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DYNAMIC MODEL OF BANKING EFFICIENCY, STABILITY, AND COMPETITION IN INDONESIA

Dyah Tari Nur'aini[1]
Universitas Terbuka, Kendari, Indonesia
dyahtarinuraini@gmail.com
Prisila Damayanty[2]
Institut Bisnis dan Informatika Kosgoro 57, Jakarta Indonesia
prisild@rocketmail.com
Faizul Mubarok[3]
Universitas Terbuka, Jakarta Indonesia
faizul.mubarok@ecampus.ut.ac.id

Abstract

The banking industry plays a vital role in Indonesia's economy, yet the dynamics among efficiency, stability, and competition levels often exhibit complex and not fully understood relationships. This study aims to analyze a dynamic model that describes the short- and long-term interactions between efficiency, stability, and competition in Indonesia's banking industry during the period 2015–2023. The research employs a quantitative approach using the Vector Error Correction Model (VECM) to examine the causal effects and the contribution of shocks among the variables. Secondary data were obtained from annual bank financial statements, OJK statistics, and Bank Indonesia publications. The findings indicate that competition positively affects efficiency, in line with the competition-efficiency hypothesis and quiet life hypothesis, but exhibits a nonlinear relationship with stability: increasing short-term risk but enhancing long-term stability, as described by the competition-stability hypothesis. Stability consistently improves efficiency and competition in both the short and long term, while the impact of efficiency on competition is more limited. The Impulse Response Function and Forecast Error Variance Decomposition analyzes also show that each variable initially dominates its own variability, with the contribution of other variables gradually increasing over the long term. These findings offer important implications for regulators and banking practitioners in formulating strategies to enhance competitiveness, improve efficiency, and maintain stability sustainably.

Keywords: Efficiency, Stability, Competition, Banking, Dynamic Model

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INTRODUCTION

The banking sector plays a central role in the Indonesian economy, controlling almost 80% of the national financial system (Ministry of Finance, 2021) and functioning as the heart of the economy, mobilizing funds and distributing risks to maintain macroeconomic stability (Sazu & Jahan, 2022). Bankruptcy in this sector could have a wide impact on the government, companies, and other stakeholders. (Liyanaarachchi et al., 2020), thus making the banking industry a primary focus in maintaining Indonesia's financial system stability. Financial system instability, which can trigger crises with high recovery costs, poses a serious challenge for banks, especially following repeated global crises in recent decades. This stability is measured by the Financial System Stability Index (FSSI), which spiked in 2015 due to the global economic crisis and rose again in 2020 due to the Covid-19 pandemic (Bank Indonesia Financial Stability Review, 2023). In the first semester of 2020, the FSSI indicated a near-critical condition, in line with weakening banking capacity due to poor debtor performance, increasing the risk of non-performing loans, asset declines, market risks, and disruptions to overall banking stability (Fares et al., 2023).

The economic crisis experienced by Indonesia has made it clear that it is important to maintain the stability of the financial system, which requires healthy banking competitiveness as well as stability to create conducive competition (Banna & Alam, 2021). The issue of whether interbank competition supports or threatens stability has become increasingly relevant, especially after the 2008 crisis, as banks compete for productive resources such as deposits, savings, and credit as the main source of income. Based on data from Bank Indonesia's Financial Stability Study (2024), the phenomenon of competition is reflected in the slowdown in third-party funds (DPK) growth, which only reached 3.73% in 2023, slower than credit growth of 10.38%. This widened the loan-to-deposit ratio (LDR) from 78.78% in 2022 to 83.33% in 2023. As a result, the funding gap at the end of 2023 widened to IDR 362 trillion, the highest level since 2010, accompanied by an increase in CASA (current account, savings, time deposit) interest rates that even exceeded the LPS guarantee interest rate, indicating increasing competition between banks in raising funds.

Although concentration is considered an imperfect measure of competition (El-Abiad et al., 2023), The number of commercial banks in Indonesia decreased significantly from 94 in 2015 to 84 in 2023, accompanied by an increase in the portion of deposits in large banks (KMBI ≥4) from 34.94% to 48.17%, as well as a decrease in the portion of deposits in small banks (KMBI <4) from 34.15% to

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28.46%, so that concentration remains relevant to describe the condition of banking competition. The phenomenon of flight to quality also emerged as an impact of competition, namely the movement of funds from small banks to large banks which are considered safer due to the belief that "too big to fail" (Chaudhry & Hydros, 2023). This situation underscores the existence of unequal competition and the potential to disrupt system stability if small banks are under pressure. Therefore, robust competitiveness is crucial for responding to pressure and innovating in competition. In this regard, competition-fragility theory argues that competition actually weakens banks by eroding profit margins and increasing fragility. (Buch & Goldberg, 2020), while the competition-stability theory emphasizes that competition can reduce excessive risk-taking and increase bank stability (Mogaji & Nguyen, 2022; Sadaa et al., 2023).

The important role of banking in supporting the economy makes efficiency a key factor in increasing the effectiveness and resilience of the financial system. (Dinc et al., 2023), even (Tripuspitorini & Setiawan, 2020) emphasized that efficiency is a crucial indicator for assessing a bank's ability to survive amidst intense competition, both within the Islamic and national banking industries. The relationship between stability and competition is increasingly complex, requiring banks to operate at optimal efficiency levels: high efficiency can strengthen stability by reducing costs and risks, but if achieved through excessive risk-taking, it can actually threaten stability. In this context, the BOPO (Operating Costs to Operating Income) ratio used by Bank Indonesia as a measure of efficiency indicates that the more efficient a bank is, the lower its risk of failure due to better asset quality. However, commercial bank inefficiency increased between 2015 and 2020, as evidenced by the BOPO ratio rising to 82.17% in 2015 and 86.55% in 2020, coinciding with the economic instability that occurred at the same time.

