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Financial Internet Quarterly 2026, vol. 22 / no. 2, p. 59-86
https://dx.doi.org/10.65748/fiqf-2026-0012

Financial Internet Quarterly

PREDICTING BANK CONTINUITY USING THE KAH-TANS MODEL: AN APPLIED STUDY OF SEVERAL IRAQI COMMERCIAL BANKS FOR THE PERIOD (2018-2023)

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Abstract

The Kah-Tans Model was used to predict the ability of Iraqi banks to achieve the continuity condition. This model, considered one of the most accurate models, was used to predict a bank's ability to maintain continuity and avoid bankruptcy. The seven most important Iraqi banks were selected, the data for which is fully available on the website of the Iraq Securities Commission. Several conclusions were reached, including that some banks face financial difficulties due to a lack of continuity. This does not occur suddenly, but rather gradually. Other non-financial factors may intervene, such as incorrect decisions by bank managers, in addition to market inefficiencies, which may be reflected in a decline in the bank's continuity. Furthermore, the presence of an efficient and effective internal audit department will provide the ability to protect shareholders' rights, preserve financial resources, and provide accurate information, which contributes to the bank's continuity.

JEL classification: G21, C53, O16, G17
Keywords: Bank Continuity, Kah-Tans Model, Commercial Banks

Received: 15.08.2025 Accepted: 13.11.2025

Cite this:
Abbas, A.A. & Huby, M.S.J. (2026). Predicting bank continuity using the Kah-Tans model: An applied study of several Iraqi commercial banks for the period (2018-2023). Financial Internet Quarterly 22(2), pp. 59-86.

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Introduction

The banking sector plays a vital role in ensuring the stability and growth of national economies, particularly in developing countries where financial institutions serve as the backbone for investment, trade, and development (Hamdaoui & Cancelo, 2024; Naili & Lahrichi, 2022). In Iraq, commercial banks occupy a critical position in the financial system by mobilizing savings, facilitating credit distribution, and supporting economic transactions across multiple sectors (Boukhatem & Ben Moussa, 2018). As of the end of 2023, there were 70 commercial banks operating in Iraq, comprising 7 state-owned banks (including 3 commercial banks, 3 specialized banks, and 1 Islamic bank) and 63 private banks (consisting of 28 local Islamic banks, 23 local commercial banks, 10 foreign banks, and 2 foreign Islamic banks). These banks collectively accounted for more than 80% of the country's financial assets (Central Bank of Iraq, 2023). However, the Iraqi banking industry has experienced a challenging environment over the past two decades, marked by political instability, fluctuating oil prices, security concerns, and global economic shifts. For instance, the World Bank (2023) reported that GDP growth in Iraq declined from 10.8% in 2016 to 4.3% in 2022, due to reduced oil production and fiscal tightening, directly affecting banking liquidity and credit flow (Qader, 2025). These factors have heightened the vulnerability of banks to both internal and external risks, making the question of their continuity and sustainability more urgent than ever (Abdulhameed, 2025). Ensuring bank continuity is vital not only for protecting depositors and investors but also for maintaining public trust and safeguarding macroeconomic stability (Cantero-Saiz et al., 2024).

Continuity in the banking context refers to the ability of a financial institution to sustain operations, meet its obligations, and adapt to changes in the market without experiencing financial distress or collapse. Discontinuity, by contrast, often signals insolvency, bankruptcy, or severe operational inefficiencies (Araujo & Dantas, 2022; Metwally et al., 2025). The consequences of discontinuity can be far-reaching, affecting not only shareholders but also employees, customers, and the broader economic environment. Globally, over 400 banks failed between 2008 and 2022 due to insolvency or liquidity crises, underscoring the critical importance of continuity management (Cox et al., 2017; Ekinci & Sen, 2024; FDIC, 2025). In the case of Iraq, with its developing capital market and fragile economic infrastructure, bank failures could trigger systemic shocks and undermine financial confidence (Fell & Schinasi, 2005). Therefore, the ability to accurately measure and predict the continuity of banks becomes a central concern for regulators, investors, and policymakers (Addy et al., 2024; Hammond & Opoku, 2023).

Financial forecasting models have been developed globally to evaluate corporate stability and predict the likelihood of business failure. Among them, the Kah and Tans (1999) model offers a structured approach to assessing bank continuity by analyzing specific financial indicators derived from published financial statements (Bachmann et al., 2022; Gül & Altınırmak, 2025). This model is grounded in quantitative analysis and provides a scientific basis for predicting whether a bank can maintain operations over a given time horizon. While various models exist for financial failure prediction, the Kah and Tans framework has proven particularly useful for the banking sector due to its capacity to integrate diverse financial ratios and generate continuity predictions with a reasonable degree of accuracy (Laitinen et al., 2023; Mishra et al., 2024). It combines key financial variables - such as liquidity, leverage, profitability, and retained earnings - through weighted root functions, producing continuity values typically ranging from 0 (risk of discontinuity) to 1 (strong continuity) (Dahmash et al., 2023).

The Iraqi banking sector's performance between 2018 and 2023 provides a rich context for applying this model. During this period, Iraqi banks faced not only domestic operational challenges but also external shocks such as fluctuating oil revenues, the COVID-19 pandemic's impact on economic activity, and shifts in global capital flows (Damghanian et al., 2023; Elnahass et al., 2021; Mohammad & Moslem, 2024). According to the Central Bank of Iraq (2024), total banking assets increased from IQD 138.6 trillion in 2020 to over IQD 165.2 trillion in 2023, yet non-performing loans (NPLs) remained high at around 6.30%, and average capital adequacy ratios fell below the regional benchmark of 12% (Central Bank of Iraq, 2023). These factors have directly influenced liquidity levels, credit risk exposure, and market confidence. By applying the Kah-Tans Model to Iraqi commercial banks over this timeframe, it becomes possible to identify trends, measure the degree of continuity, and predict future performance. Moreover, such predictive insights can be instrumental for banks seeking to preemptively address weaknesses and for regulators aiming to implement preventive measures (Al-Husainy & Jadah, 2021).

One of the key issues in assessing bank continuity lies in recognizing that financial distress often develops gradually rather than abruptly (Zhen, 2015). Warning signals - such as declining profitability, increased non-performing loans, liquidity shortages, or reduced capital adequacy - may appear years before an actual collapse. In Iraq, the average return on assets (ROA) among commercial banks dropped from 1.31% in 2022 to 1.28% in 2023, illustrating early symptoms of distress linked to pandemic-induced disruptions (Helgi Library, 2023). This considers the importance of contin-

uous monitoring using robust analytical tools (Alnabulsi et al., 2022; Cobbinah et al., 2024). However, financial indicators alone do not tell the full story. Non-financial factors such as governance quality, strategic decision-making, technological adoption, and the regulatory environment also play a crucial role in determining long-term sustainability (Saini et al., 2022). In Iraq, where institutional governance structures are still evolving, and where the banking sector is adapting to international standards, a holistic approach to continuity measurement is essential (Issa & Abbaszadeh, 2023).

Although the Kah-Tans Model was originally developed over two decades ago, it remains a relevant and reliable analytical framework for assessing financial continuity because of its strong theoretical foundation and proven empirical validity across various economic contexts. Its structure allows adaptation to contemporary datasets, including those of Iraqi commercial banks, by recalibrating the root weights and equations based on current financial ratios. Using a well-established model such as Kah and Tans (1999) also enables comparison with earlier studies, providing a historical benchmark to evaluate how banking continuity patterns have evolved over time.

From a theoretical standpoint, this study is grounded in the principles of financial distress and continuity theory, which assert that a firm's ability to survive depends on maintaining equilibrium between profitability, liquidity, and solvency (Dewi et al., 2021; Syahputra & Imronudin, 2024). The Resource-Based View (RBV) further supports this perspective, emphasizing that banks with stronger internal resources - such as capital reserves, managerial capability, and technological infrastructure - are more resilient to external shocks (Kero & Bogale, 2023). Additionally, the Signaling Theory suggests that financial ratios serve as key indicators that signal the underlying health and continuity prospects of banks to investors and regulators (Hammond & Opoku, 2023). By integrating these theoretical frameworks, this study not only tests the empirical applicability of the Kah-Tans Model but also aligns it with broader theoretical constructs of financial sustainability and strategic resilience.

Despite the critical role of banks in Iraq's economic stability, there remains a lack of comprehensive studies applying advanced continuity prediction models to Iraqi commercial banks. Many assessments focus primarily on historical financial performance without integrating forward-looking predictive tools (Ali et al., 2024; Ali & Flayyih, 2021; Peykani et al., 2025). This creates a gap in both academic literature and practical banking management. For instance, only 28% of Iraqi banks currently publish full annual reports aligned with IFRS standards, limiting transparency and comparability across institutions (Madhi & Mohammed, 2025; Thijeel et al., 2025). Given the complex interplay of domestic and global financial pressures, Iraqi banks need reliable methods to forecast continuity, identify early warning signals, and implement corrective actions. Without such measures, the risk of unexpected bank failures could undermine public confidence and economic resilience (Alsaffar & Al-Bakri, 2025).

