model presented in Table 2, the coefficients for the prices of funds (β_1), price of labour (β_2) and price of physical capital ($\beta 3$) *are 0.6720, 0.3711 and -0.0431,* respectively. The coefficient values indicate that a 1% increase in the prices of funds (W1), labour (W2), and physical capital (W3) would result in increases of 0.67% and 0.37%, and a decrease of 0.04% in total cost, respectively. This finding satisfies the property of the cost function, TC = f (W1, W2, W3), which stipulates that the overall cost would not decline when the combination of input prices increases. At the same time, the coefficients of the combined outputs were also positive. A 1.0% increase in output variables, namely loans (Y1), investments (Y2) and other earnings assets (Y3), will increase the total costs of 1.04% and 0.02%, and result in a slight decrease of 0.02%, respectively. The estimated cost function showed that all three outputs have positive effects on total costs, indicating that total costs increase as production expands. The sum of the three output coefficients was 1.0382, implying that a systematic 1% expansion in production would increase total cost by slightly more than 1%. This suggests that the Malaysian banking industry may be experiencing diseconomies of scale, where further expansion has resulted in a disproportionate increase in costs. Regarding the time variable (T), the coefficient was negative (-0.04) and statistically significant at the 5% level. This indicates that technological change might have occurred in the industry in the study period.

As shown by the results, the ownership variable, i.e. domestic versus foreign banks ($\psi_1 = 1.0956$, $p < 0.01$), was positive and statistically significant, indicating that foreign banks were less cost-efficient than domestic banks. This result diverged from findings in other emerging markets, where foreign participation has typically been associated with greater efficiency (Claessens et al., 2001). This outcome likely stemmed from regulatory constraints imposed by BNM, which restricted foreign banks' branch expansion and product diversification during the initial stage of FSMP implementation, thereby reducing the operational flexibility of foreign banking institutions and impeding the full realisation of scalability and technology-related benefits (Hui & Foong, 2021). Apart from that, the specialisation variable i.e. Islamic versus conventional banks ($\psi_2 = 0.3837$, $p < 0.10$) was positively associated with cost inefficiency, indicating that Islamic banks were less cost-efficient than conventional banks. The expansion of Islamic subsidiaries in the mid-2000s, particularly during the second phase of the FSMP, entailed transitional and administrative costs for developing the necessary infrastructure and compliance mechanisms. This development placed additional pressure on Malaysian banks to uphold Shariah compliance while simultaneously striving to maintain cost competitiveness. Additionally, the entry of new foreign Islamic banks during the same phase of the FSMP led to higher establishment costs, thereby increasing operating costs across the Islamic banking sector. These institutions also introduced Middle Eastern–based banking concepts that were comparatively more stringent and required additional resources to structure Shariah-compliant products. Furthermore, the use of specialised Shariah terminology made these products difficult for many Malaysian consumers to understand. (Abdul-Majid & Hassan, 2011; Tamjis et al., 2024).

The global financial crisis variable ($\psi_5 = 0.6225$, $p < 0.05$) demonstrated that the 2008–2010 crisis significantly reduced cost efficiency. The global liquidity crunch and deterioration in asset quality increased operational expenses as banks increased loan loss provisioning, restructured their portfolios, and strengthened their risk management frameworks. This temporary inefficiency reflects the sector's resilience strategy, which prioritised financial stability and prudence over cost minimisation during external shocks. Aside from that, the bank size variable ($\psi_6 = 2.4994$, $p < 0.01$) exhibited a strong positive coefficient, indicating that larger banks were substantially less cost-efficient than smaller institutions. This finding is consistent with the consolidation and merger activities of the early 2000s, during which increases in bank size were accompanied by greater organisational complexity, higher integration costs, and managerial redundancies, which contributed to reduced cost efficiency. (Kwan, 2006; Sufian, 2004). This finding also supported the "quiet life" hypothesis, which posited that major banking institutions with substantial market power face weaker cost discipline due to lower competitive pressure (Berger & Hannan, 1998). Regarding market structure, the market concentration variable ($\psi_7 = 3.6821$) had a positive but statistically insignificant effect, suggesting that a concentrated market structure neither enhanced nor impaired cost efficiency. On the other hand, the market share variable ($\psi_8 = -2.9020$, $p < 0.01$) was negative and statistically significant, implying that banks with larger market shares achieved greater cost efficiency. This finding supported the Relative Market Power (RMP) hypothesis, which suggests that major banking institutions leveraged economies of scale and pricing flexibility to offset cost pressures, even in competitive settings (Berger, 1995). Among the control variables, asset quality ($\chi_2 = 0.1396$), although insignificant, showed a positive relationship, suggesting that higher levels of non-performing loans (NPLs) would increase total costs due to greater loan loss provisioning and bad-loan

