Deregulation, bank efficiency and economic cooperation across China–Taiwan Strait☆

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Abstract

This study investigates whether deregulation has affected bank efficiency in the 'cross-strait' relationship between China and Taiwan. I measure bank efficiency across three periods – after Taiwan and China joined the World Trade Organization, the global financial crisis, and the signing of the Economic Cooperation Framework Agreement (ECFA) – and show that Taiwanese banks were significantly more efficient than their Chinese counterparts. These results show that the ECFA platform has not improved bank efficiency and thus has failed to function effectively. This finding suggests that China and Taiwan should continue negotiating within the ECFA context to enhance cross-strait financial cooperation.
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1. Introduction

The World Trade Organization (WTO) imposes no restrictions on the operations of foreign financial institutions in the domestic financial markets of WTO member countries; therefore, foreign banks must be granted free entry and fair, competitive conditions. In addition, financial

liberalisation and deregulation have been important topics over the past four decades, especially in terms of market entry, business opening-up, and bilateral supervisory mechanisms. Emerging Asian economies such as China and Taiwan have played important roles in global economic development over the past four decades. China and Taiwan opened their financial markets to foreign institutions when they joined the WTO in December 2001.[1] This joint entry offers an interesting case to examine how deregulation and WTO accession affect the efficiency of domestic banks. Despite similarities in language, culture, and societal conventions, China and Taiwan are entirely different polities, with different financial supervisory systems and economic programs.

As a major development, Taiwan's Straits Exchange Foundation and China's Association for Relations across the Taiwan Straits signed the Cross-Straits Economic Cooperation Framework Agreement (ECFA) in Chongqing on 29 June 2010. This agreement represents a step forward in cross-strait economic cooperation. Before the agreement, the cross-strait banking industry could not establish branches and subsidiaries, which makes it an interesting case for the effect of deregulation because the bilateral economic system and the degree of financial liberalisation have a significant gap. This study conducted a long-term analysis to provide empirical evidence on how deregulated cooperation – specifically, cooperation mechanisms, WTO accession, and the ECFA – has affected bank efficiency in a cross-strait economic zone. This study examines how deregulation after the WTO accession and the ECFA affected bank efficiency and whether (and why) these factors could have improved it.

This study contributes to the literature in several ways. First, to the best of my knowledge, it performed the first long-run analysis examining how China and Taiwan's WTO accession and ECFA, which occurred from 2005 to 2020, affected the efficiency of the banks (if at all) in the two countries, which have similar languages, cultures, and societal conventions but different patterns of economic growth. Second, by investigating whether marketability and profitability efficiency models are better than the traditional Data Envelopment Analysis (DEA) model for evaluating bank performance, this study sheds light on how best to assess the market valuation and gauge the performance of a bank's stock in terms of marketability efficiency. Therefore, following Seiford and Zhu (1999) and Luo (2003), the study used a two-stage production process in which profit is generated in the first stage and market value in the second. Third, scholars have focused their analyses on data relating to emerging Asian countries such as China and Taiwan amid the rapid growth and recovery in recent years, which has given them key global economic roles. The study enriches this research stream by providing additional empirical evidence on how the two-stage DEA model can be used to evaluate the efficiency of banks outside the United States and Europe.

The rest of this paper proceeds as follows. Section 2 briefly describes the banking industries in China and Taiwan and reviews the related literature. Section 3 presents the methodology, data, and input and output variables used in the analysis. Section 4 reports my findings on the efficiency and productivity of banks in China and Taiwan. The final section presents the implications of these empirical results and provides suggestions for future research on the topic.

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[1] Regulators in China and Taiwan are required to allow foreign financial institutions to enter their countries' financial markets. Foreign banks have been free to enter China's banking industry since the end of 2006, while foreign banks and insurers had to set up affiliates in Taiwan before it joined the WTO.

2. Background and literature review

2.1. Background

2.1.1. Financial reform in China

Since the late 1970 s, regulators in China have implemented gradual but far-reaching reforms to address the institutional and organizational problems faced by the country's banking industry. From 1978 to the early 1990 s, China's banking sector was monopolised by four large state-owned banks, the so-called 'Big Four'. Beginning in the 1990 s and continuing until China joined the WTO in 2001, Chinese regulators encouraged state-owned banks to implement market-oriented practices. During this period, many commercial banks were established by municipal governments via the restructuring and active merging of more than 5000 urban co-operative banks. Furthermore, foreign banks in China were allowed to conduct basic operations.