This study hypothesizes that there is a significant difference in the continuity status of Iraqi commercial banks over the period from 2018 to 2023 as measured by the Kah-Tans Model (1999). To test this, the research seeks to answer several key questions,

- How effectively does the Kah-Tans Model measure the continuity of Iraqi commercial banks?
- What trends in continuity can be observed among Iraqi commercial banks between 2018 and 2023?
- Which banks are most at risk of discontinuity, and what factors contribute to their vulnerability?
- How can predictive continuity assessments inform better strategic and regulatory interventions?

The primary objective of the research is to apply the Kah-Tans Model to evaluate the continuity of selected Iraqi commercial banks, analyze the resulting trends, identify potential risks, and provide actionable recommendations that enhance the resilience and sustainability of the banking sector in Iraq. By integrating theoretical insights from financial distress theory, the RBV, and signaling mechanisms, this study establishes a comprehensive foundation for understanding the determinants of bank continuity in volatile economic contexts. By leveraging financial data from seven listed commercial banks representing over 85% of total sectoral assets, this study provides an evidence-based assessment of institutional continuity within the Iraqi banking system. This study provides valuable insights for Iraqi banks and regulators to proactively identify financial instability and implement strategies to ensure long-term continuity. Additionally, it highlights the importance of integrating both financial and non-financial factors in assessing bank sustainability to strengthen the overall banking sector. The findings of this study will particularly benefit policymakers, financial regulators, investors, and bank management teams by providing them with empirical tools and predictive frameworks to enhance financial stability, improve decision-making, and safeguard the resilience of Iraq's banking system.

The remainder of this paper is organized as follows: Section 2 presents a comprehensive review of related literature, focusing on financial continuity models and their relevance to the banking sector. Section 3 outlines the research methodology, including the selection of sample banks, data collection process, and the application of the Kah-Tans Model. Section 4 discusses the empirical results and interprets the continuity patterns

observed among Iraqi commercial banks from 2018 to 2023. Section 5 provides a detailed discussion of the findings in relation to existing theories and prior studies. Finally, Section 6 concludes the study by summarizing key insights, outlining policy implications, and offering recommendations for future research.

Theoretical framework

Financial continuity and stability in banking

Financial continuity - commonly referred to as the "going concern" assumption - implies that a bank is expected to continue its operations for the foreseeable future without the intention or necessity to liquidate (Bradbury et al., 2022; Chiosea & Hategan, 2024). This assumption is fundamental for the preparation of financial statements, as it supports consistent valuation of assets and liabilities. Recent empirical evidence from developing economies, including Iraq, shows that continuity assessment must consider dynamic market conditions, fluctuating profitability, and varying levels of liquidity and leverage (Al-Harbi, 2019; Jaaz et al., 2025; Sangawi et al., 2025). Studies have emphasized that even when short-term financial stress occurs, institutions with diversified portfolios and sound capital management tend to restore stability over time (Settembre-Blundo et al., 2021). For this reason, banks must regularly assess their ability to maintain continuity. Financial analysts within each institution are tasked with conducting annual evaluations to determine whether the bank remains capable of meeting its operational and financial commitments (Bastan et al., 2024). Unless management has explicitly decided to discontinue operations, financial statements must be prepared under the assumption of continuity. This is particularly critical in the banking sector, where stability and trust form the foundation of customer relationships and market confidence (Ali & Flayyih, 2021).

Liquidity and its role in sustaining continuity

Liquidity ratios represent a bank's capacity to meet short-term obligations and sustain confidence among depositors and investors (Lalithchandra & Rajendhiranb, 2021; Zhang et al., 2020). Adequate liquidity is often associated with sound financial management and effective asset-liability matching, which contribute to the bank's resilience during market fluctuations (Nam & Tuyen, 2024). Conversely, insufficient liquidity may trigger credit constraints, profitability decline, and eventual financial distress (Masruroh et al., 2025; Vuong et al., 2023). The literature consistently emphasizes that maintaining an optimal liquidity level is critical for ensuring long-term continuity. Excessive liquidity may indicate idle resources and inefficiency in asset utilization, while liquidity shortages increase the probability of insolvency (Muchsidin et al., 2025; Zhu et al., 2025). Studies conducted across developing financial systems highlight that banks with stable liquidity ratios tend to exhibit stronger continuity performance, as liquidity enables timely response to external shocks and reinforces depositor trust (Eltweri et al., 2024; Jaafar et al., 2024).

Leverage and financial structure as predictors of continuity

Leverage plays a significant role in determining a bank's financial stability and its ability to maintain operational continuity. It represents the balance between borrowed capital and shareholders' equity, influencing both profitability potential and exposure to financial risk (Baita et al., 2024; Muscettola, 2013). A higher leverage ratio can magnify returns during favorable market conditions, yet it also increases vulnerability to losses and insolvency during economic downturns (Akwuobi et al., 2025; Murombi & Mohammed, 2025). Banks with excessive reliance on debt financing often experience heightened volatility in earnings and reduced flexibility in meeting short-term obligations, thereby compromising long-term sustainability (Cobbinah et al., 2024). Conversely, maintaining moderate leverage enhances continuity by allowing institutions to expand operations through controlled borrowing while preserving a healthy capital buffer. Previous studies emphasize that well-capitalized banks exhibit stronger resilience to market shocks, better access to funding, and more consistent profitability patterns over time (Bui et al., 2017; Korein et al., 2022). An optimal capital structure, therefore, is one that balances risk and return - leveraging debt to support growth while ensuring sufficient equity to absorb potential losses (Stoiljković et al., 2022). In emerging economies, where external shocks and liquidity constraints are common, the management of leverage becomes a key strategic tool for preserving institutional continuity and safeguarding financial system stability (Basiru et al., 2023; Eyinade et al., 2025).

Profitability and earnings retention as determinants of continuity

Profitability is one of the most critical indicators of a bank's financial strength and long-term continuity. It reflects an institution's efficiency in utilizing its assets to generate income, ensuring its ability to sustain operations, reward shareholders, and reinvest for future growth (Mashamba & Chikutuma, 2023; Yao et al., 2018). Sustained profitability enhances investor confidence, promotes capital accumulation, and contributes to the overall resilience of the banking system (Linggadjaya et al., 2025). Conversely, persistent de-

clines in profitability can signal managerial inefficiencies, weak asset utilization, or deteriorating market conditions, ultimately threatening a bank's ability to operate as a going concern (Arhinful et al., 2025a). Retained earnings also play a significant role in supporting financial continuity, acting as a self-financing mechanism that strengthens equity and mitigates dependence on external borrowing (Dumitrescu, 2019). Studies have shown that banks with higher retained earnings ratios are better positioned to withstand economic shocks and maintain growth stability over time (Arhinful et al., 2025b; Sivi et al., 2024). The accumulation of retained profits not only improves a bank's capital adequacy but also provides flexibility for reinvestment, innovation, and strategic expansion - factors closely linked to long-term sustainability (Linggadjaya et al., 2025).

Governance, auditing, and disclosure in strengthening continuity

Corporate governance, auditing, and disclosure are widely recognized as essential mechanisms that ensure the stability and continuity of financial institutions (Gyimah & Owusu-Afriyie, 2025). Governance mechanisms - both internal, such as board oversight and internal controls, and external, such as regulatory supervision - create a framework for accountability, ethical behavior, and prudent decision-making (Bhatt et al., 2024; Mertzanis, 2011). By ensuring adherence to laws, regulations, and accounting standards, governance promotes transparency and safeguards against practices that could jeopardize the institution's future (Gardi et al., 2023; Suluo et al., 2025). Effective governance establishes accountability, ethical management, and regulatory compliance, which are crucial for preventing operational inefficiencies and financial distress (Sari, 2023). Strong governance frameworks help align management decisions with shareholder and stakeholder interests, thereby minimizing the risk of mismanagement and promoting transparency (Bui & Krajcsák, 2024). A well-governed bank maintains strong values and disciplined practices, enabling it to compete effectively while withstanding external shocks (Djebali & Zaghdoudi, 2020; Wali et al., 2023). On the other hand, auditing serves as a complementary tool that reinforces governance effectiveness. Regular internal and external audits enhance managerial oversight, identify financial irregularities, and promote corrective action before critical risks emerge (Bonrath & Eulerich, 2024; Khelil, 2023). Such audits are not limited to detecting financial irregularities; they also evaluate compliance with regulations, operational efficiency, and the effectiveness of risk management frameworks (Brás et al., 2024; Dharmawati et al., 2024). Through systematic evaluation of financial statements, audit mechanisms contribute to higher accuracy, reliability, and trust in reported data, all of which are necessary for maintaining business continuity (Alkhalaileh et al., 2024; Hamid & Abdul, 2024). This proactive approach not only preserves financial health but also reinforces stakeholder trust, thereby supporting the bank's long-term operational stability (Adeniran et al., 2024; Ali & Flayyih, 2021). Disclosure quality, meanwhile, acts as a communication bridge between banks and stakeholders, influencing perceptions of stability and confidence in the institution's ongoing operations (Salem et al., 2025). Transparent financial reporting in line with International Financial Reporting Standards (IFRS) provides early warnings of potential difficulties, allowing timely intervention by management or regulators (Ball, 2006; Johri, 2024). In emerging economies such as Iraq, where institutional and regulatory structures are still developing, the effectiveness of governance and auditing is closely tied to the quality of disclosure practices and the credibility of financial information provided to investors and the public (Elmanaseer & Gerged, 2025; Hassan et al., 2014).