There are different views on the relationship between efficiency and competition. The structure-conduct-performance (SCP) approach introduced by Mason (1939) in (Hibatullah et al., 2023) states that industrial structure determines behavior, and both influence performance; from this approach was born the quiet life hypothesis (Akmal & Ghozali, 2017), namely the greater the market power and the lower the competition, managers tend to enjoy monopoly profits without trying to increase efficiency so that the market becomes inefficient. (Javaid et al., 2022) adapting this paradigm through the competition-efficiency hypothesis, which states that competition drives efficiency through cost and price pressures, and competition-inefficiency, which argues that competition actually reduces efficiency because it increases monitoring costs, reduces the value of customer

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relationships, and increases the costs of retaining and attracting customers (Hang et al., 2021; Sipahutar et al., 2024; Tsakila et al., 2024). Demsetz's efficient structure hypothesis (ESH) approach in (Zephaniah et al., 2020) argues that efficiency lowers costs, thereby improving performance, expanding market share, and reducing competition; thus, it is not competition that influences efficiency, but rather the opposite. Various studies on competition, stability, and efficiency in Islamic and conventional banks in Indonesia have also produced mixed findings: some support the competition-stability theory. (Aisyah, 2022; Syadali et al., 2023; Yuneline, 2022), some support competition-fragility (Ahmad Fauzi et al., 2022; Antwi-Wiafe et al., 2023; Dwivedi et al., 2023), and some others support competition-efficiency (Kanyamuna, 2020) and competition-inefficiency (Alamgir Hossain et al., 2021).

The differences in research findings on the relationship between stability, competition, and banking efficiency are explained through various perspectives: the competition-stability hypothesis views banks as more resilient in competitive markets, while the competition-fragility hypothesis considers high competition to actually increase the risk of bankruptcy; from an efficiency perspective, competition-efficiency argues that competition encourages innovation and cost reduction, while competition-inefficiency states that competition triggers lower credit standards, high supervisory costs, and inefficiency. Different from previous studies, this study examines the dynamic causal relationship between the three variables that influence each other, to find a pattern of mutually beneficial relationships for efficiency, competition, and stability in Indonesian banking.

Based on the problems that have been explained, this study aims to (1) measure the score and classify the level of competition, efficiency, and stability of banking in Indonesia. (2) analyze the dynamic influence between these three variables in both the short and long term. (3) evaluate the influence and contribution of dynamic shocks between competition, stability, and efficiency in the Indonesian banking sector.

RESEARCH METHOD

The research method used in this study is a quantitative method with an explanatory design based on dynamic causality, which aims to analyze the characteristics and dynamic influences between efficiency, stability, and competition in the banking industry in Indonesia during the period 2015–2023 (Sugiyono, 2021).

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Method of Collecting Data

The data collection method in this study uses secondary data, namely data obtained from the annual financial reports of banks published on their respective official websites, as well as publications from the Financial Services Authority (OJK) and Bank Indonesia for the period 2015–2023. In addition, this study is also supported by other official documents such as Indonesian Banking Statistics, Financial Stability Studies, Indonesian Banking Booklets, and relevant articles and research reports that support the analysis (Creswell & Creswell, 2023).

Population and Sample

The population of this study includes all Conventional Commercial Banks (BUK) and Sharia Commercial Banks (BUS) registered and supervised by the Financial Services Authority (OJK) during 2015–2023. The sample was selected purposively with the following criteria: active during the study period, having complete and publicly accessible financial reports, having complete efficiency, stability, and competition data, and not having undergone mergers, acquisitions, or restructuring, ensuring consistent and relevant data. Based on these criteria, a sample of 51 banks was obtained that was suitable for analysis.

Main Analysis Tools

The main analytical tool in this study is the Panel Vector Error Correction Model (VECM) to examine the short- and long-term dynamic effects of efficiency, stability, and competition in the Indonesian banking industry. Prior to estimating the VECM model, stationarity tests, cointegration tests (Pedroni Test), optimal lag determination, and model stability tests were conducted. The analysis also includes:

1. Impulse Response Function (IRF)to see the response of a variable to shocks to other variables.
2. Forecast Error Variance Decomposition (FEVD)to determine the relative contribution of variables in explaining the variability of other variables.
3. Granger causality test to determine the direction of the relationship between variables.

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RESULTS AND DISCUSSION

Vector Error Correction Model (VECM) Analysis

Stationarity Test

Table 1.
Stationarity Test Results with Test Im, Pesaran, and Shin (IPS)

Variables	Level			First Deferment		
	T-stat.	Prob.	Note:	T-stat.	Prob.	Note:
ZSCORE	0.8152	0.7925	Non-Stationary	-1.69017	0.0455**	Stationary
HHI	-0.4738	0.3178	Non-Stationary	-2.42699	0.0076****	Stationary
DEA	0.84402	0.8007	Non-Stationary	-2.86035	0.0021***	Stationary

Note: **significance level 5 percent

*** significance level 1 percent

Stationarity testing is a crucial initial stage in time series analysis to avoid pseudo-regression and ensure a good estimation model (Gempati et al., 2025). In this study, the unit root test was conducted using the Im, Pesaran, and Shin (IPS) method using EViews11 software, which showed that at the level of all variables, namely ZSCORE, HHI, and DEA, were non-stationary because the probability value was > 0.05. To overcome this, the data was then differentiated at the first derivative (first difference), and the results of the retest showed that all variables became stationary at a significance level ≤ 0.05. This indicates that the data fluctuations are around a constant average value so that it is suitable for further model testing because it has met the stationarity assumption.

