

The Impact of Utilizing the Bank of Algeria's Big Data on Forecasting Algerian Banking Stability via the Z-score Model (2009–2023)

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Abstract:

The aim of this study was to determine the degree of stability of the Algerian banking system during the period 2009–2023. To achieve this, the z-score method was used, based on big data compiled on the Bank of Algeria's website, which serves as a source of open data.

The results of applying the Z-score indicator have shown that the Algerian banking sector's profits would need to fall by a factor of 70.45 times the standard deviation before equity is completely eroded, which would mean an inability to meet financial obligations. This suggests that the Algerian banking system enjoys an acceptable degree of stability, as it remains far from the risk levels associated with default or bankruptcy.

Keywords: big data, banking stability, z-score method.

JEL Classification Codes: G21; G28; E58

Introduction

Big data has become a key factor in the digital environment, given its significant role in planning and forecasting the future. Consequently, with the proliferation of such data – particularly via social media – governments have begun to focus on collecting it on their official websites in the form of open government data, in order to formulate and develop macroeconomic policies. This data constitutes a wealth of information that is processed using modern methods for storage, analysis and distribution, thereby aiding various decision-making processes.

In this context, the Bank of Algeria is working to compile this data to assist banks in formulating their lending policies, using data provided by various specialised supervisory centres in this field – most notably the Risk Centre – with a view to ensuring the soundness and stability of the banking system as a whole and averting systemic risk.

By utilising the data available on the Bank of Algeria's website and applying the z-score method, it is possible to assess the degree of banking stability of Algerian public banks and their capacity to finance the economy within a banking environment undergoing rapid changes, in order to identify areas of strength to be reinforced and highlight shortcomings and weaknesses so that appropriate solutions can be found to overcome them, as this method assesses the extent to which Algerian banks are able to mitigate banking risks, thereby determining whether the banks enjoy acceptable levels of banking stability. Consequently, based on the foregoing, we may pose the following key question: **Can the data compiled in the Bank of Algeria's reports be utilised as a source of big data to determine the degree of banking stability of the Algerian banking system using the Z-Score method over the period 2009–2023?**

- **Sub-questions:** The main question gives rise to the following sub-questions:

- What is meant by big data and open government data, and what is their significance?;
- What is meant by banking stability?;
- What is the theoretical basis for the **Z-Score** method **in assessing the degree of banking stability?**;

Hypotheses: The Algerian banking system enjoys an acceptable level of banking stability as measured by the **Z-Score** method, based on data from the Bank of Algeria.

Significance of the study: This study is significant because it utilises the extensive data provided by the Bank of Algeria to accurately assess banking stability using the Z-score method. This assessment helps to identify the strengths and weaknesses of the Algerian banking system during the period 2009–2023, thereby supporting sound financial decision-making that enhances the stability of the banking sector and contributes to sustainable economic development.

- **Research objective:** The aim of this research is to examine the content of big data and its role in determining the degree of banking stability using the Z-score.

- **Scope of the study:** The time frame of this study is limited to the period from 2009 to 2023, whilst the geographical scope covers the Algerian banking system.

- **Methodology:** Given the nature of the research topic and in order to answer the main research question and test the validity of the hypotheses, we will adopt a deductive approach to describe and analyse the various dimensions of the study.

1. The conceptual framework of big data and open government data.

With the rapid development of modern technologies, data has become a crucial resource, particularly given its increasing volume and complexity. This has heightened the need to adopt advanced methodologies for data collection and analysis, with the aim of simplifying access to data and utilising it effectively, particularly in the field of decision-making. Given this importance, governments have begun to move towards making this data available as open data. In this context, we will address aspects relating to big data as follows:

1-1 Definition of big data

It is difficult to encapsulate the concept of big data within a single, precise definition, given its complex and multidimensional nature; it is a flexible term whose interpretation varies depending on the party dealing with it, whether a user, a service provider or otherwise. Accordingly, a number of definitions can be considered, such as the following:

The International Organisation for Standardisation (ISO) defines it as a set or sets of data characterised by attributes such as volume, velocity, variety, data integrity and others, which cannot be processed efficiently using current and traditional technology to derive value from them (Rashwan and Mohamed, 2018, p. 27) .