Technological and strategic responses to financial instability

Recent literature highlights the growing influence of technological innovation and strategic restructuring in enhancing the continuity and resilience of financial institutions (Fakhrullah et al., 2025; Li & Ding, 2024). The introduction of advanced digital reporting tools, such as the eXtensible Business Reporting Language (XBRL), has been found to improve the accuracy, timeliness, and comparability of financial disclosures (Frijat, 2024; Nofel et al., 2024). These technologies facilitate automated data exchange and standardization, thereby reducing human error and enabling more effective financial supervision. Artificial intelligence (AI) and machine learning applications have further expanded the scope of predictive financial analytics. Studies indicate that AI-based systems can identify early warning signals of financial distress by analyzing complex patterns across liquidity, profitability, and solvency ratios (Najem et al., 2025; Vuković et al., 2025). Such predictive tools are increasingly integrated into risk assessment frameworks to enhance proactive decision-making and regulatory compliance. Strategic responses such as mergers, acquisitions, and alliances are also emphasized as stabilizing mechanisms for banks experiencing declining performance or continuity risks. Through consolidation, banks can strengthen their capital bases, diversify risk exposure, and achieve operational efficiency (Al-Binali et al., 2023; Pubodhya & Rajapakshe, 2025). Moreover, mergers facilitate technology transfer, managerial development, and knowledge sharing, thereby reinforcing long-term competitiveness and institutional resilience (Na & Shimizu, 2024).

Review of models and approaches to bank continuity assessment

To establish the research gap and justify the current use of the Kah-Tans Model, previous empirical studies on bank continuity and failure prediction are examined according to their main methodological frameworks. The evolution from traditional statistical techniques to advanced neural and hybrid models reveals both the strengths and limitations of existing approaches, as well as the areas where further research, particularly in the context of Iraqi commercial banks, is needed (Ecer, 2013; Sen & Figueiredo, 2021).

Early studies using multivariate discriminant analysis (MDA), such as the classical Altman framework, classified banks and firms into solvent or distressed categories based on selected financial ratios. These models effectively differentiated institutions within sample data but were less robust under changing macroeconomic conditions due to their linear structure (Chijoriga, 2011). Their inability to capture nonlinear interactions among financial indicators has limited their predictive power in dynamic financial environments. Moreover, few applications of this method have been extended to the Iraqi banking context over a multi-year horizon (Lahouel et al., 2022).

Logistic and probit regression models marked an important advancement by estimating the probability of failure as a function of financial and macroeconomic variables. These methods offered valuable statistical inference, revealing consistent risk factors such as liquidity shortages, non-performing loans, and low profitability (Klieštik et al., 2015). However, they still relied on pre-specified functional forms and struggled to capture complex nonlinear relationships. Despite their usefulness for policy analysis, such models remain underexplored in Iraq, where their integration with more adaptive machine-learning tools is minimal (Jose et al., 2020). Survival or duration analysis models introduced the time-to-event dimension by focusing on how long a bank remains solvent. They successfully incorporated macroeconomic shocks and changes in financial conditions over time but required a large number of observed failures for reliable estimation (Laitinen, 2005). This methodological constraint limited their applicability in markets like Iraq, where bank failures are relatively infrequent due to policy interventions or restructuring measures (Arena, 2008).

In recent years, artificial neural networks (ANNs) and other machine-learning techniques have offered new perspectives by modeling nonlinear patterns and interdependencies among variables. These approaches emphasize predictive accuracy through training and validation processes, outperforming traditional linear models in many empirical settings (Lee, 2024). The Kah-Tans Model represents a specific ANN-based framework that uses multiple transformation roots to produce continuity probabilities. However, its application to Middle Eastern banking systems, particularly Iraqi commercial banks, remains rare. Additionally, the interpretability of ANN outputs continues to pose a challenge, as most studies emphasize prediction accuracy without explaining how specific financial attributes shape continuity outcomes (Yetiz et al., 2025). Hybrid approaches that integrate AI with financial reporting technologies, such as XBRL, have emerged as a promising area for enhancing data quality and model input precision. These studies demonstrate that improved data standardization enhances the reliability of predictive systems (Artene et al., 2024). Nonetheless, limited adoption of XBRL in emerging economies has restricted such innovations, leaving a gap in the context of Iraq where data accessibility and reporting consistency remain significant barriers (Tohang & Lan, 2017).

Beyond financial indicators, some empirical works incorporate governance quality, audit standards, and other non-financial variables into predictive frameworks. These studies highlight the stabilizing influence of sound governance and strong audit practices on bank performance and continuity (Khan, 2010; Nguyen & Nguyen, 2024). Yet, such multidimensional analyses are scarce in Iraq, where governance disclosure is inconsistent and often excluded from continuity prediction models. From this methodological review, it is evident that several gaps persist: the underuse of advanced ANN-based continuity models such as Kah-Tans in Iraqi banking research, the absence of multi-year analyses integrating financial and non-financial factors, and the limited implementation of AI and XBRL-enabled systems due to data constraints. The present study addresses these shortcomings by applying the Kah-Tans Model to a multi-year panel of Iraqi commercial banks, documenting its root weights and computational results, and interpreting these within the context of governance and disclosure conditions unique to Iraq.

Methodology

Research community and sample

The research community for this study comprises all Iraqi commercial banks listed on the Iraq Stock Exchange (ISX), totaling 22 banks. From this population, a purposive sample of seven banks was selected based on the availability and completeness of financial data over the study period. The selected banks demonstrated a high level of transparency by publishing comprehensive annual reports, which were readily accessible through the Iraq Securities Commission's official website (https://www.isc.gov.iq/en). The research covers a six-year period, providing a robust dataset for continuity analysis. This time frame was chosen to capture both short-term and medium-term financial dynamics, allowing for the detection of patterns and trends that could influence the probability of bank continuity.

Measurement model

The study adopts the Kah-Tans Model (1999) as the primary analytical tool for assessing banking continuity. This model is grounded in artificial intelligence principles, specifically neural networks, and is recognized for its capability in processing parallel data streams to achieve accurate predictions. Unlike traditional statistical methods such as discriminant analysis, logistic regression, or probit models, the Kah-Tans framework accommodates complex, nonlinear relationships by incorporating multiple equations and root-based calculations. Previous research has validated its application in financial stability assessments, making it suitable for this study. The model's structure involves a series of six financial ratios (X_1 - X_6) representing key indicators of financial health,

X_1: Current assets to current liabilities.
X_2: Book value of shareholders' equity to total tangible assets.
X_3: Total liabilities to total tangible assets.
X_4: Interest expense to earnings before interest and taxes.
X_5: Net profit to total tangible assets.
X_6: Retained earnings to total tangible assets.

Computational procedure

The computational procedure for applying the Kah-Tans model to predict the continuity of Iraqi commercial banks begins with substituting the six selected financial ratios (X_1 - X_6) into the model's predefined thirteen equations. Each equation produces a transformed value for every ratio, which is then multiplied by its corresponding root weight as shown in Table 1. The results of these multiplications are summed to obtain the total weights. These totals are then converted into probabilities using the logistic function:

$$P = \frac{1}{1+e-z} \tag{1}$$

where Z represents the calculated total weight. The probabilities are next multiplied by the fixed continuity weights, and their sum is transformed again using the exponential function to yield the final total. Finally, the continuity probability is determined by reapplying the logistic function, providing a predictive measure of each bank's likelihood of continued operation within the studied period. This stepwise calculation integrates mathematical precision with sector-specific financial data, ensuring a reliable continuity forecast.

The products are then summed, and the base of the natural logarithm is applied to the negative of this sum, following the equation:

$$Final\ total = e^{-(sum\ of\ weighted\ probabilities)} \tag{2}$$

with this final total, the probability of continuity is calculated with the equation:

$$Continuity\ probability = \frac{1}{1+e-final\ total} \tag{3}$$

The result of this equation ranges between 0 and 1. If the expected continuity value is 0.5 or less, it indicates that the bank is at risk of financial failure and facing potential financial difficulties. Conversely, if the value is greater than 0.5, the bank is considered financially stable and not at risk of failure in the near or medium term.

Statistical analysis

For the period 2018–2023, the standard deviation, arithmetic mean, and median were calculated using the applied equation, and the results are summarized in Table 1. The findings indicate that Ashur Bank, Bank of Baghdad, Commercial Bank of Iraq, and Mansour Bank recorded a standard deviation of 0.000000, signifying complete consistency with no variability in their performance metrics over the study period. For the remaining banks, the standard deviation values were relatively low, implying that their data points are closely concentrated around the mean. This narrow dispersion reflects a high degree of accuracy and stability in the evaluated indicators, suggesting that the banks maintained consistent operational performance across the observed years.

Table 1: Statistical summary of selected Iraqi banks (2018–2023)

Bank name	Mean	Stdev	Median
Ashur Bank	1.000000	0.000000	1.000000
Bank of Baghdad	1.000000	0.000000	1.000000
Commercial Bank of Iraq	1.000000	0.000000	1.000000
Economic Investment Bank	0.749664	0.150351	0.787800
Mansour Bank	1.000000	0.000000	1.000000
Middle East Bank	0.831679	0.097909	0.777152
Sumer Bank	0.564680	0.164278	0.502209

Source: Author's own work.