VECM Model Stability Testing

Model stability testing was conducted to ensure that the number of lags used resulted in a stable and reliable VECM model, where the model is said to be stable if all modulus roots values <1 or graphically within the unit circle.

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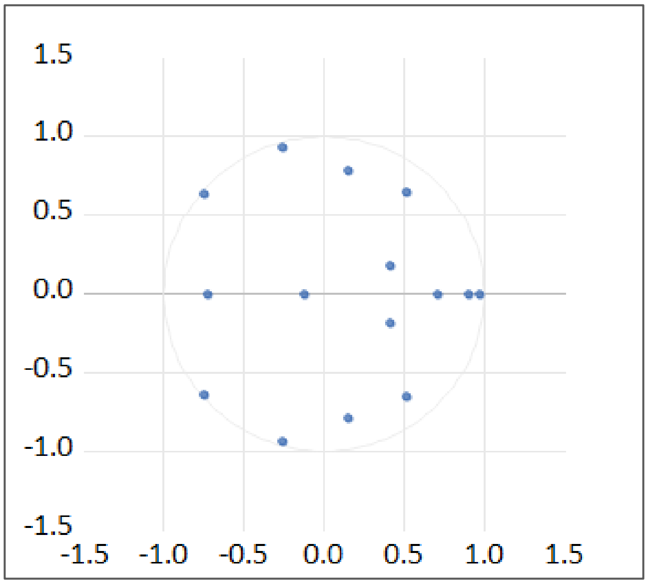

Figure 1.
VECM Model Stability Test Results

The test results show that with a maximum lag of 5, all roots are within the unit circle, whereas if the lag is extended, some roots exit the unit circle so that the model becomes unstable. Therefore, lag 5 was chosen as the optimum number. This stability ensures that the results of the impulse response function (IRF) and variance decomposition (VD) analysis are valid because all moduli have met the stability criteria.

Optimum Log Testing

Table 2.
Optimum Log Test Results

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-1139,531	NA	14.69717	11.20129	11.25008	11.22102
1	-892.6180	484.1434	1.426448	8.868804	9.063987	8.947759
2	-884.0811	16.48784	1.433034	8.873345	9.214916	9.011516
3	-825.8528	110.7481	0.884545	8.390713	8.878672*	8.588101
4	-803.6130	41.64503	0.777089	8.260912	8.895258	8.517516
5	-783.4080	37.24063*	0.696558*	8.151059*	8.931793	8.466880*

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The next step is to determine the optimum number of lags by testing the maximum lag that meets the stability conditions, namely lag 5. The determination of the optimum lag is carried out using several criteria, namely Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike's Information Criterion (AIC), Schwartz's Information Criterion (SIC), and Hannan Quinn's Information Criterion (HQ), by selecting the lag that is supported by the most criteria. Based on the test results, four criteria namely LR, FPE, AIC, and HQ indicate lag 5 as the optimum lag, while only SIC selects lag 3. The more asterisks on lag 5, accompanied by the smallest FPE and AIC values, confirm that lag 5 is the best choice. The selection of lag 5 is considered appropriate because, according to (Aufa & Afdal, 2025), the use of lag based on FPE and AIC can minimize forecast error variance and produce good predictions.

Cointegration Testing

Table 3.
KAO Test Results

Test Statistics (ADF)	Probability
-5.531603	0.0000

The cointegration test aims to detect the existence of a long-term equilibrium relationship between the variables of competition, stability, and efficiency. The three variables were initially non-stationary but became stationary at the same integration order, namely I(1), so a panel cointegration test is needed to confirm the long-term relationship between these variables. This study uses the Kao test, the results of which show a statistical probability value of ADF of ≤ 0.05 so that H_0 is rejected. This indicates the existence of cointegration or long-term equilibrium between HHI, DEA, and ZSCORE, which means that when the relationship of the three variables deviates in the short term, the long-term equilibrium will help correct the deviation to return to its normal state.

Granger Causality Test

Table 4.
Granger Causality Test Results

Null Hypothesis	F-statistic	Prob.
ZSCORE does not Granger-cause HHI	8.16313	5.E-07***
HHI does not Granger-cause ZSCORE	1.56210	0.1726
DEA does not Granger-cause HHI	2.57205	0.0280**

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HHI does not Granger-cause DEA	1.99769	0.0807**
DEA does not Granger Cause ZSCORE	1.09649	0.3637
ZSCORE does not Granger Cause DEA	2.84534	0.0167**

Note: *** significant at α=1%
** significant at α=5%
* significant at α=10%

The Granger causality test is carried out to determine the direction of the causal relationship between variables, both one-way and two-way, and to see whether endogenous variables can be treated as exogenous (Bulasima, 2023). The causal relationship is considered significant if the probability value ≤ the significance level. Based on the test results, it was found that ZSCORE has a significant one-way effect on HHI and DEA at the 1% and 5% significance levels, indicating that stability affects the competitive conditions and efficiency of general banking. In addition, there is a two-way causal relationship between HHI and DEA at the 5% significance level, meaning that competition and efficiency influence each other. These findings indicate that in Indonesian general banking, stability plays an important role in shaping competition and efficiency, while competition and efficiency also have a reciprocal influence.