monitoring-related expenses (Girardone et al., 2004). Conversely, liquidity ($\chi_3 = -0.8275$, $p < 0.01$) exhibited a statistically significant negative relationship with cost efficiency, indicating that excessive liquidity holdings during the FSMP period generated operational inefficiencies and opportunity costs associated with underutilised funds.

4.1. Cost Efficiency Scores

As indicated in Table 3, the average cost efficiency scores for the Malaysian banks for the period 2000–2011 is 82.7%. The average cost efficiency scores suggested that Malaysian banks wasted around 20.0% of their inputs compared with the best-performing banks to produce the same level of output. This finding, reflecting 20.0% inefficiency, was consistent with earlier studies that employed the SFA approach to estimate cost efficiency (A. N. Berger & DeYoung, 2001; Bonin et al., 2005; DeYoung, 1998). The first phase of the FSMP (2000–2003) was regarded as the initial reform period in Malaysia's banking industry. Following the 1997–98 Asian Financial Crisis, the Malaysian government undertook several structural measures to strengthen the banking sector (Abdul-Majid & Hassan, 2011; Sufian, 2004). For instance, unlike several other Association of Southeast Asian Nations (ASEAN) member countries, Malaysia did not seek assistance from the International Monetary Fund (IMF) following the Asian financial crisis. Under these IMF-led programmes, insolvent banks in some of the ASEAN countries were forced to close. However, Malaysia deliberately avoided this approach due to potentially severe social costs. Instead, Malaysia pursued an internally driven restructuring strategy by consolidating domestic banking institutions, with BNM acting as an intermediary to ensure equitable treatment among all parties involved (Abd Kadir et al., 2010). This policy decision implemented during the first phase of FSMP exhibited a downward trend of cost efficiency during this period, reflecting transitional inefficiencies arising from mergers, integration and structural adjustments. During this period, domestic banks were required to streamline various rationalisation programmes, including restructuring duplicated branch networks, managing staff redundancies, and synchronising technology with the acquiring partners (Sufian, 2004).