Results

Root weights and computational outputs of the Kah-Tans model

The Kah-Tans neural network model was applied to evaluate the continuity potential of Iraqi commercial banks using six financial ratios (X_1 - X_6). These ratios were processed through thirteen equations weighted by specific root values (Table 2). The variation in root weights shows that some equations, such as 3 and 7, had higher influence on the output, while others contributed moderate stabilizing effects. The final probabilities of bank continuity were obtained by aggregating weighted values and applying a logistic transformation.

Table 2: Root weights for the Kah-Tans Model variables (X_1 - X_6) in Iraqi commercial banks

Weights	Root 1	Root 2	Root 3	Root 4	Root 5	Root 6
Equations	X_1	X_2	X_3	X_4	X_5	X_6
1	-1.7131	-0.7445	1.0923	0.7894	-1.2190	1.4748
2	2.4090	0.4731	0.9675	1.4973	1.5736	0.0608
3	-4.7666	-0.6464	-0.4594	1.8110	-3.0948	1.1088
4	2.4481	1.5166	-1.9108	-1.0374	3.4716	-1.7151
5	-1.8592	0.8320	0.5539	-0.3472	-3.8518	1.0478
6	2.3792	-1.6206	0.9388	0.9583	0.5343	-1.4635
7	-0.3777	-1.9838	4.7112	0.3435	-4.1620	0.2471
8	0.7749	0.0680	-3.0032	-0.9030	3.8518	2.9925
9	0.1082	-2.7006	0.8004	2.8183	-1.4552	-1.5489
10	-1.4331	-3.8039	1.5506	-1.5812	-1.5487	1.6800
11	-1.0690	1.1740	1.8209	3.2994	1.9189	-1.3918
12	-3.4508	1.6278	1.5102	-1.2572	-1.4740	-3.2479
13	1.5860	-1.8089	1.3851	3.2692	-0.9288	-1.7903

Source: Author's own work.

Positive roots (e.g., 4 and 8) strengthened continuity predictions, whereas negative roots (e.g., 7 and 12) reduced them. Overall, the model effectively distinguished between financially stable and vulnerable banks, providing a reliable projection of continuity across Iraq's commercial banking sector (Table 3).

Table 3: Assigned root weights for the thirteen equations in the Kah-Tans Model applied to Iraqi commercial banks

Roots	Weights
1	-0.2511
2	0.2906
3	-1.9166
4	2.4069
5	-1.0360
6	1.1450
7	-4.0270
8	4.5182
9	-0.7421
10	-2.4982
11	1.3286
12	-3.5450
13	0.4856

Source: Author's own work.

Trends and comparative analysis of financial ratios among selected banks

The result presents the calculated financial ratios for each bank in the study sample over multiple years, offering insights into their liquidity, leverage, profitability, and earnings retention trends. Overall, some banks, such as the Commercial Bank of Iraq and Al-Mansour Bank, display generally stable liquidity ratios with mod-

est fluctuations, suggesting consistent short-term financial health. Others, like the Economic Investment Bank, show declining liquidity over time, accompanied by notable variations in interest expense relative to earnings, indicating potential pressure on profitability. Assyria Bank and the Bank of Baghdad reveal more pronounced year-to-year changes in leverage and profitability measures, suggesting shifting financial structures and operational performance. Middle East Bank's ratios reflect significant volatility in interest expense measures, indicating periods of extreme financial strain or accounting adjustments. Sumer Bank exhibits a trend of relatively high liquidity that increases in later years, though its profitability and earnings retention ratios show fluctuations, with some periods turning negative, signaling potential operational challenges (Table 4).

Table 4: Yearly financial ratios of selected Iraqi commercial banks (2018-2023)

Years	Current assets to current liabilities	Book value of shareholders' equity to total tangible assets	Total liabilities to total tangible assets	Interest expense to earnings before interest and taxes	Net profit to total tangible assets	Retained earnings to total tangible assets
Commercial Bank of Iraq						
2018	3.20578725	34.09311670	19.284604	-0.77575721	1.30202743	2.21320368
2019	3.00175406	28.10976180	18.384417	-1.92055136	0.67524344	0.62401889
2020	2.18629504	31.66828690	31.816462	-0.41731590	3.64851797	3.92609695
2021	3.09009564	17.77118400	11.173626	-1.38886690	0.73500266	2.46415423
2022	3.02319161	18.53728020	11.580238	-1.22795428	0.66363135	3.06145006
2023	3.47523624	23.37254500	12.454101	-0.87858860	1.11379192	3.23291772
Economic Investment Bank						
2018	2.88620030	3.54966529	3.063087	5.03294281	0.02669123	0.14924345
2019	3.01714867	3.62183574	2.988196	2.44942642	0.07107630	0.18709873
2020	3.12655038	3.87207441	3.009243	3.20528942	0.04948208	0.24452203
2021	2.74553412	2.71637482	2.182058	136.47549920	0.00068514	0.17215253
2022	2.11687271	2.58287865	1.946231	4.63607878	0.02369989	0.09973439
2023	2.60109399	2.29300170	1.906859	0.92413411	0.10103450	0.08472950
Assyria Bank						
2018	2.30292564	8.46176118	6.275852	-1.77324216	0.14928309	0.27158970
2019	2.67644198	9.80585673	5.787766	-1.33263905	0.22212185	0.35712243
2020	2.32020706	10.63627342	7.852111	-0.44287817	0.57651093	0.59516607
2021	1.79909681	10.42940991	12.309851	-1.10596052	0.28242411	0.83565229
2022	1.61176038	7.71310677	12.712162	-1.91737342	0.33782396	1.20598329
2023	1.68132402	5.14480088	7.560605	-0.84129011	0.41876361	0.58338427
Bank of Baghdad						
2018	1.28698261	3.71386485	11.789957	-5.70356854	0.05780981	0.10650616
2019	1.13580284	1.43866895	4.516730	-3.90397479	0.03837239	0.07558221
2020	1.21632969	3.71374575	15.219761	-1.03921748	0.26942625	0.22928663
2021	1.22625876	3.65669160	14.557677	-0.69944409	0.35463716	0.53989153
2022	1.14518553	1.86616069	7.336905	-0.48704360	0.28371670	0.44823180
2023	1.15741470	2.94022741	14.118869	-0.18176790	0.96689177	0.98846280
Al-Mansour Bank						
2018	1.20595718	6.31533107	26.617940	-0.20773998	0.44959510	0.68088165
2019	1.21667689	6.38833018	26.996380	-0.82358030	0.18910110	0.31363443
2020	1.26235416	8.00146032	27.708330	-0.94003664	0.19560411	0.55942441
2021	1.61600023	7.93299232	11.834746	-0.88050480	0.22993030	0.34953564
2022	1.57233428	7.52692280	12.066919	0.81026849	0.33642565	0.38184667
2023	1.35899890	7.77169836	20.523247	-0.41769503	0.98808058	1.03174884

Middle East Bank						
2018	1.36266340	1.37319142	2.737897	9.05150010	-0.01178389	0.01414512
2019	1.59050117	1.33018280	1.945537	-82.77705650	0.00039154	0.01408315
2020	1.48444725	1.00449490	1.643708	-24.40256570	0.00462274	2.84445039
2021	1.47466071	1.12583193	1.795363	-196.55555560	-0.00016074	4.38657532
2022	1.34131449	1.49889194	2.995051	-44.61661470	8.18864E-05	0.00578484
2023	1.33493426	1.30477003	2.185604	1.13087940	-0.05623113	-0.05097846
Sumer Bank						
2018	2.89179227	9.32789546	4.904035	5.62567327	0.03149432	0.35261435
2019	4.57498540	7.86445120	2.361973	4.05239911	0.02927218	0.31978531
2020	4.41926459	7.57590471	2.023866	5.34104892	0.03074018	0.12161017
2021	5.48573813	7.27040168	2.984012	4.86989865	0.03214220	0.14232165
2022	4.70586957	6.95968302	1.642435	4.03580718	0.03308969	0.16082180
2023	6.08532099	4.23849091	0.661057	-2.24795045	-0.11498106	-0.05575430

Source: Author's own work.

Analysis of financial ratio contributions to bank continuity

The results demonstrate how financial ratios are combined with root values to calculate continuity according to the Kah and Tans model. For the Commercial Bank of Iraq in 2018, liquidity ratios show moderately high levels, which, when multiplied by the corresponding roots, generally produce positive contributions. Leverage ratios contribute both positively and negatively, reflecting mixed impacts of total liabilities relative to tangible assets. Interest expense relative to earnings exhibits a negative trend, which reduces the continuity potential, while profitability ratios contribute moderately positive values, indicating some strengthening effect on financial stability. Retained earnings also provide a positive impact, reinforcing continuity. Overall, the weighted multiplication highlights that some financial indicators have strong amplifying effects, whereas others reduce the overall continuity score, illustrating the interplay of different financial dimensions in determining the bank's sustainability (Table 5).