Empirical Model Panel Vector Error Correction Model (PVECM)

Short Term Analysis

Table 5.
Short Term Test Results

Variable	Model D(HHI)		Model D(ZSCORE)		Model D(DEA)	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
CointEq1	-0.290947	0.0000***	-0.109564	0.0000***	-0.018419	0.0526*
D(HHI)-1	-0.249140	0.0009***	0.219266	0.0713**	-0.022081	0.0398**
D(HHI)-2	-0.830641	0.0000***	0.576955	0.0000***	-0.035315	0.0027***
D(HHI)-3	0.256445	0.0857*	-0.171419	0.4792	0.001325	0.9482
D(HHI)-4	0.154950	0.3639	-0.347098	0.2112	0.011563	0.6166
D(HHI)-5	-0.004537	0.9794	0.273138	0.3383	-0.010097	0.6626
D(ZSCORE)-1	-0.036310	0.2892	-0.490946	0.0000***	0.002289	0.6313
D(ZSCORE)-2	0.035405	0.3112	-0.356839	0.0000***	0.003679	0.4587
D(ZSCORE)-3	-0.142331	0.0087***	-0.422063	0.0000***	0.018044	0.0130**

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D(ZSCORE)-4	0.095901	0.0961*	-0.375813	0.0001***	-0.009180	0.2281
D(ZSCORE)-5	0.006937	0.9090	-0.195758	0.0477**	0.010080	0.2091
D(DEA)-1	-0.461691	0.5163	-0.393442	0.7337	-0.146831	0.0964*
D(DEA)-2	-1.500593	0.0449**	-0.599186	0.6216	-0.272478	0.0015***
D(DEA)-3	-2.195023	0.0170**	-0.368613	0.8046	-0.229873	0.0153**
D(DEA)-4	-0.390425	0.6644	-2.112356	0.1493	-0.011396	0.9196
D(DEA)-5	-0.139876	0.8543	-0.532823	0.6670	0.025204	0.8805
C	0.860581	0.0000***	-2.591464	0.0000***	-6.219409	0.0000***
R-squared			0.754570		0.258914	
Adj. R-	0.709290		0.725696		0.171728	
squared	0.675089		26.13308		2.969662	
F-statistic	20.73877		0.00000***		0.00000***	
Prob.F-	0.00000***					
Statistic						

Note: *** significant at α=1%
** significant at α=5%
* significant at α=10%

After all variables were declared stationary in the first derivative, passed the optimum lag test, stability test, and cointegration test, the analysis was continued with the estimation of the Panel Vector Error Correction Model (PVECM) to test the short-term causal relationship between HHI, ZSCORE, and DEA (Bulasima, 2023). The regression results show three PVECM models with dependent variables D(HHI), D(ZSCORE), and D(DEA). The CointEq1 coefficient values in all three models are significant, indicating the existence of an adjustment mechanism towards long-term equilibrium. Several lags of HHI, ZSCORE, and DEA are also significant at various levels (1%, 5%, 10%), indicating the existence of dynamic influences between variables in the short run. The overall model is significant (Prob. F-Statistic <0.01) with a fairly good R-squared value for D(HHI) (0.71) and D(ZSCORE) (0.75), while for D(DEA) it is lower (0.26), indicating that the dynamics of competition, stability, and efficiency influence each other although with different strengths in each model.

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a) DHHI Model

$$\Delta HHI_t = -0.290947ECT_1^{***} - 0.249140\Delta HHI_{t-1}^{***} - 0.830641\Delta HHI_{t-2}^{***} + 0.256445\Delta HHI_{t-3}^{*} + 0.154950\Delta HHI_{t-4} - 0.004537\Delta HHI_{t-5} - 0.036310\Delta ZSCORE_{t-1} + 0.035405\Delta ZSCORE_{t-2} - 0.142331\Delta ZSCORE_{t-3}^{***} + 0.095901\Delta ZSCORE_{t-4}^{*} + 0.006937\Delta ZSCORE_{t-5} - 0.004537\Delta DEA_{t-1} - 0.256445\Delta DEA_{t-2}^{**} - 2.195023\Delta DEA_{t-3}^{**} - 0.390425\Delta DEA_{t-4} - 0.139876\Delta DEA_{t-5} + 0.860581$$

The Δ(HHI) model in the PVECM regression illustrates the short-term influence of ΔZSCORE and ΔDEA on ΔHHI, with the equation showing that the error correction term (ECT) is negative and significant at 1%, making it valid for measuring HHI adjustments towards long-term equilibrium. The ECT coefficient value of -0.290947 indicates that the HHI imbalance will be corrected by 29.09% each period. The adjusted R^2 value of 67.51% indicates that the competition and efficiency variables substantially influence stability. In the short term, HHI is negatively influenced by HHI in the previous 1–2 years (significant at 1%) and positively in the 3rd year (weak, significant at 10%), reflecting the dynamics of competition due to regulatory changes, digital technology, and banks' ability to adapt. ZSCORE also has a significant negative effect at the 3rd lag (strong, 1%) and positive at the 4th lag (weak, 10%), indicating that past stability reduces current concentration, in contrast to the findings (Az-Zahra & Widarjono, 2023). Meanwhile, DEA shows a significant negative relationship at the 2nd and 3rd lags (5%), indicating that past efficiency increases current competition, not supporting the efficient structure hypothesis (ESH), but rather in line with the findings (Siagian et al., 2023), that small banks with high efficiency are more competitive in concentrated markets.