Table 3: Average SFA Cost Efficiency Scores, 2000–2011

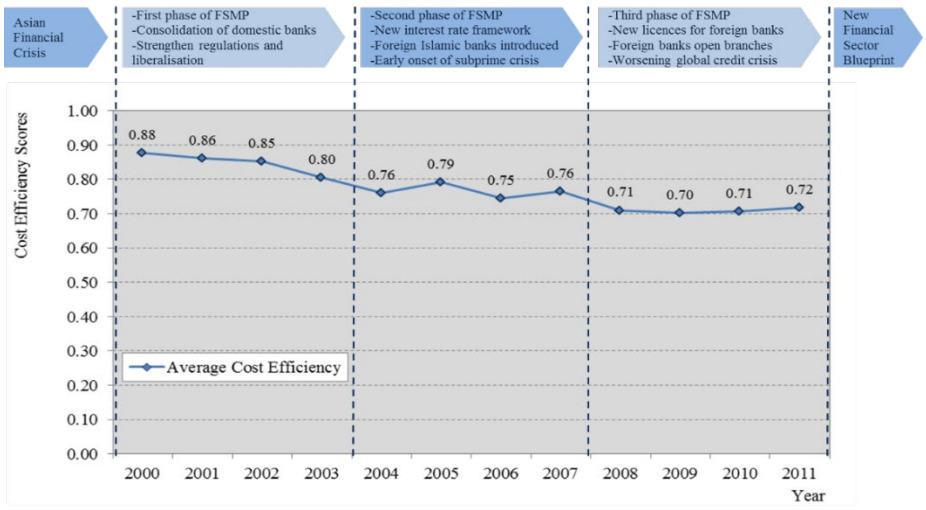
Year	Count	Mean	Standard Deviation	Minimum	Maximum
2000	24	0.8760	0.1519	0.2600	0.9721
2001	26	0.8614	0.1537	0.2698	0.9787
2002	24	0.8523	0.1524	0.3253	0.9725
2003	24	0.8103	0.1528	0.3731	0.9582
2004	25	0.7596	0.1734	0.2404	0.9270
2005	26	0.7913	0.1554	0.2088	0.9418
2006	29	0.7450	0.2095	0.2033	0.9317
2007	31	0.7648	0.1440	0.2704	0.9402
2008	36	0.7098	0.1783	0.0509	0.9324
2009	37	0.7025	0.1877	0.0296	0.9271
2010	37	0.7065	0.1884	0.0738	0.9478
2011	35	0.7177	0.2157	0.0848	0.9702
2000-2003	98	0.8502	0.1523	0.2600	0.9787
2004-2007	111	0.7647	0.1707	0.2033	0.9418
2008-2011	145	0.7090	0.1909	0.0296	0.9702
2000-2011	354	0.7655	0.1834	0.0296	0.9787

In the second phase of the FSMP (2004–2007), BNM introduced NIRF to promote more efficient pricing of financial products. Following the removal of BNM's intervention rate, Malaysian banks were able to price their funding costs and revenues according to their own cost structures and to compete for customers using independent interest rate pricing. This deregulation of interest rates aimed to enhance efficiency, productivity, innovation and profitability within the banking system (Berger & Mester, 2003; Leightner & Lovell, 1998; Sensarma, 2006). As a result of interest-rate deregulation, banks needed to adjust their inputs and outputs to remain competitive. During this period, a slight increase in the cost efficiency scores was observed in 2005, following the liberalisation of Base Lending Rate (BLR), indicating greater price competition among Malaysian banks. Towards the end of the second phase of the FSMP, cost efficiency scores fell marginally partly due to significant losses incurred by one Islamic bank and the entry of several new foreign Islamic banks. The overall average cost-efficiency scores declined because newly established foreign Islamic banks incurred inherently higher operational costs in their early stages (Sufian, 2010).

In the third phase of the FSMP (2008–2011), Malaysian banks were initially insulated from the early stages of the U.S. subprime crisis. Malaysian banks had been prudent in their investments, particularly relating to derivatives products originated in the U.S. and Europe. However, by mid-2008, as the global economy weakened, demand for Malaysian exports declined, adversely affecting the real sector (Elekdag et al., 2012). Consequently, Malaysia's GDP contracted by 1.7% in 2009. As a result, banks' non-performing loans (NPL) rose slightly in 2009, reflecting the broader economy contraction. The downward trend in cost efficiency scores during the third FSMP phase was also driven by higher operating costs by Malaysian banks in managing delinquent loans (Ibrahim, 2011). During the same period, BNM reduced its policy interest rate, overnight policy rate (OPR) from 3.5% to 2.0% between November 2008 and February 2009. This policy rate reduction required banks to adjust input prices and outputs in line with the indicative market interest rate. Consistent with Berger and Humphrey (1990), slower adjustment to market changes led Malaysian banks to experience lower cost efficiency during the third phase of the FSMP (2008-2011). In addition, Basel II was implemented between 2008 and 2010 (covering both the Standardised and Internal Ratings-Based Approaches), prompting Malaysian banks to invest heavily in technology, physical assets, external consultants, and specialised labour to meet the new capital requirements.