Table 5: Multiplication of financial ratios by roots for the Commercial Bank of Iraq (2018)

Weights	Root 1	Root 2	Root 3	Root 4	Root 5	Root 6
Equations	Current assets to current liabilities	Book value of shareholders' equity to total tangible assets	Total liabilities to total tangible assets	Interest expense to earnings before interest and taxes	Net profit to total tangible assets	Retained earnings to total tangible assets
Ratios 2018	3.2058	34.0931	19.2846	-0.7758	1.3020	2.2132
1	-1.7131	-0.7445	1.0923	0.7894	-1.2190	1.4748
2	2.4090	0.4731	0.9675	1.4973	1.5736	0.0608
3	-4.7666	-0.6464	-0.4594	1.8110	-3.0948	1.1088
4	2.4481	1.5166	-1.9108	-1.0374	3.4716	-1.7151
5	-1.8592	0.8320	0.5539	-0.3472	-3.8518	1.0478
6	2.3792	-1.6206	0.9388	0.9583	0.5343	-1.4635
7	-0.3777	-1.9838	4.7112	0.3435	-4.1620	0.2471
8	0.7749	0.0680	-3.0032	-0.9030	3.8518	2.9925
9	0.1082	-2.7006	0.8004	2.8183	-1.4552	-1.5489
10	-1.4331	-3.8039	1.5506	-1.5812	-1.5487	1.6800
11	-1.0690	1.1740	1.8209	3.2994	1.9189	-1.3918
12	-3.4508	1.6278	1.5102	-1.2572	-1.4740	-3.2479
13	1.5860	-1.8089	1.3851	3.2692	-0.9288	-1.7903
	New Root 1	New Root 2	New Root 3	New Root 4	New Root 5	New Root 6
Financial Ratio • Root	-5.4918	-25.3823	21.0646	-0.6124	-1.5872	3.2640
	7.7228	16.1295	18.6579	-1.1615	2.0489	0.1346
	-15.2807	-22.0378	-8.8594	-1.4049	-4.0295	2.4540
	7.8481	51.7056	-36.8490	0.8048	4.5201	-3.7959

Weights	Root 1	Root 2	Root 3	Root 4	Root 5	Root 6
Equations	Current assets to current liabilities	Book value of shareholders' equity to to-tal tangible assets	Total liabilities to total tangible assets	Interest expense to earnings before interest and taxes	Net profit to total tangible assets	Retained earnings to total tangible assets
	New Root 1	New Root 2	New Root 3	New Root 4	New Root 5	New Root 6
Financial Ratio • Root	7.6273	-55.2513	18.1044	-0.7434	0.6957	-3.2390
	-1.2108	-67.6339	90.8536	-0.2665	-5.4190	0.5469
	2.4842	2.3183	-57.9155	0.7005	5.0151	6.6230
	0.3469	-92.0719	15.4354	-2.1863	-1.8947	-3.4280
	-4.5942	-129.6870	29.9027	1.2266	-2.0165	3.7182
	-3.4270	40.0253	35.1153	-2.5595	2.4985	-3.0803
	-11.0625	55.4968	29.1236	0.9753	-1.9192	-7.1883
	5.0844	-61.6710	26.7111	-2.5361	-1.2093	-3.9623

Source: Author's own work.

Expected continuity of banks based on weighted financial indicators

The result presents the expected continuity for each bank, calculated using the weighted sum of financial ratios and the Kah-Tans Model. Positive sums of weights generally result in high expected continuity values, indicating strong financial stability, whereas negative sums correspond to very low contributions, suggesting potential risks. Some banks show dominant positive weights, producing expected continuity close to one, reflecting a very low risk of financial failure. Conversely, certain negative weights, even when present in combination with positive ones, have minimal impact due to the exponential transformation, maintaining the overall continuity trend near stability. The final total demonstrates that the compounded effect of all weighted ratios leads to an expected continuity at the maximum level, highlighting that, according to this model, the banks in the sample are projected to maintain strong financial continuity (Table 6).

Table 6: Expected continuity of banks based on weighted financial indicators

Weights	Sum of all weights* 7 1 + … + 6	Expect = 1/ (1 + (EXP(-Final total))) ** 8 Expect = 7	Outgoing weights*** 9	Expect • Outgoing weights 8 • 9 = 10
1	-8.74511	0.000159000	-0.2511	-3.99784E-05
2	43.53194	1.000000000	0.2906	0.2906000
3	-49.15830	4.4755E-22	-1.9166	-8.57775E-22
4	24.23371	1.000000000	2.4069	2.4069000
5	30.66020	1.000000000	-1.0360	-1.0360000
6	-32.80650	5.65369E-15	1.1450	6.47347E-15
7	16.87025	0.999999953	-4.0270	-4.0269998
8	-40.77440	1.95849E-18	4.5182	8.84887E-18
9	-83.79870	4.04298E-37	-0.7421	-3.0003E-37
10	-101.45000	8.7266E-45	-2.4982	-2.18008E-44
11	68.57226	1.000000000	1.3286	1.3286000
12	65.42568	1.000000000	-3.5450	-3.5450000
13	-37.58330	4.76198E-17	0.4856	2.31242E-17
Total				-4.5819398
Final total =EXP(-(Total))				97.7037351
Expect continuity opportunities= 1/(1+(EXP(-Final total)))				1.0000000

*To find the values in column 7, we go to Table 5 and take the numbers resulting from (Financial ratio x Root)= New Root. We then sum the cells horizontally: New Root 1 + New Root 2 + New Root 3 + New Root 4 + New Root 5 + New Root 6. We apply this sum to all 13 rows, **We apply this equation Expect = 1 /(1 + (EXP(-Final total))) to each cell in column 7 to get the result, *** The values (Outgoing weights) in column 9 were obtained from Table 3

Source: Author's own work.

Expected continuity of banks based on weighted financial indicators

The same methodology applied in the earlier stages of the analysis was extended to cover the remaining years for all banks included in the study sample. The results reveal distinct patterns in the expected continuity scores over the six-year period. Several banks, including the Commercial Bank of Iraq, Ashur Bank, Bank of Baghdad, and Mansour Bank, consistently maintained the highest possible continuity score across all years, indicating strong and stable performance based on the weighted financial indicators. In contrast, other banks exhibited fluctuations in their continuity levels. The Economic Investment Bank showed noticeable variability, with relatively lower scores in certain years, suggesting periods of reduced stability. The Middle East Bank also recorded intermittent declines, reflecting occasional performance weaknesses despite recovering to near-perfect levels in the final year. Meanwhile, Sumer Bank consistently scored at the lowest range across almost all years, indicating persistent challenges in achieving financial stability and raising concerns regarding its long-term sustainability. These trends highlight the divergence in resilience and operational stability among the banks, with some maintaining steady continuity while others demonstrate either periodic volatility or prolonged underperformance (Table 7). The results show that banks maintaining a ratio of one across the years demonstrate strong financial positions and high stability. In contrast, banks with ratios of around one-half or lower exhibit signs of instability in their financial performance.

Table 7: Continuity scores of selected Iraqi banks (2018-2023) according to the Kah-Tans Model

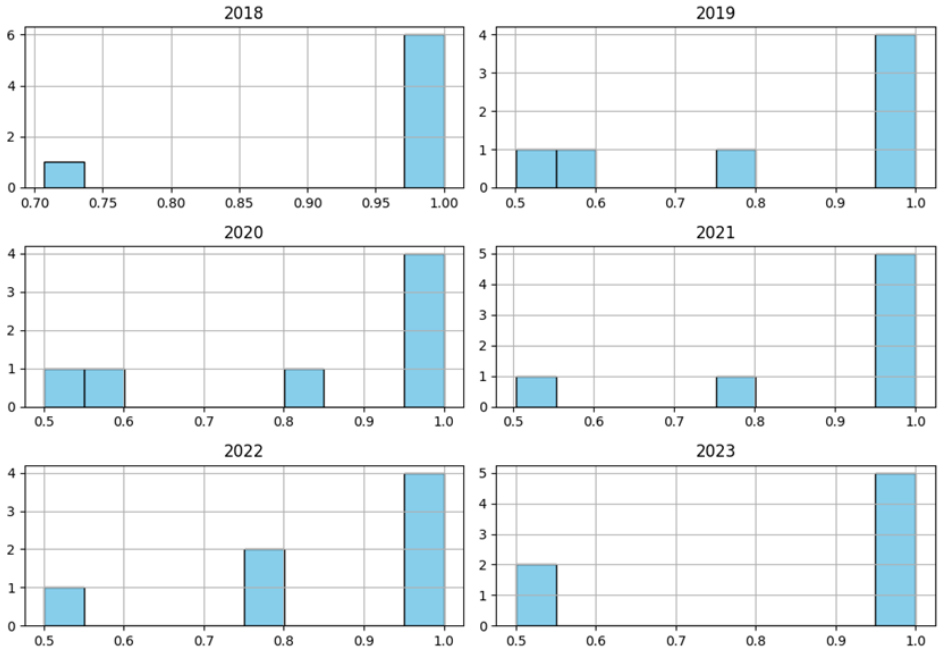
Bank	2018	2019	2020	2021	2022	2023
Commercial Bank of Iraq	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Economic Investment Bank	0.7073	0.5820	0.6005	1.0000	0.7878	0.5499
Ashur Bank	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Bank of Baghdad	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Mansour Bank	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Middle East Bank	1.0000	0.7625	0.8291	0.7625	0.7702	0.9999
Sumer Bank	1.0000	0.5010	0.5009	0.5030	0.5008	0.5000

Source: Author's own work.