b) Model D (Zscore)

$$\Delta ZSCORE_t = -0.109564ECT_1^{***} + 0.219266\Delta HHI_{t-1}^{**} + 0.57695\Delta HHI_{t-2}^{***} - 0.171419\Delta HHI_{t-3} - 0.347098\Delta HHI_{t-4} + 0.273138\Delta HHI_{t-5} - 0.490946\Delta ZSCORE_{t-1}^{***} - 0.356839\Delta ZSCORE_{t-2}^{***} - 0.422063\Delta ZSCORE_{t-3}^{***} - 0.375813\Delta ZSCORE_{t-4}^{***} - 0.195758\Delta ZSCORE_{t-5}^{**} - 0.393442\ \Delta DEA_{t-1} - 0.599186\Delta DEA_{t-2} - 0.368613\Delta DEA_{t-3} - 2.112356\Delta DEA_{t-4} - 0.532823\Delta DEA_{t-5} - 2.591464^{***}$$

The D(ZSCORE) model in the PVECM regression shows the short-term effects of HHI and DEA on ZSCORE, with the error correction term (ECT) being significant at 1%, confirming the model's validity in explaining stability adjustments towards long-run equilibrium. The ECT coefficient of -0.109564

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means that each short-term imbalance will be corrected by approximately 10.96% per period. The adjusted R^2 value of 72.57% indicates that competition and efficiency substantially affect stability, while the remaining 27.43% is influenced by other factors. In the short run, HHI has a significant positive effect on ZSCORE at lags 1 and 2, supporting the competition-fragility hypothesis that reduced competition increases stability, in line with the findings of (Pada et al., 2024). In contrast, ZSCORE at lags 1–5 has a negative effect on the current period ZSCORE, in line with (Afriyenis & Utari, 2023) which explains this phenomenon as an agency problem due to increased leverage and risk when previous stability is high. Meanwhile, DEA shows a negative but insignificant effect on ZSCORE, consistent with the results (Hindasah, 2025), but different from the findings (Yulianti et al., 2023) which is significant in certain models.

c) Model D (DEA)

$$\begin{aligned}\Delta(DEA)_t = & -0.018419ECT_1{}^{*} - 0.022081\Delta HHI_{t-1}{}^{**} \\ & - 0.035315\Delta HHI_{t-2}{}^{***} + 0.001325\Delta HHI_{t-3} \\ & + 0.011563\Delta HHI_{t-4} \\ & - 0.010097\Delta HHI_{t-5} + 0.002289\Delta ZSCORE_{t-1} \\ & - 0.003679\,\Delta ZSCORE_{t-2} + 0.018044\Delta ZSCORE_{t-3}{}^{**} \\ & - 0.009180\Delta ZSCORE_{t-4}{}^{*} + 0.010080\Delta ZSCORE_{t-5}{}^{*} \\ & - 0.146831\Delta DEA_{t-1}{}^{*} - 0.272487\Delta DEA_{t-2}{}^{***} \\ & - 0.229873\Delta DEA_{t-3}{}^{**} - 0.0011396\Delta DEA_{t-4} \\ & - 0.025204\Delta DEA_{t-5} - 6{,}219409^{***}\end{aligned}$$

The D(DEA) model shows the short-term effect of HHI and ZSCORE on DEA, with the error correction term (ECT) significant at the 10% level and a coefficient of -0.018419, meaning the DEA imbalance will be corrected by approximately 1.84% per period to return to long-term equilibrium. The F-test is significant, while the adjusted R^2 of 17.17% indicates that a small portion of the DEA variation is explained by HHI and ZSCORE, with the remainder by other factors. In the short run, DEA is negatively affected by HHI at lags 1 and 2 (significant at 5% and 1%), supporting the competition-efficiency and Quiet Life Hypothesis (QLH), that competition increases efficiency, consistent with (Budianto & Dewi, 2023). ZSCORE also has a significant positive effect at lag 3 (5%), in line with (Syariah et al., 2023), indicating that stability improves efficiency through better risk management. Meanwhile, DEA itself at lags 1, 2, and 3 has a significant negative effect on current DEA (10%, 1%, and 5%).

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Long-Term Analysis

Table 6.
Long-Term Test Results

Variable	Model HHI	ZSCORE	DEA
HHI	1,000,000	-2.787848*** (-9.05625)	-0.423875*** (-7.81624)
ZSCORE	-0.358700*** (-3.88461)	1,000,000	0.193408*** (4.48580)
DEA	-2.872194 (-1.83553)	8.007240 (1.88600)	1,000,000
C	-1.336982	3.727302	0.489468

Description: *** significant at α=1%, with |t0.995;459|=|1.965157|
** significant at α=5%, with |t0.975;459|=|2.248796|
* significant at α=10%, with |t0.95;459|=|2.820701|

The cointegration test proves a long-term relationship between the dependent and independent variables, so it is continued with the estimation of long-term coefficients using the Vector Error Correction Model (VECM). The estimation results indicate that in the long run there is a significant causal relationship between HHI, ZSCORE, and DEA. Specifically, HHI has a significant negative effect on ZSCORE (-2.787848) and DEA (-0.423875) at the 1% significance level, while ZSCORE has a significant negative effect on HHI (-0.358700) but positive on DEA (0.193408), both of which are also significant at 1%. Meanwhile, DEA shows a negative coefficient on HHI and a positive one on ZSCORE, but both are insignificant. These findings confirm the existence of a long-term relationship between the three variables, with a complex interaction pattern between competition, stability, and banking efficiency.

a) HHI Model

The long-term equation of the estimated results shows that only ZSCORE (stability) has a significant effect on HHI (competition) with a negative and significant coefficient at the 1% level, namely:

$$HHI_t = -1{,}336982 - 0{,}358700ZSCORE_t^{***} - 2{,}8872194DEA_t$$

This means that increased stability will lower the HHI or increase competition, consistent with the short-term pattern. This suggests that stability encourages banks to be more innovative, competitive, and adaptive to market changes, in line with the findings. (Budianto & Dewi, 2023) which states that