Overall, the analysis of cost efficiency from 2000 to 2011 reveals that Malaysian banks underwent a complex transition characterised by alternating periods of efficiency gains and declines, broadly mirroring the sequencing of the FSMP reforms. The persistence of moderate efficiency levels, amid structural and macroeconomic shocks, underscores the resilience of Malaysia's banking system and its capacity to absorb reform-related adjustments while maintaining operational stability. The findings suggest that liberalisation, though initially costly, laid the foundation for a more efficient, competitive, and technologically adaptive banking sector in the post-FSMP era.

Figure 1: Average SFA Cost Efficiency Scores of Malaysian Banks, 2000–2011



5. CONCLUSION

This study's analysis of cost efficiency using the SFA reveals a downward trend in the cost efficiency performance of Malaysian banks during the FSMP period (2000-2011). Average cost efficiency remained moderately high at approximately 82.0%; however, the decline from 87.6% in 2000 to 71.8% in 2011 reflected the transitional and structural costs associated with the liberalisation and consolidation of banks. This finding aligns with expectations that financial reforms, while improving long-term competitiveness, often generate short-term inefficiencies as institutions adjust to new operational, technological, and regulatory frameworks (Shah et al., 2023). The evidence indicated that the initial FSMP phase was characterised by post-crisis consolidation and rationalisation, which created integration costs that temporarily reduced cost efficiency. During the second phase, the implementation of the NIRF, coupled with heightened foreign competition, exerted additional pressure on operating margins, compelling banks to invest in technological infrastructure, compliance systems, and product diversification (Sufian & Kamarudin, 2017). The 2008–2010 global financial crisis exacerbated this trend, as heightened liquidity management, loan restructuring, and stricter prudential measures increased operational expenditures of the banks, contributing to the lowest efficiency levels of the decade (Toh, 2019).

Nevertheless, the negative and statistically significant time coefficient in the cost frontier model indicates that technological progress took place during the period, enabling banks to gradually reduce production costs through process innovation and learning effects. The mild recovery in cost efficiency observed after 2010 supports the notion that the long-term gains of the FSMP, namely institutional strengthening, digital transformation, and enhanced supervisory frameworks, began to outweigh the short-term costs of structural adjustment (Sufian & Habibullah, 2013). In essence, the findings demonstrate that financial liberalisation in Malaysia produced short-term cost inefficiencies but lasting structural benefits. The short-term decline in cost efficiency represented a necessary adjustment toward a more resilient, competitive, and technologically adaptive banking system. From a policy perspective, the Malaysian experience underscores that efficiency improvement under financial liberalisation was gradual and evolutionary rather than immediate (Budina, 2023). Effective regulation reforms, sequencing, continuous supervisory enhancement, and sustained investment in technology and human capital were essential for translating regulatory transformation into enduring efficiency gains (Allub et al., 2023; Grechyna, 2018). This conclusion laid the foundation for the subsequent discussion of policy implications, in which lessons from Malaysia's FSMP experience can inform future strategies to sustain cost efficiency while promoting innovation and stability in the financial sector.

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7. CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in the paper.

8. AUTHOR CONTRIBUTION STATEMENT

Author 1 contributed to the conceptualization, research design, and writing of the original draft.
Author 2 was responsible for data collection, analysis, and validation of the results.
Author 3 provided supervision, critical review, and editing of the final manuscript.
All authors have read and approved the final version of the manuscript.

9. ETHICS STATEMENT

This study used secondary data obtained from publicly accessible sources, including publications by the Central Bureau of Statistics (Badan Pusat Statistik/BPS) and other official government publications. The research did not involve direct interaction with human participants, the collection of personal data, clinical procedures, or experiments involving humans or animals. Therefore, formal ethical approval and informed consent were not required. All data used in this

study were analyzed solely for academic and research purposes, and the authors ensured that the data were reported accurately, objectively, and responsibly in accordance with academic research ethics standards.

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