Chinese regulators continued to pursue a series of deregulation policies from the early 2000 s until the last few years, during which time reforms were accelerated to enhance the international standing and competitiveness of China's banking sector. In the last decade, this sector has suffered from a lack of efficiency and high uncertainty in operating, all of which have driven regulators to accelerate and deepen banking reforms. Since 2007, China's domestic banks have had to compete with foreign banks on a level playing field because of the rules and regulations set by the WTO. However, the Big Four continue to face many internal and external challenges. Internally, the huge volume of non-performing loans (NPLs) from policy lending has generated many loss-making state-owned enterprises (SOEs). China's population lacks experience in operating a market-based financial system due to the Big Four's specialisation in serving the SOE sector (Yao, Han et al., 2007). Therefore, a three-stage reform has taken place that has changed the banks' market and ownership structures (Hussain & Bashir, 2020): interest rate liberalisation, deposit insurance, and listing on the Hong Kong stock exchange. This suggests that changing competitive conditions in the Chinese banking industry and their role in banking stability may be sufficient.

2.1.2. Financial reform in Taiwan

The Taiwanese banking industry plays a pivotal role in emerging markets. Over the past four decades, Taiwan, South Korea, Hong Kong, and Singapore have been known as the 'Four Asian Tigers' due to the rapid development of their financial markets and world-leading rates of economic growth. In particular, Taiwan's financial market underwent significant structural changes beginning at the end of the 1980s, when Taiwanese regulators allowed new financial institutions to enter individual financial markets. However, as in China, Taiwan's market suffered from a lack of efficiency, low profitability, and a host of NPLs in the late 1990s

Since 2001, Taiwan's regulators have implemented a series of financial reforms aimed at improving the asset quality of financial institutions and encouraging mergers between banks because smaller banks have tended to have low risk-taking ability, few reliable non-interest sources of income, and frequently inefficient selling platforms. However, these reforms have led to only slightly higher profits, and Taiwan's banks have had lower-than-average return on asset (ROA) rates, which did not exceed 1 % during the global financial crisis from 2008 to 2017.[2] In summary, although Taiwan's banking industry has undergone significant changes in market

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[2] Financial supervisory Commission, R.O.C. Banking Bureau website: https://www.banking.gov.tw/en/index.jsp.

structure, regulatory policies, and types of business allowed since deregulation, Taiwanese banks remain unable to overcome the poor profitability that has plagued them for 30 years.

2.1.3. Communication between Chinese and Taiwanese banking industries

Relationships between China and Taiwan in the finance, economics, and trade fields stagnated before the end of the 1980s because the government intervened in these spheres. It was not until the end of the 1980s that the political situation between the cross-straits eased the opportunity for economic cooperation and exchange. The first financial transaction between Taiwan and China occurred when the China Commerce Bank Xiamen branch enabled businesses to remit US dollars from China to Taiwan in 1992 (Liao, 2020). Since then, especially since 2001, both countries' governments have agreed on Taiwanese banks to establish offices in China and cultivate business cooperation, while bilateral banks have widened the permitted scope of financial dealings.

In March 2002, the Chinese government first allowed two Taiwanese banks to establish offices in China, indicating the institutionalisation of cross-strait banking exchanges. With the increasingly frequent economic interactions among cross-strait countries, in 2010, there was a significant advance in cross-strait economic and financial cooperation. They signed the ECFA following multiple bilateral negotiations in June 2010 in a cross-strait. During the same year, China's Banking Regulatory Commission approved plans for six Taiwanese banks to establish branches in China. By the end of 2020, sixteen Taiwanese banks had established branches and subsidiaries in China, while the Chinese Bank had three branches and two offices in Taiwan.

The governments of the cross-strait signed a financial supervision memorandum in 2009. Its primary destination financial institution was engaged in cross-border business, and the regulatory agencies of the home and host countries agreed to exchange opinions and assist each other in performing financial regulatory duties. As another step forward in cross-strait financial cooperation, a bilateral supervisory committee met in Taipei in 2011 to discuss establishing a supervisory platform for financial institutions from both sides. However, ECFA negotiations are still in the Early Harvest Program stage, and many essential policies, such as investment protection, dispute settlement agreements, and agreements on trade in services, have not been effective and substantially developed.

2.2. Literature review

The DEA tool is commonly used to analyse bank performance. Several studies have investigated financial reform, ownership structures, and foreign bank entry in China (e.g. Berger, Hasan, & Zhou, 2009; Jiang, Yao, & Zhang, 2009; Yao & Jiang Feng, 2007a; Koutsomanoli-Filippki, Mamatzakis & Staikouras, 2009). Berger et al. (2009) detected strongly favourable efficiency effects from reforms that reduced the state ownership of banks in China and increased the role of foreign ownership.

However, few studies have compared Taiwanese banks' efficiency before and after WTO accession and the signed ECFA. Because Taiwanese regulators implemented financial reforms simultaneously, most scholars have examined whether financial reform or diversification has had more significant effects on the banking industry's performance. Hsiao, Chang, Cianci, and Huang (2010) found that Taiwan's First Financial Restructuring policy improved the efficiency of Taiwanese banks in the post-reform period. The impact of activity diversification on bank efficiency and value has also been investigated. Peng, Jeng, Wang, and Chen (2017) observed that banks more highly involved in the bancassurance business generally tended to experience improved efficiency, which offered banks several benefits. Scholars have also argued that banks

can benefit from deregulation in the form of their nation's WTO accession, financial reform, introduction of foreign banks, and permission for new types of business.