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banking stability strengthens competition between banks which has a positive impact on economic growth.

b) Zscore Model

Long-term equation of the model

$$ZSCORE_t = 3.727302 - 2.787848HHI_t^{***} - 8.007240DEA_t$$

Shows that only HHI significantly affects ZSCORE at the 1% significance level, while DEA has no significant effect. These results indicate that the greater the HHI (market concentration/decreased competition), the banking stability actually decreases, while increased competition (decreased HHI) strengthens stability, supporting the competition-stability hypothesis as found. (Syariah et al., 2023) Healthy competition encourages banks to increase their capabilities, profits, and capitalization to survive in competitive conditions. However, the different directions of the relationship between competition and stability in the short and long term indicate a non-linear relationship influenced by threshold effects, scale effects, and complexity effects. (Siregar, 2023), where excessive competition can create additional risks due to margin pressure, increased scale of operations, and product complexity to maintain competitiveness.

c) DDEA Model

Long-term equation of the model

$$DEA_t = 0.489468 - 0.423875HHI_t^{***} + 0.193408ZSCORE_t{}^{***}$$

Shows that both HHI and ZSCORE have a significant effect on DEA at the 1% significance level. HHI has a negative effect, meaning that increasing HHI (decreasing competition) reduces efficiency, while ZSCORE has a positive effect, indicating that higher stability increases efficiency. This finding supports the competition-efficiency hypothesis, which states that competition drives banks to be more efficient through specialization, technological innovation, and cost management. (Fajri, 2022; Hermanto & Dewinta, 2023; Muhri et al., 2022), and is in line with the quiet life hypothesis, which states that banks with market power tend to be less efficient (Budi gautama Siregar et al., 2023; Saputro & Safuan, 2024; Siregar, 2023). Meanwhile, the positive influence of stability on efficiency is in accordance with research. (Saputro & Safuan, 2024), where stability reduces risk and managerial costs, so that banks can achieve higher efficiency.

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Impulse Response Function (IRF)

a) The Effect of Shocks to the Zscore, HHI, and DEA Variables on the Zscore

In the model with ZSCORE as the dependent variable, the Impulse Response Function (IRF) results show that a shock of one standard deviation in ZSCORE and DEA gives a positive response to ZSCORE, while a shock to HHI

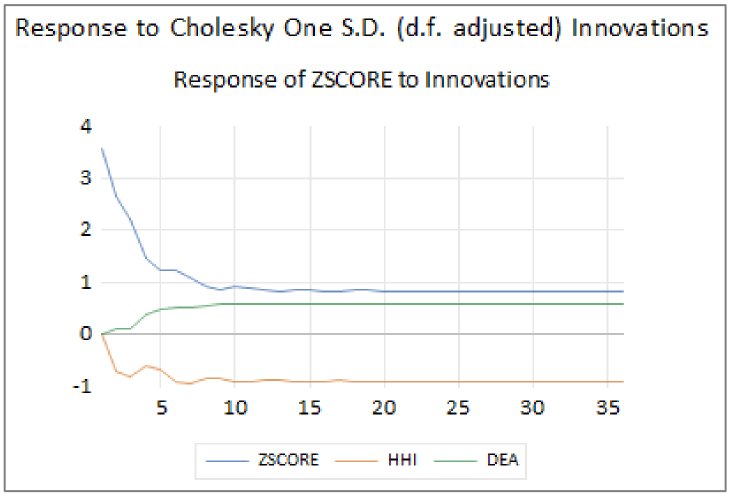

Figure 2.
Zscore Response to Zscore, HHI, and DEA Shocks of Indonesian General Banking for 35 Periods (years)

gives a negative response. Over 35 periods, ZSCORE responds positively to its own ZSCORE shock, with the highest increase of 3.58 points in the first year, then declines steadily until reaching equilibrium in year 16 with a response of 0.83 points. The DEA shock begins to impact ZSCORE from the second year with a small increase, then rises significantly to 0.59 points in year 12 when equilibrium is reached. Meanwhile, the HHI shock begins to respond negatively from the second year, causing a decline in ZSCORE that fluctuates to -0.92 points in year 10, then reaches equilibrium in year 16. These findings indicate that banking stability is positively affected by efficiency, but decreases as market concentration increases.

b) The Effect of Shocks to the HHI, Zscore, and DEA Variables on the HHI

In the model with HHI as the dependent variable, the Impulse Response Function (IRF) results show that shocks to the HHI itself and DEA respond positively to the HHI, while shocks to the ZSCORE respond negatively.

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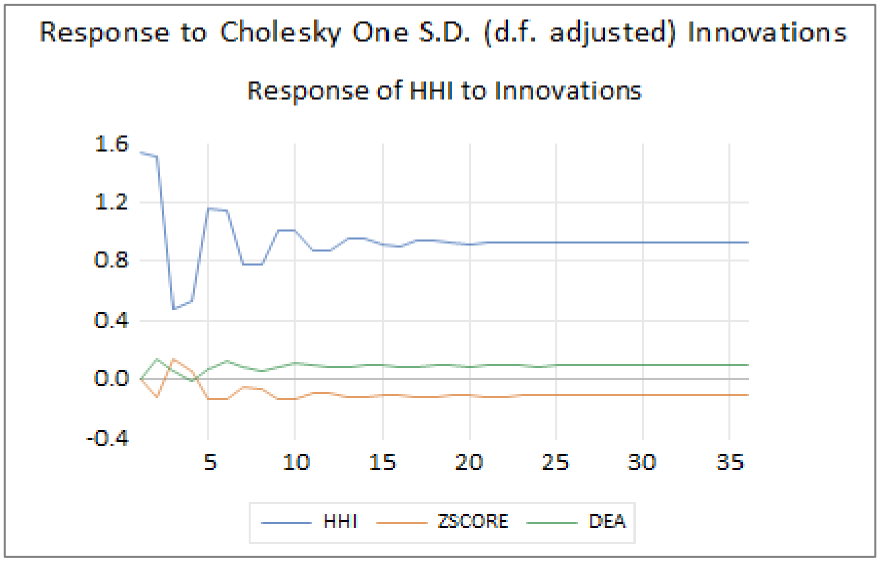