As defined by the United Nations Economic and Social Council, it is data characterised by its sheer volume, high velocity and great variety, such that it requires cost-effective and flexible approaches to understand it more deeply and utilise it more effectively in decision-making processes . . It is also defined as a vast amount of complex data characterised by high levels of distribution, massive data sources, extremely high velocity and great variety, the volume of which exceeds the capacity of traditional software and computers to store, process and distribute it; it is often available in real time and takes various forms if understood more deeply and utilised more effectively in the decision-making process (Al-Ghubairi and Hassan Hassan, 2019, p. 35)

In accordance with the above definitions, big data can be defined as a large and complex set of data that is difficult to process using traditional techniques and tools, enabling its users to improve their understanding and make appropriate decisions.

1.2. Characteristics of big data: Big data is characterised by the following features (Sakri, Nashad, and Adlan, 2019, pp. 45–46) (Safahlo and Miliani, 2019, p. 66) :

- Volume refers to the quantity of data generated, which may reach vast proportions, and its volume determines its value...
- Diversity: this ranges from organised or structured data, which represents the smallest proportion, to unstructured or unorganised data, which represents the largest proportion, or a mixture of the two, known as semi-structured or semi-organised data.
- Speed: the frequency with which data is generated, as well as the processing of the data set within a reasonable period of time.
- Variability, which refers to the inconsistency of data at times and prevents it from being processed and managed effectively.

- Accuracy: This relates to the quality of the data obtained and requires a thorough analysis of its usefulness, whilst verifying its source and validity.

1.3 Types of big data: Big data can be classified into three main types (Mahmoud Abdel-Aal, Emad Mohamed, and Magdy Meligi, 2024, p. 250) :

- Structured or organised data is data organised in the form of tables or databases; organised data takes the form of fixed, formatted fields within a record or file and is found in relational databases.
- Unstructured or unorganised data is a variety of electronic data that cannot be easily categorised, such as images, charts, videos, photographs, blogs and emails.
- Semi-structured or semi-organised data is similar to structured big data, but is not organised into tables or databases

1.4. The importance of big data: The importance of big data lies in (Nourhan, 2021, p. 488):

- Contributing to a comprehensive overview of the company and the development of a strategy and roadmap for private business organisations in terms of customer engagement, automated operations and predictive analytics for decision-making.
- To support the preparation of more effective integrated business reports by utilising both financial and non-financial information to disclose the company's performance.
- Improving and increasing opportunities for clear and sound decision-making based on information derived from advanced big data analytics. Big data therefore eliminates the biases resulting from decisions based on limited information.
- Identifying potential weaknesses across all the company's operations and functions, as well as untapped opportunities, based on the results of data analysis.
- Big data analytics can add significant value to the company; it is therefore crucial to identify the processes that will provide comprehensive, accurate and actionable insights.
- Analysing big data can help companies gain a more comprehensive and detailed understanding of the characteristics and needs of the various individuals and groups they deal with, by incorporating multiple and diverse data sets into the analysis process, Consequently, the services and offers provided to these groups and individuals can be more personalised and tailored, and communication and interaction with them can be more effective.
- Detecting material misstatements in financial statements, particularly within the financial services sector.
- To enable company officials to find solutions to potential problems identified through data analysis in certain company processes or transactions across various areas of business.
- The results of big data analysis can give the company a competitive advantage by increasing productivity, improving operational efficiency, reducing costs and, consequently, boosting profits.
- Enabling the company to provide better services to users of financial reports in terms of the financial and non-financial data disclosed.

- When companies switch all their transactions to electronic formats, they can gather more accurate and detailed information on performance.
- Identifying bottlenecks and improving processes across all functions within the company.
- Enhancing the company's ability to make predictions about future information that supports decision-making by its stakeholders.