Comparing the efficiency changes in the cross-strait banking industry pre- and post- ECFA, this is a valuable case for the effect of deregulation because the bilateral economic system and degree of financial liberalisation have a significant gap. Therefore, I examined whether deregulation has indeed improved the profitability and marketability efficiency of banks in the cross-strait zone and analysed changes in bank efficiency in the decade following the global financial crisis of 2008.

3. Methodology

3.1. DEA and Malmquist index

To measure the Malmquist index of efficiency for individual banks, this study applied DEA, developed by Charnes, Cooper, and Rhodes (1978), a nonparametric approach that uses a linear programming technique to construct an envelope for observed input–output combinations of all market participants under the constraint that all best-practice banks support the envelope, whereas all inefficient banks are kept off the frontier. Below, I briefly describe how to estimate efficiency using the linear programming approach of the DEA.

Assuming n DMUs with x-input and y-output vectors generated by the jth bank, the efficiency of DMUs using the conventional Cooper–Charnes–Rhodes input-oriented model can be defined as

$$\min \theta$$
$$st. \sum_{j=1}^{n} w_j X_{ij} \leq \theta X_{i0} \qquad I = 1, 2.......,m;$$
$$\sum_{j=1}^{n} w_j Y_{rj} \geq Y_{r0} \qquad r = 1, 2, ...s;$$
$$w_j \geq 0, j \in 1, 2, ...,n \tag{1}$$

where w_j is the weight of reference unit j.

By solving the linear programming problem, I obtained the results for technical efficiency (TE) from the optimum value of object θ for jth bank. The DEA variable returns to scale (VRS) input-oriented model can be expressed as

$$\min \pi$$
$$st. \sum_{j=1}^{n} w_j X_{ij} \leq \pi X_{i0} \qquad i = 1, 2.......,m;$$
$$\sum_{j=1}^{n} w_j Y_{rj} \geq Y_{r0} \qquad r = 1, 2, ...s;$$
$$\sum w_j = 1 w_j \geq 0, \qquad j \in 1, 2, ...,n \tag{2}$$

The essential difference between the VRS model (i.e. Equation 2) and the constant returns to scale (CRS) model (i.e. Equation 1) is the addition of a constraint $\sum w_j = 1$ to the latter. With this added constraint, the reference set changes from a cone in the case of the CRS model to a convex hull in the case of the VRS model.

In the second step, I used the Malmquist index to measure the total factor productivity index (TFPCH) as well as changes in efficiency, TE, pure TE (PTE), and scale efficiency (SE). Because the DEA model is a static state index, it cannot represent a dynamic efficiency index. As an alternative, I use the Malmquist index to determine banks' changes in efficiency from period t to period $t+1$. Following Isik and Hassan (2003), I also used output orientation, meaning that I estimated the frontier in terms of the maximum level of output that can be achieved with a given set of inputs. The Malmquist index was calculated as follows:

$$TFPCH_0(x_t, q_t, x_{t+1}, q_{t+1}) = \left[\frac{d_0^t(x_{t+1}, q_{t+1})}{d_0^t(x_t, q_t)} \times \frac{d_0^t(x_{t+1}, q_{t+1})}{d_0^{t+1}(x_t, q_t)} \right]^{\frac{1}{2}} \tag{3}$$

This formula can be further decomposed into changes in efficiency and TE, as follows:

$$TEPCH_0(x_t, q_t, x_{t+1}, q_{t+1}) = \left[\underbrace{\frac{d_0^t(x_{t+1}, q_{t+1})}{d_0^t(x_t, q_t)}}_{EFFCH} \times \underbrace{\frac{d_0^t(x_{t+1}, q_{t+1})}{d_0^{t+1}(x_t, q_t)}}_{TECHCH} \right]^{\frac{1}{2}} \tag{4}$$

where the value outside parentheses represents the change in efficiency, and the value within parentheses represents the change in TE. A Malmquist index of TFPCH greater than 1 would indicate positive growth in total factor productivity from period t to $t+1$, whereas a value less than 1 would indicate a decline in TFPCH.

3.2. Equation for the determinant of efficiency

In the regression analysis, two models were used to estimate bank efficiency, including traditional DEA efficiency, profitability efficiency, and marketability efficiency, all regressed on dependent variables. Specifically, this study tested the effect of ECFA on bank efficiency using a dummy variable. The empirical regression is expressed as follows:

$$BEFF_{it} = \alpha_0 + \beta_1 DV_{ZONE_I} + \beta_2 DV_{ECFA_I} + \sum_{i=1}^{4} \beta_i X_{it} + \varepsilon_{it}, \tag{5}$$

where DV_{ZONE_I} is a dummy variable that equals 1 if the banks are Chinese and 0 if the banks are Taiwanese; DV_{ECFA_I} is a dummy variable that equals 1 for the post-ECFA period and 0 if the banks are from China; $\sum_{i=1}^{4} X_{it}$ are control variables for bank-specific variables; SIZE is the natural log of banks' total assets; EQUIT is the equity-to-asset ratio; MS is the market share of loans; NPL is the non-performing loan ratio. The subscript i denotes the bank, and t denotes the time dimension in Equation (5).