Stability assessment of banks based on ratio analysis

The result displays histograms showing the distribution of numerical values for each year from 2018 to 2023. Across most years, the values are heavily concentrated near 1.0, indicating that many banks consistently achieve the highest possible stability or continuity scores. A smaller cluster of values appears around mid-range levels (0.5 - 0.8), representing banks with moderate stability. Very few data points fall below 0.5, showing that low stability scores are rare. The consistent peaks at 1.0 suggest that a significant portion of the banks maintained strong performance throughout the observed period (Figure 1).

Figure 1: Distribution of numerical columns (2018-2023)

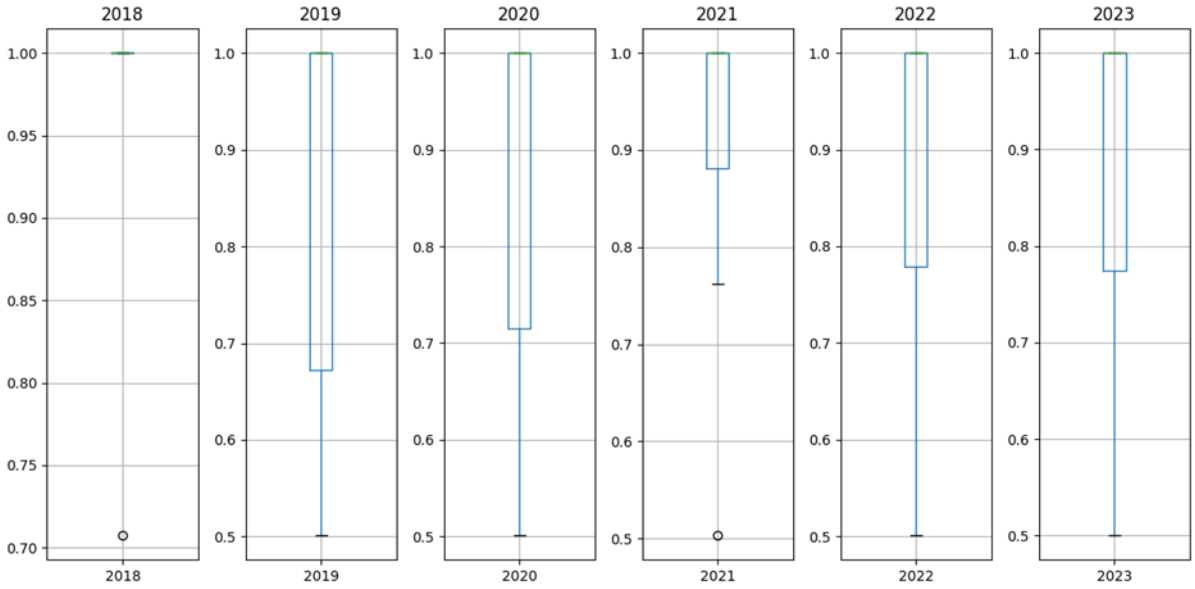


Source: Author's own work.

Distribution analysis of continuity ratios using box plots

A series of box plots illustrating the distribution of continuity ratios for each year from 2018 to 2023 is presented in Figure 2. Across most years, such as 2018, 2019, 2020, 2022, and 2023, the median line is positioned closer to the lower bound of the box, indicating that the data is skewed toward higher values, with most banks achieving ratios near the upper limit. In 2021, however, the median is positioned closer to the upper bound, suggesting a skew toward lower values for that year. The boxes for 2019 and 2020 are relatively long, reflecting a wider spread in the data and greater variability among banks. Outliers are visible in 2018 and 2021, represented by individual points, indicating that some banks significantly deviated from the general trend in those years.

Figure 2: Box plots of annual continuity ratios for banks (2018-2023)



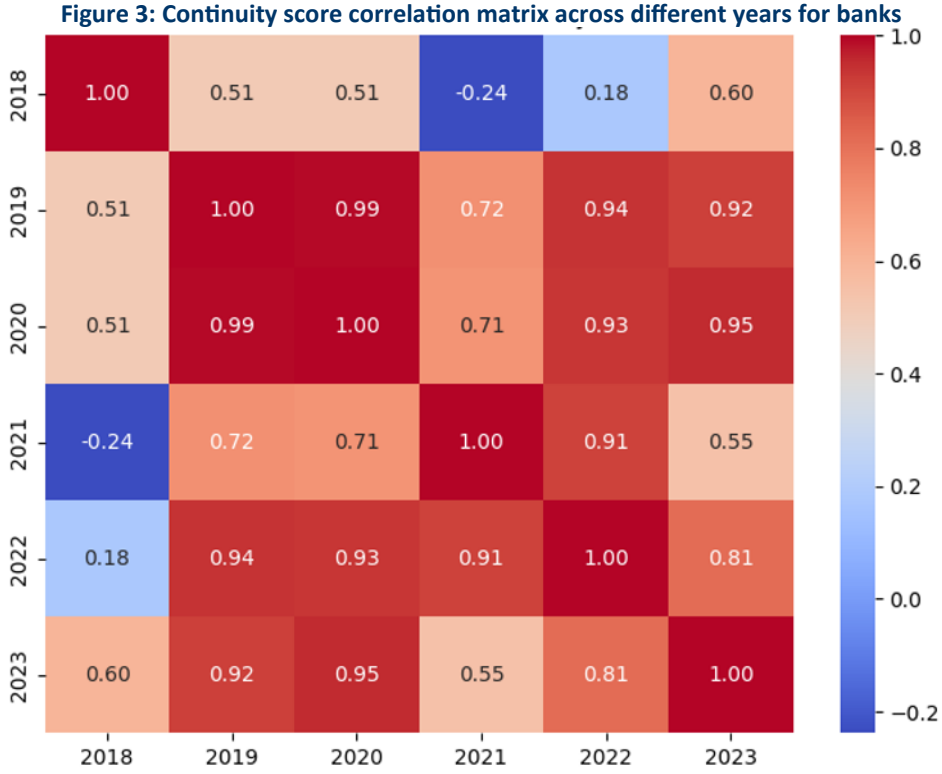
Source: Author's own work.

Continuity score correlation across years

The Continuity score correlation matrix in Figure 3 provides a tabular representation of the linear relationships between Continuity scores across different years for banks. The matrix contains years as rows and columns, with each cell representing the correlation coefficient between the Continuity scores for two different years. The values are Pearson correlation coefficients, ranging from -1 to +1. A value close to +1 indicates a strong positive linear relationship, meaning that as Continuity increases in one year, it tends to increase in the next year as well. A value close to -1 indicates a strong negative linear relationship, meaning that as Continuity increases in one year, it tends to decrease in the next year. Values close to 0 suggest a weak or no linear relationship between the continuity scores of the two years. On the diagonal of the matrix (where the row year equals the column year), the value is 1, reflecting perfect correlation with itself.

By examining the correlation matrix, we can determine which years have continuity scores that are closely related. For instance, a high positive correlation between tween 2018 and 2019 may indicate that factors influencing continuity in 2018 continued to affect 2019 in a similar manner. Conversely, a low correlation suggests that different factors may have influenced the scores or that there was greater variability in those years. The correlation matrix is visualized using a heatmap, where color intensity represents the magnitude of the correlation coefficients. Warm colors (e.g., red) indicate strong positive correlations, cool colors (e.g., blue) indicate strong negative correlations, and neutral colors (e.g., white or gray) indicate weak correlations. This visualization allows for quick identification of patterns in continuity across the years.

Figure 3: Continuity score correlation matrix across different years for banks



Source: Author's own work.