1.5. Definition of open government data:

The term 'open government data' comprises two elements: firstly, government data, which is any data produced or collected by government bodies; and secondly, open data, which is data that can be freely used, reused and redistributed by anyone (Vasarhelyi & Alzamil, 2019, p. 178) . When these two elements are combined, the term can be defined as data produced by the government that can be freely accessed, used or modified; consequently, this supports greater transparency and public participation (Rahmat, Nurmandi, & Kusuma Dew, 2019, p. 136) .

In other words, it refers to any content published by government bodies on information networks; the data may be simple text, a statistical file, an image or an audio file.

For government data to be characterised as open, several conditions must be met. These conditions are a set of principles formulated in 2007, namely: (Rodrigo, Deisy, & Barbiero, 2018, p. 7) (Al-Saadani, 2015, pp. 49–50–51)

- **Completeness:** making all working data available to the public so that the available datasets are as complete as possible, reflecting a comprehensive picture of what has been recorded on a particular subject; public data is data that is not subject to privacy, security, confidentiality or discriminatory restrictions;
- **Primary data:** Data is collected directly from the source in as much detail as possible, rather than in aggregated or modified forms;
- **Timeliness:** making data available as soon as it is produced, thereby preserving its utility;
- **Accessibility of data:** Data must be made available to a wide range of users for various purposes;
- **Machine-readable:** Data must be formatted in such a way that users can process it electronically;
- **Non-discriminatory:** It must be made available to anyone without the need to register or obtain a specific authorisation;
- **Non-proprietary:** data must be made available in a way that does not grant any party absolute control over or disposal of it;
- **Open licence:** The data is not subject to copyright, patents or trade marks, although certain restrictions may be imposed for the purposes of privacy and information security;
- **Support for scientific research:** Access to open government data enables researchers and research institutions to conduct rigorous research by utilising the available data;
- **Encouraging innovation:** The flow of data and information provides citizens with extensive opportunities for innovation and creativity through the development of complex applications to integrate and synthesise information from various sources, which may provide useful tools for market analysis, forecasting prevailing trends, and so on;

-Supporting new ventures: The benefits of open government data are not limited to existing projects; they also benefit potential ventures and business sectors planning to establish their operations. New businesses will be able to make good use of the data; for example, they can use the data to study the demographic characteristics of a specific area, and on that basis, the organisation can decide on the most suitable location for its business;

- Enhancing citizen participation: this data creates a basis for citizens to participate in governance, making them more informed and effective;

- Promoting good governance and reducing corruption: as the core of open government data initiatives consists of data on government expenditure and performance, the publication of such data may enable civil society to expose government misconduct and help curb corruption;

- Improving the effectiveness of public service delivery: The accurate presentation of data on service providers may help citizens make informed decisions about the best services available, whilst also helping service providers to improve their performance; For example, the United States of America has made available applications developed on the basis of the Open Government Data Initiative, which provide data on car products and safety, airline performance and mortgage plans, thereby helping consumers make the right choices and assisting service providers in improving their performance.

1.5. The role of the Bank of Algeria as a provider of big data services:

Big data is of paramount importance to many parties, foremost among them government bodies and macroeconomic policymakers, as it now provides information that constitutes a valuable asset and generates economic returns, contributing to the formulation of plans and policies aimed at achieving the economic and social development of any country. It can therefore be said that big data is a sophisticated industry, like other information-related industries, and that it contributes to enhancing the efficiency of numerous industries and sectors, perhaps most notably the banking system (the banking sector), through the benefits of big data analysis at the level of the banking system as a whole or at the level of individual banking units, as represented by ((Prasad & Balachandran, 2017, p. 1118) :

-Identifying bottlenecks and weaknesses and improving processes across all financial and administrative units

-Making better decisions based on insights derived from big data analysis across all financial and administrative units;