3.3. Specification of DEA inputs and outputs

Many researchers have examined bank efficiency, but the definition and measurement of inputs and outputs for banks has long been debated, as has the optimal combination of input and output variables. Consequently, outputs may consist of loans and investments, whereas inputs can consist of labour, fixed assets, and loanable funds. In general, banks' operating revenues come primarily from business loans and investments. Thus, I used loans (i.e. short-term loans, long-term loans, and advances) and net income after tax as output variables and

used salary expenses, fund expenses, and physical expenses as input variables in the traditional DEA model.

Among the studies on bank efficiency, few have focused on bank performance in terms of both profitability efficiency and marketability efficiency (e.g. Luo, 2003; Seiford & Zhu, 1999). This study followed Seiford and Zhu (1999) production approach in selecting its inputs and outputs. They evaluated profitability efficiency based on three inputs (i.e. employees, assets, and stockholders' equity) and two outputs (i.e. revenue and profits), whereas marketability efficiency was based on two inputs (i.e. revenue and profits) and three outputs (i.e. market value, return to investors, and earnings per share). I followed both their study and Luo (2003) in developing my two-stage DEA model, for which I adopted three inputs (employees, total assets, and equity) and two outputs (revenue and profit) for profitability efficiency. For marketability efficiency, this study used two inputs (revenue and profit) and three outputs (market value, stock price, and earnings per share).[3]

Regarding the output and input factors' definitions, *employees* denoted staff members in the bank who needed to maintain normal operations. *Total assets* denoted banks' year-end reports, while *equity* denoted the sum of all capital stock, paid-in capital, and retained earnings in banks' year-end reports. *Revenues* denoted consolidated subsidiaries but excluded excise taxes, while *profits* denoted profits after taxes, extraordinary credits and charges, and the cumulative effects of accounting charges. *Market value* was obtained by multiplying the number of common outstanding shares by the price per common share at each year's last trading day. *Earnings per share* for each company were the primary earnings per share that appeared in the income statement, and the *stock price* was the price per common share as of the last day of trading in each year. The primary data source for this study was the *Taiwan Economics Journal*. The descriptive statistics of the input and output variables and the control variables are shown in Table 1.

4. Empirical results

4.1. Efficiency of banks in cross-strait: 2005–2020

The results, as shown in Table 2, also indicate that nearly 30 % of banks' costs were wasted according to the best-practice frontier when facing the same output within the samples, revealing a gap and unevenness in efficiency between cross-strait banks. Sun and Chang (2011) found a general bank efficiency of approximately 0.6 in emerging Asian countries; furthermore, this study's results show that bank efficiency is higher in the cross-strait region than in other emerging Asian countries.

However, the findings reveal that bank efficiency was not significantly changed during the study period relative to the existing literature in other periods (Peng et al., 2017; Yao & Jiang, Feng, 2007).[4] Although the study results suggest that bank efficiency did not significantly improve after WTO accession in the cross-strait zone,[5] one possible reason for this phenomenon

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[3] Following Luo (2003), I used stock price instead of total revenue to investors, because empirical data of dividend yields to investors in bank stocks are not available. Further research to overcome that gap in the data would be useful.

[4] Liao (2020) has argued that stronger reforms and the entry of more foreign banks under WTO rules can push domestic banks to become more efficient.

[5] Liao (2020) has argued that stronger reforms and the entry of more foreign banks under WTO rules can push domestic banks to become more efficient.

Table 1

Descriptive statistics of variables employed in this study.

	mean	Std.
DEA model		
Salary expense	82430.55	205922.52
Interest expense	291178.36	388794.55
Physical expense	38879	705984.96
Loans	9063366.52	242863.78
Net income after tax	214113.57	596065.54
Employee	60484.47	105481.7
Total assets	31433511.57	51651548.17
Equity	2342879.81	4064885.25
Revenue	902671.91	14589366.64
Profit	438765.48	732616.16
Market value	147974.99	262600.9
Stock price	7.1275	10.1833
Earnings per share	0.6405	0.8132
Regression model		
SIZE	9.0981	0.3764
EQUIT	0.0687	0.04
MS	0.1374	0.0114
NPL	0.0129	0.0013

Note: The primary data source for this study was the *Taiwan Economics Journal*. The final sample comprised data from 39 Chinese banks and 36 Taiwanese banks from 2005 to 2020, for a total of 1046 observations. To estimate Chinese bank efficiency, I used the limited amount of data available for that purpose. Unit: million RMB.