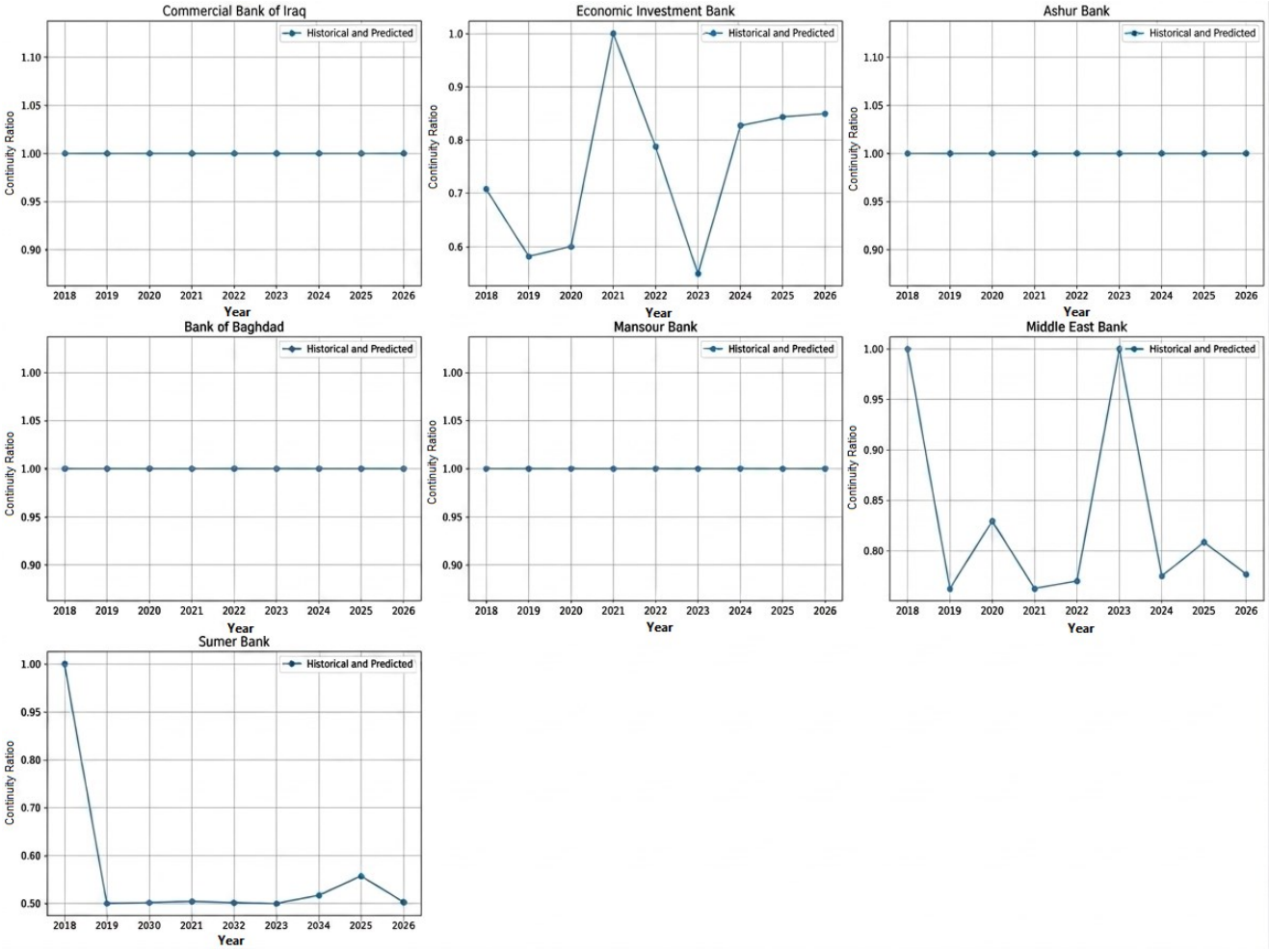
Prediction of bank continuity for the year 2026

Figure 4 presents a prediction of bank continuity for the year 2026, based on the continuity data obtained from previous years. Using historical continuity patterns, we can make informed projections about which banks are likely to maintain stability and which may face financial challenges. From the prediction, several banks have a continuity score of 1, indicating that they have consistently demonstrated stability in their operations and are unlikely to experience bankruptcy during the years 2025 and 2026. These banks exhibit strong financial management, effective strategic planning, and resilience to external shocks. Conversely, some banks show lower continuity scores, suggesting potential financial instability. In particular, the Middle East Bank and Sumer Bank are identified as being in poor condition and at risk of bankruptcy in the upcoming years. This prediction highlights the need for these banks to carefully examine the factors contributing to their financial vulnerability. By reviewing previous financial reports, analyzing internal and external challenges, and revisiting their strategic and operational approaches, these banks may be able to mitigate risks and improve their continuity in the future.

Discussion

The analysis of financial ratios for the selected Iraqi commercial banks over the period 2018–2023 provides valuable insights into their liquidity, leverage, profitability, and earnings retention trends. The outcomes of the Kah-Tans Model demonstrate its strong ability to distinguish between stable and vulnerable commercial banks in Iraq by capturing complex, nonlinear relationships among key financial ratios. The variation in root weights across the equations indicates the differing levels of influence that each financial ratio exerts on the overall continuity prediction. Some equations showed a stronger impact on the output, reflecting the critical importance of certain financial indicators, while others maintained a stabilizing role that balanced variations within the dataset (Dewi et al., 2023). The distribution of assigned root weights highlights the model's adaptive nature. Positive roots enhanced the likelihood of continuity, suggesting that favorable financial attributes such as profitability, efficiency, or capital adequacy contribute to a higher probability of operational stability (Coccorese & Girardone, 2021; Ekadjaja et al., 2021). In contrast, negative roots reduced the probability of continuity, indicating that adverse financial conditions, such as weak liquidity or excessive debt, increase the risk of vulnerability (Oluwadamilola, 2025). This interplay of positive and negative influences reflects the realistic financial environment in which both growth and risk factors coexist. The Kah-Tans Model, by integrating multiple ratios through its weighted structure, captures these interactions with greater precision than conventional linear models (Çetin et al., 2023). It provides a nuanced interpretation of how individual and collective financial indicators shape institutional sustainability.

Figure 4: Predicted continuity of banks for the year 2026, highlighting stable banks and those at potential risk of bankruptcy



Source: Author's own work.

Banks such as the Commercial Bank of Iraq and Al-Mansour Bank exhibit relatively stable liquidity ratios with modest fluctuations, suggesting that these institutions have maintained consistent short-term financial health. This stability indicates effective management of current assets and liabilities, allowing these banks to meet their short-term obligations reliably. The steadiness in liquidity also reflects disciplined operational practices and adequate capitalization, which together contribute to continuity in banking operations (Al-Aaraji, 2024; Yassen & Alrefaee, 2022). In contrast, the Economic Investment Bank shows a declining trend in liquidity over the years, accompanied by substantial variations in interest expense relative to earnings. This pattern suggests that the bank faces increasing pressure on profitability, potentially due to rising borrowing costs, inefficient asset management, or fluctuations in revenue streams. The volatility in interest expenses relative to earnings indicates periods of financial strain where the bank's ability to cover its obligations from operational profits may be challenged, signaling vulnerabilities that could affect long-term stability (Arnone et al., 2024; Eltweri et al., 2024; Ghosh, 2016).

Assyria Bank and the Bank of Baghdad reveal pronounced year-to-year fluctuations in leverage and profitability measures, pointing to shifts in their financial structures and operational performance. These changes may be driven by adjustments in debt financing strategies, fluctuations in asset quality, or variations in investment returns. The observed volatility implies that these banks may be more sensitive to internal managerial decisions or external economic factors, such as changes in market conditions or regulatory requirements, which can significantly influence both profitability and risk exposure (Aledeimat & Bein, 2025; Apau et al., 2023; Cobbinah et al., 2024). The financial ratios of Middle East Bank show particularly high volatility in interest expense measures, indicating periods of extreme financial stress or accounting adjustments. Such fluctuations may reflect irregular cash flow management, unexpected operational costs, or corrective measures following financial misreporting. These varia-

tions highlight the bank's vulnerability to sudden financial pressures and the importance of robust risk management practices (Essers, 2013; Haq et al., 2024).

Sumer Bank, on the other hand, demonstrates a trend of relatively high liquidity that increases over the observed years, suggesting that the bank has been able to strengthen its short-term financial position. However, its profitability and retained earnings ratios display fluctuations, with certain years showing negative outcomes. This pattern indicates potential operational challenges, such as inefficient cost management, suboptimal investment strategies, or temporary declines in revenue generation. Despite maintaining strong liquidity, the inconsistencies in profitability suggest that Sumer Bank may face difficulties in sustaining long-term financial performance without addressing operational inefficiencies (Altavilla et al., 2025; Osma et al., 2022).

The results demonstrate the application of the Kah -Tans Model in calculating bank continuity by combining financial ratios with root values. For the Commercial Bank of Iraq in 2018, the liquidity ratios, when multiplied by their corresponding roots, generally produce positive contributions to continuity, suggesting a relatively stable short-term financial position. These results indicate that the bank's current assets were sufficient to meet its short-term obligations, which reinforces the overall financial stability and contributes positively to its continuity score (Al Zaidanin & Al Zaidanin, 2021; Bilal et al., 2024; Yassen & Alrefaee, 2022). Leverage ratios, however, display mixed impacts on continuity, reflecting both positive and negative contributions depending on the specific root applied. This variability highlights how total liabilities relative to tangible assets can simultaneously enhance or constrain continuity, depending on the interplay with other financial dimensions. Banks with high leverage may benefit from additional capital for growth, but excessive debt relative to tangible assets can increase risk exposure, reducing stability if earnings are insufficient to cover obligations (Dalci, 2018; Vo, 2017).

Interest expense relative to earnings shows a negative trend, lowering the continuity potential. High interest expenses reduce the net returns available for reinvestment or retained earnings, which can constrain the bank's ability to maintain operations during periods of financial stress. In contrast, profitability ratios contribute moderately positive effects, indicating that net profits were sufficient in some periods to support continuity, although not consistently strong enough to fully offset the negative effects of interest expenses (Alshehadeh et al., 2024; Arhinful & Radmehr, 2023). Retained earnings also provide a positive influence on continuity, reflecting the bank's ability to retain and reinvest profits rather than distribute them entirely as dividends. This practice strengthens the financial base, providing additional resources to absorb shocks and support ongoing operations. The weighted multiplication of financial ratios by roots emphasizes that some indicators, such as retained earnings and liquidity, have amplifying effects on continuity, whereas others, such as high interest expense or fluctuating leverage, may reduce the overall continuity score (Dahmash et al., 2023).