Figure 3.
HHI Response to HHI Shocks, Zscore and DEA of Indonesian General Banking for 35 Periods (Years)

Over the 35 periods, the HHI's response to the HHI itself shocks fluctuated considerably, with an initial increase of 1.54 points in the first year, a sharp decline in years 3 and 4, and then stabilizing to reach equilibrium at 0.93 points in year 21. The DEA shocks began to be positively responded to by the HHI from the second period by 0.14 points, briefly becoming negative in period 4, then returning to positive and reaching equilibrium at 0.09 points in period 13. Meanwhile, the ZSCORE shocks were initially unresponsive in the first month, but began to negatively impact the HHI from the second period, indicating that greater stability tends to suppress market concentration or increase competition in the long run.

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c. The Effect of Shocks to DEA Variables, HHI, and Zscore on DEA

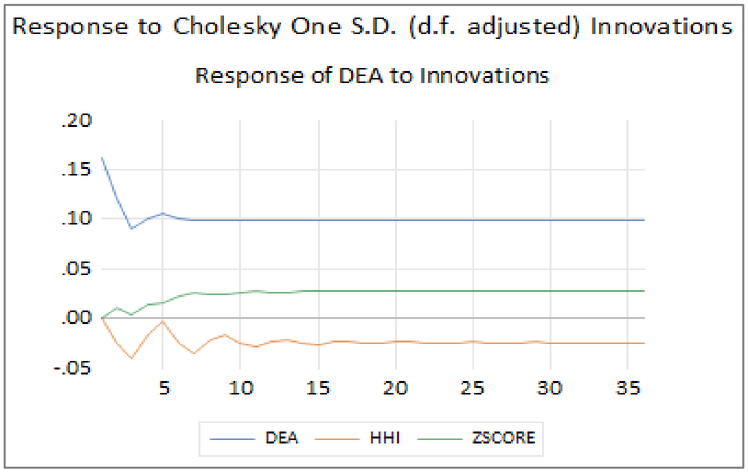

Figure 4.
DEA Response to Shocks of DEA, HHI, and Z-Score of Indonesian General Banking during 35 Periods (Years)

In the model with DEA as the dependent variable, the Impulse Response Function (IRF) results show that shocks to DEA itself and ZSCORE respond positively to DEA, while shocks to HHI respond negatively. A DEA shock of one standard deviation is immediately responded positively in the first year by 0.16 points, then decreases to 0.09 points in the fourth year and stabilizes at around 0.1 points in the long run. The DEA response to the ZSCORE shock appears in the second period with an increase of 0.01 points, decreases briefly in the third period, then rises again and reaches a positive balance of 0.02 points in the sixth period. Meanwhile, the DEA response to the HHI shock begins to appear in the second period with a decrease of -0.02 points, then continues to show a fluctuating negative trend until it stabilizes in the 10th period with the same decrease, reflecting that increasing market concentration (HHI) tends to reduce efficiency, while previous stability and efficiency encourage further efficiency.

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Forecast Error Variance Decomposition (FEVD)

a. Contribution of ZSCORE and DEA variables to the HHI of banking in Indonesia

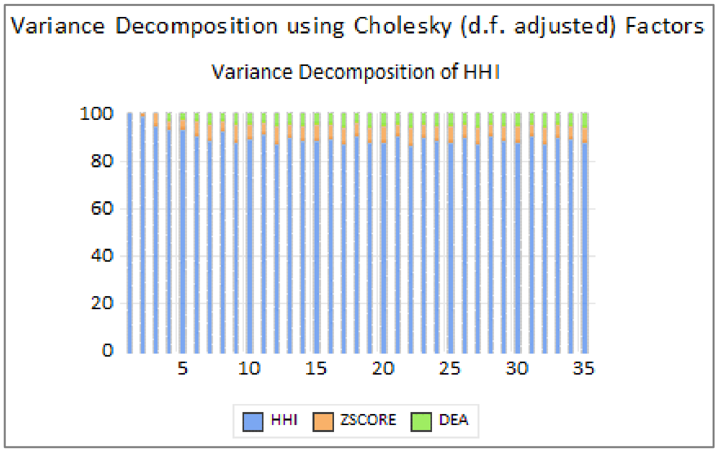

Figure 5.
Forecast Error Variance Decomposition (FEVD) from the HHI banking modeling in Indonesia for 35 periods (years)

The contribution of ZSCORE and DEA shocks to HHI variability can be predicted through Forecast Error Variance Decomposition (FEVD), which shows the importance of each variable in the VECM model. Over the 35 years of observation, HHI variability was dominated by HHI shocks themselves, with a contribution that remained high until it reached 87.94% in year 35. Meanwhile, the contribution of ZSCORE and DEA began to appear from the second year and continued to increase slowly, until in year 35 they contributed approximately 6.50% and 5.56% to HHI variability, respectively. These findings indicate that although HHI remains the main factor, the role of ZSCORE and DEA as explanatory factors of HHI variability also becomes increasingly important in the long run.