-Identifying untapped opportunities and potential weaknesses across all business operations; Enabling stakeholders to find solutions to potential problems in certain processes revealed by big data analysis;

-Increasing the likelihood of making clear and sound decisions;

Given that commercial banks act as financial intermediaries, despite the technological and IT advancements in the banking sector, they are compelled to collect data from daily interactions with digital products or services – including mobile phones, credit cards and social media platforms – in order to attract more deposits and grant loans; The latter require a significant

amount of information, such as that found at , in order to grant loans to groups with acceptable creditworthiness and thereby avoid the problem of non-performing loans; in other words, this helps them to establish an acceptable lending policy.

As part of this trend, the Bank of Algeria, as a provider of big data services and a supplier of government data, provides information and data on credit activity in Algeria to commercial banks. The Bank of Algeria operates within the framework of a series of preventive measures, gathering the necessary information aimed at helping the banking system to minimise credit risk, and thereby achieve a reasonable degree of banking stability. These preventive centres comprise the Risk Centre, the Payment Defaults Centre, the Budget Centre and the Financial Stability Committee.

- Risk Centre: This department was established under Article 106 of Law No. 90-10 on Currency and Credit and was named the Risk Centre; and is currently regulated and governed by Regulation No. 12-01 of 20 February 2012, which sets out the organisation and functioning of the Risk Centralisation Unit for institutions and households, referred to therein as the Risk Centralisation Unit. In accordance with this regulation, the Risk Centralisation Unit is divided into two (02) sections (Bank of Algeria, 2012, page 45) :

- Corporate Risk Centre: where data relating to loans granted to legal and natural persons who carry out professional activities on a voluntary basis;

- Household Risk Centre: this collects data relating to loans granted to individuals.

A risk centre is a department responsible for centralising risk management, tasked with collecting, from each bank and financial institution in particular (referred to as ‘authorised institutions’), information on the identity of loan beneficiaries, the nature and limits of the loans granted, the amount of funds utilised, the amount of outstanding loans, and the collateral taken for each category of loan. In this regard, authorised institutions are required to report to the Risk Centralisation Unit, according to the nature of the data, in the section dedicated to institutions and in the section dedicated to households, as follows: :

- Data relating to the identification of loan beneficiaries and the maximum loan amounts granted to customers, regardless of the sum, covering transactions carried out at their branches as well as the collateral taken, whether in kind or personal, for each category of loan; this information is referred to as ‘positive data’;

- Outstanding amounts from loan portfolios; this information is referred to as ‘negative data’.

The Central Risk Office in Algeria is one of the models that fall within the category of centralised bodies owned and managed by central banks (government bodies). These systems are characterised by the obligation on banking institutions to provide credit data and information, thereby ensuring greater cooperation from these institutions, alongside the supervisory authority’s credibility and transparency in handling such data and information, which leads to greater assurance regarding the integrity and proper use of this data; However, their most notable drawback lies in the nature of the information collected itself; it is predominantly negative information concerning defaults, bankruptcies and liquidations, and does not include positive information that contributes to building creditworthiness – a shortcoming addressed by Regulation No. 12-01 (Mohammed, 2012, pp. 17–18) .

-Payment Clearing Centre: To mitigate the risks associated with banking operations, the Bank of Algeria for Reserves and Protection established the Payment Disputes Centre pursuant to Regulation No. 92-02 dated 22 March. For each means of payment and/or loan, this Centre is responsible for the following: :

- Organising a central register of payment obstacles and any resulting follow-up actions, and subsequently managing and maintaining this register;
- Periodically notifying financial intermediaries and any other designated authority of the list of payment obstacles and the resulting follow-up actions.