Table 2

Results of banks efficiency: Basic and Two-stage DEA model.

	Basic DEA model			Two-stage DEA model					
	OTE	PTE	SE	**OTE$_P$**	**OTE$_M$**	**PTE$_P$**	**PTE$_M$**	**SE$_P$**	**SE$_M$**
2005	0.8508	0.9032	0.9408	0.7156	0.81	0.8936	0.811	0.7961	1.00
2006	0.8413	0.8840	0.9514	0.7169	0.76	0.8404	0.76	0.8474	1.00
2007	0.6144	0.8122	0.7240	0.5051	0.796	0.8245	0.821	0.6159	0.969
2008	0.7872	0.8459	0.9309	0.5276	0.742	0.8574	0.796	0.6155	0.932
2009	0.7876	0.8534	0.9260	0.5244	0.766	0.8905	0.911	0.5943	0.945
2010	0.7694	0.8459	0.9141	0.5529	0.37	0.8855	0.734	0.6282	0.482
2011	0.7114	0.8310	0.8604	0.7039	0.352	0.9167	0.739	0.7639	0.47
2012	0.7242	0.8420	0.8662	0.753	0.358	0.9412	0.744	0.7947	0.467
2013	0.7177	0.8381	0.8602	0.7375	0.356	0.9259	0.687	0.7913	0.508
2014	0.6705	0.8170	0.8232	0.7516	0.408	0.9308	0.73	0.8029	0.573
2015	0.6765	0.8129	0.8342	0.7516	0.444	0.9308	0.769	0.8029	0.585
2016	0.6693	0.8167	0.8162	0.7192	0.44	0.8982	0.711	0.7971	0.624
2017	0.6668	0.8238	0.8098	0.767	0.403	0.9277	0.641	0.8256	0.625
2018	0.7528	0.8410	0.8931	0.752	0.332	0.9443	0.673	0.7947	0.491
2019	0.7454	0.8500	0.8769	0.7215	0.4	0.9327	0.69	0.7713	0.564
2020	0.6941	0.8349	0.8360	0.7709	0.279	0.9332	0.524	0.8252	0.504
mean	0.7300	0.8407	0.8665	0.6857	0.501	0.9046	0.734	0.7542	0.672

is the 'home field advantage' hypothesis, which maintains that domestic banks enjoy the advantage of familiarity with the culture, currency, and other country-specific market features of their home nations. Thus, regulators and supervisory structures may not play important roles in domestic bank performance.

The mean marketability efficiency scores were greater than the mean profitability efficiency scores, which implies that considering the market valuation of a bank's stock as output would increase the bank's efficiency. This result suggests poor profitability efficiency from 2007 to 2009 due to the global financial crisis. This result may have occurred because the emerging market share index has significant volatility, implying that banks have a higher probability of profit (or less). It has been influenced primarily by rapid cross-strait financial development and higher economic growth in the zone over the past two decades. Thus, banks should boost their marketability efficiency to enhance their market value and earnings per share.

The profitability and marketability efficiency results and the mean PTE exceeded the mean SE, which implies that scale inefficiency is a major source of bank inefficiency. In addition, following Luo (2003), I classified the bank groups into the following four quadrants: 'stars', 'cows', 'dogs', and 'sleepers'. The study results indicate that cross-strait banks achieve lower profitability and marketability efficiency, characterising them as dogs.

In summary, the gap in efficiency between Chinese and Taiwanese banks was massive in the decade following the global financial crisis, and the uneven efficiency levels between them are likely to remain. As expected, amid WTO accession and deregulation processes, emerging countries such as China and Taiwan have allowed foreign banks to enter their financial markets as part of a financial liberalisation process thought to improve bank efficiency. However, the empirical results do not support this assumption. A possible reason for this discrepancy is that foreign investors' need to transfer technology is strongest when they have a majority, or at least a controlling stake. Foreign banks want to continue using their international experience to their advantage to be competitive with domestic banks in developing countries.

4.2. Comparison of cross-strait banks between pre- and post-ECFA periods

This section reports the results of comparing bank efficiency before and after the signing of the ECFA in a cross-strait region. As shown in Table 3, OTE and SE were significantly higher post-ECFA, although they were only slightly higher in the basic model. The other results clearly show that the ECFA platform did not increase bank efficiency, which implies that the cross-strait ECFA has not been able to serve its function effectively and that banking cooperation is still at a superficial level of interaction rather than playing a complementary role.

This result may be due to Taiwanese banks' keenness to establish branches and expand businesses in China by contract, while only three Chinese banks have established branches, and only two have set up offices in Taiwan. This implies that financial cooperation and communication are driven not by bilateral economic incentives but by policy intervention; most Chinese banks invest and expand their business in Taiwan by following policy directives. The results also indicate that both efficiencies declined after the ECFA, but the marketability efficiency declined further. One possible explanation for this phenomenon is that the stock market saw violent cross-strait fluctuations over the study period, making the output variables of market value and stock prices more uncertain. This gradually widened the gap between the good and poor banks.