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b. Contribution of HHI and DEA variables to the ZSCORE of banking in Indonesia

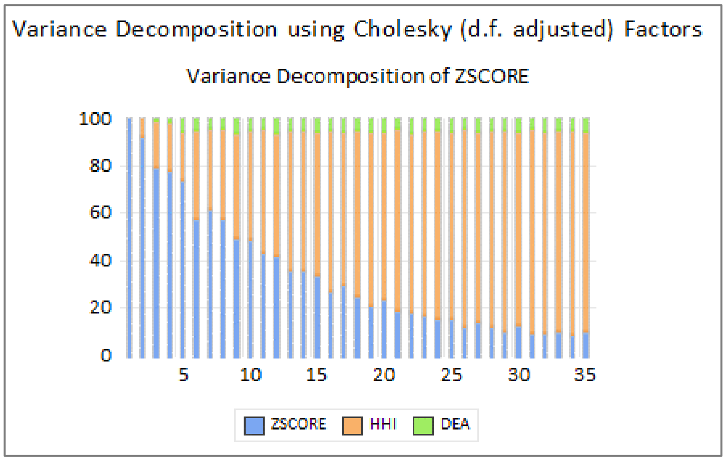

Figure 6.
Forecast Error Variance Decomposition (FEVD) from ZSCORE modeling of banking in Indonesia for 35 periods (years)

The contribution of HHI and DEA shocks to ZSCORE variability is analyzed using Forecast Error Variance Decomposition (FEVD) to measure the importance of these variables in the VECM model. Over the 35 years of observation, ZSCORE variability was initially dominated by the ZSCORE shock itself, but its contribution decreased to only 9.62% in year 35. In contrast, the contribution of HHI shocks increased significantly from 7.45% in the first year to 84.46% in year 35, making it the dominant factor in the long run. Meanwhile, DEA shocks had a relatively small contribution but increased gradually from 0.61% in the first year to 5.92% at the end of the period, indicating that although the main influence came from HHI, ZSCORE was still gradually influenced by all three variables.

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c. Contribution of HHI and ZSCORE Variables to DEA of Banking in Indonesia

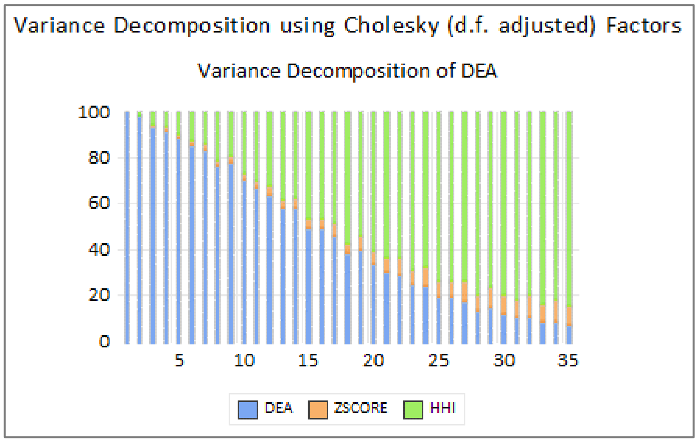

Figure 7.
Forecast Error Variance Decomposition (FEVD) from the HHI banking modeling in Indonesia for 35 periods (years)

The contribution of HHI and ZSCORE shocks to DEA variability was analyzed using Forecast Error Variance Decomposition (FEVD) to examine the role of both variables in the VECM model. Over 35 periods, DEA variability was initially dominated by the DEA shock itself, which contributed fully in the first year and remained at 98.08% in the second year. However, the DEA's contribution to itself continued to decline to only 6.88% in the 35th year. Conversely, the HHI's contribution increased significantly from 1.67% in the second year to dominate with 84.51% in the 35th year. Meanwhile, the ZSCORE contribution to DEA also increased slowly but remained small, reaching only 8.61% in the final period, indicating that in the long run, HHI becomes the main factor explaining DEA variability.

CONCLUSION

Based on the research results, the condition of the Indonesian banking industry shows quite high competition, especially in medium and small banks with monopolistic market characteristics, financial stability with low bankruptcy risk, and at a moderate level of efficiency. This study also proves that competition drives increased efficiency in accordance with the competition-efficiency hypothesis and the quiet life hypothesis (QLH), but shows a nonlinear relationship with stability where in the short term it increases the risk of bankruptcy as in the competition-fragility hypothesis, but in the long term it actually increases stability as in the competition-stability hypothesis. Stability has

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been proven to consistently increase competition and efficiency in the short and long term, while efficiency only has an impact on short-term competition and is not in line with the efficient structure hypothesis (ESH). In addition, shocks to competition and stability generally give a positive response to other variables, while shocks to efficiency are only responded positively by stability but negatively by competition, indicating the need for strategies to increase efficiency without sacrificing competitiveness.

As a follow-up, it is recommended that the Financial Services Authority (OJK) strengthen technology-based supervision of banks vulnerable to funding gaps, while Bank Indonesia needs to enforce strict sanctions on banks that violate financing limits or fail to meet minimum intermediation requirements. Banks are also advised to strengthen their structures by increasing economies of scale and accelerating digitalization to enhance competitiveness and reduce inefficiencies. For further research, it is recommended to consider using the GMM-VECM model to capture the complexity of dynamic relationships by considering endogeneity and cointegration, and incorporating instrumental variables such as economic indicators, financial policies, or the impact of the crisis.

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