This centralised system was reinforced by the issuance of Regulation No. 08-01 of 20 January 2008 concerning measures to prevent and combat the issuing of cheques without sufficient funds, This measure is based on a system for centralising information relating to cheque payment failures due to insufficient funds and disseminating it to banks, the Public Treasury and the financial departments of the Algerian Post Office for consultation and use, particularly when issuing a customer's first cheque book; As soon as a payment failure occurs due to insufficient funds, the drawee is required, in accordance with the provisions of the Commercial Code, to notify the Central Payment Faults Centre within four (04) working days following the date of presentation of the cheque, They must also prepare and deliver, or arrange for the delivery of, a certificate of non-payment to the payee. The drawee is also required to send to the issuer of the cheque, within the prescribed time limit, a payment instruction stating that the payment default has been reported to the Central Payment Defaults Centre, Should the matter not be settled within ten (10) days, the drawer will be prohibited from issuing cheques for a period of five (05) years at all authorised institutions, with effect from the date of the payment instruction, and criminal proceedings will be initiated in the absence of settlement (Algeria, 2008, pp. 21–22) ,

- Budget Centralisation: This centralised system was established at the Bank of Algeria pursuant to Decree No. 96-07 of 3 July 1996, which sets out the organisation and operation of the Budget Centralisation system, In this regard, banks, financial institutions and leasing companies are required to provide the Budget Centralisation Authority with accounting and financial information relating to the last three years for their clients, namely borrowing economic entities, in accordance with a standardised format drawn up by the Bank of Algeria, Under this system, the financial and accounting information comprises the balance sheet, the profit and loss account and the notes to the accounts (Bank of Algeria, 27 October 1996, p. 23)

- Financial Stability Committee: Established in 2009 as a committee under the Bank of Algeria, it enables the early detection of vulnerabilities through continuous monitoring of the performance of Algerian banks and financial institutions, by reviewing a set of financial soundness indicators numbering eleven (11) indicators known as 'minimum indicators', whilst targeting other indicators referred to as 'proposed indicators'. In 2010, great importance was attached to the periodic assessment of the stability of the banking and financial system through the soundness tests introduced in 2007, alongside increased focus on the structural liquidity surplus that characterises the Algerian banking system. The Committee found that the risk of

default remains the principal banking risk within the Algerian banking system, which the Bank of Algeria is striving to reduce through centralised risk management.

Consequently, it is noted that the Bank of Algeria has become a provider of big data services via its website, which offers open government data. The Bank of Algeria is working to aggregate data from various sources at different supervisory centres (by creating metadata describing borrowing institutions) and presenting it through big data analysis, whilst providing the necessary infrastructure by searching data sources, collecting data via direct requests, and storing and integrating it, so that Algerian banks can utilise it to determine the degree of banking stability.

2. Key Concepts of Banking Stability

Banking stability is a modern term that has gained prominence recently. Against the backdrop of contemporary changes in the banking sector and the increasing diversity and complexity of banking risks, this has impacted the stability and safety of the banking system; consequently, achieving banking stability has recently become a goal pursued by various banking systems.

2.1. Definition of banking stability:

The banking system is considered stable as long as it is not subject to systemic risks (Ami Al-Said, 2016, p. 69) and there is nothing hindering the process of financial intermediation. Consequently, the stability of the banking system hinges on financial crises and systemic risks. Furthermore, the term ‘stability’—as a modern concept that the Basel Committee on Banking Supervision seeks to achieve through its various amendments—overlaps with numerous other terms. It is also defined as a system in which most banks are able to meet their obligations and are likely to remain so, and private funds (net worth) the bank’s ability to meet its obligations, which is measured by the difference between assets and liabilities (excluding capital and reserves) on the balance sheet. The likelihood that a bank will remain able to meet its various obligations depends on many factors, such as the bank’s ability to generate profits, be managed efficiently and have sufficient capital; Inefficient banks will suffer from a lack of liquidity and ultimately cause a solvency crisis, Although banks can conceal losses and finance themselves by attracting new deposits or other liabilities, the escalation of problems—which usually become apparent after insolvency—causes net cash flows to turn negative and leads to a liquidity shortage (Jumana, 2011, p. 3).