Overall, the study found that the two models produced the same results, implying that the cross-strait ECFA did not play an important role in bank efficiency. This suggests that the

Table 3

Results of comparison of bank efficiency pre- and post-ECFA.

	Efficiency Score	*T*-test	One way ANOVAs	Mann-Whitney-Wilcoxon Test
Basic DEA				
OTE Pre-	0.7735	-5.488 * **	196.66 * **	0.000 * **
Post-	0.7029			
PTE Pre-	0.8562	-2.362 * *	5.673 * *	0.004 * **
Post-	0.8308			
SE Pre-	0.8975	-4.926 * **	326.17 * **	0.000 * **
Post-	0.8475			
Two-Stage DEA				
OTE_P Pre-	0.7458	9.354 * **	132.643 * **	0.000 * **
Post-	0.6168			
PTE_P Pre-	0.9363	7.27 * **	41.8 * **	0.000 * **
Post-	0.8698			
SE_P Pre-	0.7943	7.232 * **	104.61 * **	0.000 * **
Post-	0.707			
OTE_M Pre-	0.6973	12.644 * **	159.861 * **	0.000 * **
Post-	0.3766			
PTE_M Pre-	0.7881	5.106 * **	26.075 * **	0.000 * **
Post-	0.6885			
SE_M Pre-	0.9915	11.235 * **	126.262 * **	0.000 * **
Post-	0.5428			

Note: This study examines whether there is a difference in the efficiency of banks in cross-strait after signing the ECFA., as follows T-test, one-way ANOVA test with F-statistics, and Mann-Whitney-Wilcoxon Test with Z-statistic. Significant level at the $\alpha = 0.1$, **at $\alpha = 0.05$ and ***at $\alpha = 0.01$

government's first order of business should pursue further financial deepening and facilitate fund exchanges between cross-strait nations.

4.3. Results for changes in productivity

In line with previous research efforts to isolate the components of productivity changes, this study measured the Malmquist Index as a proxy for dynamic efficiency. The mean value of TFPCH was 1.03, indicating that bank productivity improved slightly during the study period. This result also suggests that the TFPCH improved only slightly, most likely due to the frontier shift effect and not the catch-up effect, which suggests that deregulation policies and liberalisation partially improve bank productivity.[6]

Regarding the possibility that bank inefficiency is due to a failure to keep pace with the efficient frontier, the scale efficiency changes and pure technical efficiency change were both < 1, which indicates that banks have not moved toward their optimal size and thus expanded their operating scales in favour of productivity. Overall, this trend suggests that banks increase their productivity using input resources or management factors more effectively. It also points to allocative inefficiency due to bureaucratic power and the interference of regulators in emerging countries.

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[6] These estimation results are available on request from the authors.

Table 4
Regression results: basic model and two-stage DEA model.

	Basic model			Profitability Efficiency Model			Marketability Efficiency Model		
	OTE	PTE	SE	OTE_P	PTE_P	SE_P	OTE_M	PTE_M	SE_M
SIZE	0.068	0.1119	-0.0399	-0.1208	0.0711	-0.1906	-0.2224	0.0248	-0.3122
	(6.27)***	(12.29)***	(-5.02)***	(-9.47)***	(7.13)***	(-17.94)***	(-6.74)***	(1.04)***	(-6.99)***
EQUIT	-0.1247	-0.4942	0.2082	3.3363	2.3464	1.6238	2.16	0.7947	0.7475
	(-0.45)***	(-2.20)***	(1.04)***	(12.68)***	(11.43)***	(7.42)***	(3.64)***	(1.62)***	(0.81)***
MS	-0.04	0.02	-0.0374	0.1406	0.0235	0.1437	-0.4737	0.0875	-0.034
	(-1.56)***	(0.93)***	(-1.98)***	(6.13)***	(1.31)***	(7.52)***	(-3.92)***	(2.04)***	(-0.42)***
NPL	-4.0597	-16414	-2.6846	0.973	-0.6141	1.7441	0.4099	2.2028	-1.6508
	(-8.48)***	(-5.00)***	(-7.98)***	(2.07)***	(-1.68)***	(4.47)***	(0.35)***	(2.50)***	(-1.00)***
DV_{Zone}	-0.1092	-0.0222	-0.1108	-0.1441	-0.089	-0.0895	-0.3115	-0.1588	-0.1645
	(-8.57)***	(-2.13)***	(-11.91)***	(-12.33)***	(-9.77)***	(-9.22)***	(-10.21)***	(-7.23)***	(-4.02)***
DV_{ECFA}	-0.0969	-0.0588	-0.0434	0.1779	0.0196	0.179	-0.3034	-0.0905	-0.3325
	(-7.78)***	(-5.69)***	(-4.77)***	(15.19)***	(2.15)***	(18.41)***	(-10.87)***	(-4.14)***	(-8.12)***
Obs.	1046	1046	1046	642	642	642	642	642	642
Log likelihood function	361.5898	538.387	681.4096	456.8091	613.2454	572.2648	174.5329	60.60481	-354.0391

Note: SIZE=log banks total asset, EQUIT=Total Equity divided by total assets, NPL=non-performing loans, MS=market share of loan. Equation (5) is estimated by the Tobit censored

regression model. α = 0.1 significant at the 10 % level, **α = 0.05 significant at the 5 % level, * ** α = 0.01 significant at the 1 % level.