The results of the expected continuity analysis, calculated using the weighted sum of financial ratios and the Kah and Tans model, indicate that most banks in the sample are projected to maintain strong financial continuity. Positive sums of weights generally produce high expected continuity values, reflecting a combination of favorable financial ratios such as strong liquidity, retained earnings, and profitability. These positive contributions suggest that the banks have robust internal financial structures that support ongoing operations and reduce the risk of financial failure (Kweh et al., 2024). Even when certain negative weights are present, their impact on overall continuity appears minimal due to the exponential transformation applied in the Kah and Tans model. This transformation effectively dampens the influence of negative indicators while preserving the overall trend of stability. As a result, banks with mixed positive and negative weighted contributions still achieve expected continuity values close to one, indicating that the cumulative effect of all financial ratios outweighs isolated vulnerabilities (Hordofa, 2024; López-Penabad et al., 2022).

The final total demonstrates that the compounded influence of all weighted ratios leads to a maximum expected continuity, highlighting the strong resilience of the sampled banks. This outcome suggests that, despite fluctuations in specific financial indicators, the banks possess sufficient compensatory strengths - such as adequate liquidity buffers, profitable operations, and retained earnings - to sustain operations under normal market conditions (Eltweri et al., 2024). The reasons behind these high continuity projections can be attributed to prudent financial management practices within these banks. Effective asset-liability management, careful control of interest expenses, and consistent reinvestment of earnings likely contribute to positive weighted indicators. Additionally, the Kah and Tans model accounts for both positive and negative contributions in a manner that emphasizes the overall stability, allowing banks with minor weaknesses in certain areas to still demonstrate strong expected continuity (Arhinful et al., 2025a).

The results of the continuity score analysis from 2018 to 2023 indicate a clear division in the financial resilience of the banks examined. A group of banks - including the Commercial Bank of Iraq, Ashur Bank, Bank of Baghdad, and Mansour Bank - maintained a perfect score of 1.0 throughout the entire period.

This consistent performance reflects strong financial fundamentals, effective risk management, and the ability to sustain operations despite potential economic or sectoral challenges. The stability of these banks suggests that they have well-established operational strategies, robust governance structures, and diversified portfolios that minimize exposure to sudden market shocks. Such institutions are well-positioned to navigate uncertainties and maintain investor and customer confidence over the long term (Bastan et al., 2024; Issa & Abbaszadeh, 2023). In contrast, other banks displayed fluctuations or persistently low scores, indicating varying degrees of instability. The Economic Investment Bank, for instance, recorded notable dips in several years, with scores dropping as low as 0.5499 in 2023. Such variability suggests operational weaknesses during certain periods, possibly linked to shifts in market conditions, underperformance in specific investment portfolios, or inefficiencies in internal management processes. While the bank demonstrated the capacity to recover - reaching a perfect score in 2021 - the recurring drops point to structural vulnerabilities that, if unaddressed, could hinder sustained growth (Handoyo et al., 2023; Orlando & Bace, 2021; Tang et al., 2022).

The Middle East Bank exhibited a similar pattern of intermittent declines, although its near-perfect score in 2023 indicates some level of recovery. Its inconsistent performance may stem from external market pressures, ineffective implementation of strategic plans, or overreliance on unstable revenue streams. This irregularity, while less severe than that of the Economic Investment Bank, still raises concerns about the bank's ability to maintain long-term operational continuity without targeted corrective measures (Arslan & Alqatan, 2020; Ngo & Trinh, 2025). Sumer Bank's case is more concerning, as it consistently scored at the lowest possible range after 2018, remaining around the 0.50 mark across most years. Such persistent underperformance suggests deep-rooted challenges, potentially including chronic liquidity constraints, high exposure to non-performing loans, inadequate capitalization, and deficiencies in governance and regulatory compliance. Unlike other banks that exhibited temporary declines, Sumer Bank's prolonged stagnation points to systemic problems that threaten its sustainability unless comprehensive restructuring is undertaken (Galletta & Mazzù, 2019; Vihriälä, 2023).

The histogram patterns from 2018 to 2023 reveal that a substantial proportion of Iraqi banks maintained exceptional financial stability, as indicated by the recurring peak of continuity scores at 1.0 across all years. This consistency reflects the dominance of a few well-managed institutions capable of sustaining operational resilience despite economic uncertainties and sectoral challenges. The smaller cluster of scores between 0.5 and 0.8 points to a subset of banks with moderate stability, likely reflecting periodic fluctuations in profitability, liquidity, or capital adequacy due to market volatility or internal management inefficiencies (Adamyk et al., 2025; Challoumis, 2025). The scarcity of scores below 0.5 suggests that extreme instability was uncommon, possibly due to regulatory interventions, mergers, or restructuring efforts that prevented banks from falling into severe distress. The persistence of high scores for many banks may also be attributed to Iraq's banking sector structure, where a limited number of large, financially robust institutions dominate market share, while weaker banks either stabilize through corrective measures or maintain moderate positions without collapsing (Ghenimi et al., 2017; Hansen, 2022).

The box plot analysis from 2018 to 2023 shows that, in most years, the distribution of continuity ratios is skewed toward higher values, with medians positioned closer to the lower bound of the box and most banks performing near the upper limit. This pattern suggests that the majority of Iraqi banks maintained strong and stable operations during these periods. The exception in 2021, where the median is closer to the upper bound, indicates a shift toward lower continuity ratios, possibly reflecting the lingering economic impacts of the COVID-19 pandemic, market instability, or reduced banking activity that year (Feyen et al., 2021; Korzeb & Niedziółka, 2020). The wider spread in 2019 and 2020 signifies greater variability in performance, which may be linked to differing capacities of banks to adapt to regulatory changes, technological transitions, or economic fluctuations. Outliers in 2018 and 2021 point to individual banks that experienced unusual circumstances - either exceptionally strong resilience or notable operational weaknesses - possibly due to unique strategic decisions, risk exposure levels, or sudden financial shocks (Ionașcu et al., 2023).

The correlation analysis of continuity scores across years reveals distinct patterns in the stability of banks' performance over time. Strong positive correlations between consecutive years, such as between 2018 and 2019, suggest that similar operational, economic, or regulatory conditions persisted, enabling banks to maintain consistent continuity performance (Ahamed et al., 2021; Rojas Rincón et al., 2024; Swamy, 2014). In contrast, weaker correlations or changes in sign indicate shifts in influencing factors, such as alterations in regulatory frameworks, macroeconomic shocks, or strategic changes within banks that disrupted previous performance trends. The high correlations across certain year pairs likely reflect the sustained impact of stable governance, effective risk management practices, and favorable market conditions, while lower correlations - particularly in years affected by external disruptions like the COVID-19 pandemic - may be attributed to sudden operational challenges, policy adjust-

ments, or market volatility that altered continuity performance trajectories (Arnone et al., 2024; Athanasoglou et al., 2008; Liang et al., 2024).

The prediction of bank continuity for 2026 indicates a clear divide between financially stable institutions and those facing potential instability. Banks with a continuity score of 1 are expected to maintain their stability, reflecting strong governance, prudent risk management, diversified revenue streams, and the ability to adapt to market fluctuations. These institutions have likely benefited from consistent profitability, adequate capital buffers, and effective regulatory compliance over the years, enabling them to withstand economic uncertainties (Ngo & Trinh, 2025; Paltrinieri et al., 2021). In contrast, the lower scores for Middle East Bank and Sumer Bank suggest underlying weaknesses, such as poor asset quality, inadequate liquidity reserves, high exposure to non-performing loans, or ineffective strategic responses to market changes. These vulnerabilities may also stem from external pressures, such as adverse macroeconomic conditions, regulatory challenges, or increased competition (Athari et al., 2023; Hasan & Khan, 2023; Pancotto et al., 2024).

Conclusions

By applying the Kahn-Tans Model, we find that the majority of Iraqi banks listed on the Iraq Stock Exchange demonstrate continuity, as reflected in the sampled data. The Kahn and Tans model has proven effective in measuring bank continuity, producing positive results for most banks in practical application. However, banks should not rely solely on financial indicators to assess continuity; non-financial factors - such as internal management decisions and external changes in the banking environment - also play a critical role. Discontinuity does not occur suddenly but emerges gradually, often influenced by managerial errors or market inefficiencies that can reduce a bank's continuity. An efficient and effective internal audit function is vital in safeguarding shareholders' rights, preserving financial resources, providing accurate information, and enhancing continuity. Proper audit procedures help uncover financial weaknesses, offer solutions, and strengthen banking operations. Following international auditing standards is particularly important, as these standards provide both confirmatory and advisory guidance that contributes to the stability and development of banking activity. Iraqi banks must also employ financial models to predict potential risks and investigate causes of discontinuity. Mathematical models using financial statement indicators are effective tools for forecasting financial failure and assessing continuity, but they must be complemented by consideration of internal and external environmental changes. Transparency in financial reporting further improves the accuracy of such predictions, enabling banks to make informed strategic decisions that promote long-term stability.

Future research could expand the current framework by incorporating non-financial and macroeconomic variables - such as governance quality, audit effectiveness, and regulatory reforms - into continuity prediction models. Comparative analyses between Iraqi banks and those in other emerging markets could help determine whether contextual differences affect model performance. Moreover, future studies might apply more advanced artificial intelligence techniques, such as deep learning or hybrid models integrating financial and textual data from annual reports, to enhance predictive accuracy and interpretability. Longitudinal research could also investigate how structural and policy changes in Iraq's banking sector influence continuity dynamics over time.

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