Table 5
Regression Results: a robustness test.

	China						Taiwan					
	Profitability Efficiency Model			Marketability Efficiency Model			Profitability Efficiency Model			Marketability Efficiency Model		
	OTE_P	PTE_P	SE_P	OTE_M	PTE_M	SE_M	OTE_P	PTE_P	SE_P	OTE_M	PTE_M	SE_M
SIZE	0.0608	−0.0478	0.1079	−0.3689	−0.1671	−0.2691	0.1621	−0.2433	0.4214	−0.1879	−0.2492	0.104
	(4.25)***	(−4.40)***	(11.43)***	(−10.40)***	(−5.79)***	(−8.18)***	(2.59)***	(−4.1)***	(10.50)***	(−2.13)***	(−3.20)***	(0.83)***
EQUIT	−0.9734	−0.5389	−0.4543	−2.7623	−2.3134	−1.4695	2.8959	1.2944	1.7839	1.8819	0.6992	2.1039
	(−2.37)***	(−1.73)***	(−1.68)***	(−2.78)***	(−2.80)***	(−1.58)***	(6.92)***	(3.23)***	(6.65)***	(3.24)***	(1.34)***	(2.55)***
MS	−0.0759	0.0745	−0.151	0.0878	0.0855	−0.0333	−2.3359	59.2616	−62.1241	−17.99	44.0456	−84.8199
	(−3.45)***	(4.46)***	(−10.46)***	(1.52)***	(1.93)***	(−0.63)***	(−0.15)***	(3.98)***	(−6.23)***	(−0.80)***	(2.27)***	(−2.66)***
NPL	−0.621	−0.3287	−0.2887	0.0257	0.8778	−0.42	−2.4556	−4.747	1.558	2.3465	0.7683	4.1056
	(−1.27)***	(−0.89)***	(−0.90)***	(0.02)***	(0.89)***	(−0.38)***	(−2.13)***	(−4.3)***	(2.12)***	(1.48)***	(0.54)***	(1.82)***
DV_{ECFA}	−0.0715	−0.037	−0.0358	0.0785	0.0487	0.0725	−0.0247	−0.0344	0.0135	−0.18	−0.1135	−0.1613
	(−5.23)***	(−3.57)***	(−3.97)***	(2.32)***	(1.77)***	(2.32)***	(−1.05)***	(−1.54)***	(0.91)***	(−5.57)***	(−3.92)***	(−3.51)***
Obs.	268	268	268	268	268	268	347	347	347	347	347	347
Log likelihood function	273.4571	347.4577	385.2007	57.8334	85.6692	62.8845	147.2957	162.9973	313.116	39.4852	65.8505	−91.76234

Note: SIZE=log banks total asset, EQUIT=Total Equity divided by total assets, NPL=non-performing loans, MS=market share of loan. Equation (5) is estimated by the Tobit censored regression model. $\alpha = 0.1$ significant at the 10 % level, $*\alpha = 0.05$ significant at the 5 % level, $**\alpha = 0.01$ significant at the 1 % level.

4.4. Results concerning determinants of bank efficiency

This section explains the determinants of banks' estimated efficiency derived from the two-stage DEA model.[7] Table 3 reveals that the result for bank size is a puzzle due to the coefficient conflict, suggesting that the efficiency of large banks is not necessarily greater than that of small banks. This result is consistent with Liao (2022) but inconsistent with Christopoulos, Lolos, and Tsionas (2002). The equity-to-assets ratio, as a proxy for external corporate governance, implies that equity stakes could pressurize management to reduce efficiency shortcomings, meaning that external corporate governance continues to be important for the efficiency of cross-strait banks. Simultaneously, Tabak, Fazio, and Cajueiro (2012) argue that the capital ratio is a risk-averse source of funding relative to liabilities, suggesting that more risk-averse funding makes banks more technically efficient.

This result means that having a larger share of the loan business reduces banks' marketability efficiency but benefits their profitability efficiency. In this study, this dynamic may be due to the increase in market uncertainty when banks had high shares of the loan business after the global financial crisis. Khan, Ahmad, and Chen (2018) argue that higher profits in concentrated banking industries are partially attributable to banks' anti-competitive conduct; thus, higher market power increases their profitability efficiency.

The result concerning NPLs in relation to bank efficiency was unexpected because it implies that a higher volume of NPLs does not necessarily cause bank efficiency to decline. This phenomenon may occur because bureaucratic power continues to play an important role in profitability efficiency in emerging countries, where banks, even those with many NPLs, do not suffer from reduced profitability efficiency due to the interference of regulators, protective policies, or both.

As shown in Table 4, the regional dummy variables for the coefficients are significantly positive in all columns, implying that the profitability and marketability efficiencies of Taiwanese banks are greater than those of their Chinese counterparts. This implies that Taiwanese banks benefited more from the earlier implementation of financial liberalisation and deregulation of business operations. The results of using a dummy variable to test whether the prior DEA model results support the ECFA improved efficiency among cross-strait banks. Profitability efficiency improved significantly after the ECFA, but marketability did not. Overall, there is no strong evidence that bank efficiency improved after the ECFA.

4.5. Robustness test

This subsection discusses the robustness checks of the results obtained through several sensitivity analyses. The subsamples were treated in three ways: First, this study tested whether the primary results were valid when the sample was divided into two subsamples, comprising Chinese and Taiwanese banks, and re-estimated the equation. As shown in Table 5, the results did not change significantly. Two changes were observed. First, the capital ratio is significantly negative in all columns in China, implying that higher equity may incentivise Chinese banks to invest in riskier assets. Banks may encounter distress because of moral hazards, restrictive regulations, and poor supervision (Shen & Huang, 2003). Second, this result shows that marketability efficiency significantly improved after the ECFA in China, perhaps because it

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[7] First, a variance inflation factor (VIF) was used to test whether the collinearity problem was significant. The VIF was less than 10 for all variables, which implies that collinearity problems did not exist in the regression analysis.

benefited from the stock market's rapid and massive growth in China, whereby the total market value of the securities market grew from 3.7 trillion in 2012–8.52 trillion in 2019.

This study also tested whether the primary two-stage DEA results were valid when the sample was divided into Chinese and Taiwanese bank subsamples. However, these results did not change significantly. Finally, I test whether the global financial crisis affected the determinants of bank efficiency. Using the original sample, the equation was re-estimated after deleting all the 2008 data. These findings were consistent when the 2008 data were deleted.[8]

5. Conclusions

This study investigated whether deregulation and cooperation agreements affect bank efficiency in cross-strait regions. When regulators gradually lifted restrictions after China and Taiwan joined the WTO in 2001, foreign banks began operating freely in cross-strait financial markets, especially the Chinese financial market, promoting cross-strait financial cooperation and closer exchanges. The findings show that marketability efficiency scores were greater than the mean profitability efficiency scores, which implies that considering the market valuation of a bank's stock as output increases bank efficiency, perhaps because the emerging market share index has seen significant volatility and has been influenced primarily by rapid cross-strait financial development and high economic growth, giving a higher probability of profit over the past two decades. Therefore, banks should boost their marketability efficiency to enhance their market value and earnings per share.

In investigating bank efficiency in the pre- and post-ECFA periods, this study finds no solid evidence that efficiency has improved, implying that the cross-strait ECFA has not been effective and that banking cooperation is still at a superficial level of interaction rather than complementary. This study also found that Taiwanese banks' profitability and marketability efficiency were greater than those of their Chinese counterparts because Taiwan's financial market opened earlier than China's. This result offers substantial evidence that deregulation benefits bank efficiency.

5.1. Policy implications

This study's findings offer several important implications regarding how to improve bank efficiency in the cross-strait zone. First, China has the fastest-growing economy in the world; it has a high average economic growth rate and the largest amount of foreign indirect investment, and many international financial institutions have established branches or subsidiaries in the nation. However, invisible controls and uncertain regulations remain in China's financial markets. For example, deposit interest rates have not been fully liberalised. Moreover, an invisible bureaucracy still plays a considerable role in bank operations, leading the Chinese government to implement vigorous financial anti-corruption measures in 2021 and 2022.[9]

Second, it was hoped that the efficiency of domestic banks would be improved through the entry of foreign banks. However, foreign banks' need to transfer technology is strongest when they have a majority or at least a controlling stake and want to continue leveraging their international experience to remain competitive with domestic banks in developing countries. If domestic banks wish to learn from or replicate the operating methods of foreign banks, they

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[8] These estimation results are available on request from the authors.
[9] In the early 2000s, the government implemented a series of financial reforms to enhance bank efficiency and health in Taiwan, but financial scandals adversely affected this financial reform.

must anticipate gaining only limited benefits from the effect of technological transfer. Third, China and Taiwan should continue negotiating within the ECFA context to deepen cross-strait financial cooperation. Negotiations are at a stalemate due to the intervention of non-economic factors. Breaking this deadlock requires both governments to abandon political differences and establish a cross-strait financial cooperation platform based on reciprocity.

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