If, however, we attempt to define banking stability at the micro level, the concept of stability refers to the failure of a bank, which is defined as a significant and unusual decline in the value of its assets, resulting in the liquidation value of the assets being less than the value of the deposits; in this case, the bank is said to be insolvent (Nasiri and Ami al-Sa’id, 2014, p. 17). As for its overlap with the term ‘banking safety’, it can be defined from two perspectives: from a liquidity perspective, it refers to a bank’s ability to meet its various obligations, foremost among which are its obligations to depositors (Belgham, 2019, p. 32), which means instilling confidence in them on a daily or periodic basis when they wish to withdraw their deposits; this is where the concept of financial ease comes into play. From the perspective of profitability, it

refers to the bank's ability to generate net profits through its various investments whilst maintaining acceptable levels of risk, and to underpin these profits with equity, which implies not over-distributing dividends to the bank's shareholders, with the aim of strengthening equity capital to absorb unexpected losses and protect depositors' funds (Elifi and Serir, 2020, p. 36). From the International Monetary Fund's perspective, achieving banking stability requires adherence to macroprudential indicators across the banking system.

From the above, we see that banking stability is achieved as long as banks do not suffer from insolvency problems; in other words, banks must possess the foundations for stability and continuity, including sufficient capital to meet their obligations at any time, in addition to the robustness of their internal systems and the efficiency of their management frameworks in conducting their affairs, so as to perform their lending and investment functions efficiently, and their ability to cope with modern banking developments and the associated challenges and requirements in terms of capital, management and expertise (Noui, 2013–2012, p. 60).

2.2. Mechanisms for achieving banking stability

The absence of a management system capable of anticipating and managing the crises of confidence affecting the banking sector contributes to its inherent fragility, as banking stability is maintained through a financial safety net comprising a range of arrangements and procedures that take various forms, which can be defined as the set of measures and policies designed to safeguard the solvency of banks, protect their capital and prevent their collapse. Decision-makers regard the financial safety net as essential for preserving the integrity of the banking system and the economy (Nasiri and Omi Al-Said, 2014, p. 18):

These can be divided into preventive measures (capital adequacy, liquidity, profitability) and remedial measures (deposit insurance, lender of last resort).

2.2.1. Preventive measures to achieve banking stability:

Both capital adequacy and banking liquidity are issues that have come to occupy a significant place and hold great importance for bank management, supervisory authorities and market participants alike, as they represent the most crucial elements ensuring, on the one hand, a bank's financial security and, on the other, the continuity of its operations in the long term.

- **Capital adequacy:** This is defined as a bank's capital capacity to hedge against various risks, and its ability to withstand losses and crises without jeopardising the bank's financial position (Majid Al-Huraith and Ismail Hazouri, 2018, p. 248).

- **Banking liquidity:** This refers to a bank's ability to meet its obligations immediately by converting any asset into liquid cash swiftly and without loss of value, in order to honour withdrawals from deposits and provide credit in the form of loans and advances to serve the community (Haddah, 2009, p. 97)

- **Banking profitability:** Commercial banks seek to achieve the objective of increasing the wealth of investors and shareholders by realising the highest level of profits within a changing economic environment (Fakhri and Asou, 2016, p. . Profitability can be defined as the relationship between the profits generated by an organisation and the investments that

contributed to those profits; Profitability is considered an objective for the enterprise and a measure of its efficiency at the level of the whole organisation or its sub-units. It is measured either through the relationship between profits and sales or through the relationship between profits and the investment that contributed to their generation, noting that ‘investments’ refer to the value of assets or equity (Muqimah, 2014, p. 382) . Commercial banks work towards achieving their profitability objective through two decisions, namely (Muqimah, 2014, pp. 382–383) : the investment decision and the financing decision

2.2.2. Remedial measures: The remedial measures consist of the following: (Nasiri and Amal-Sa'id, 2014, pp. 18–19) :

- Deposit insurance: Deposit insurance plays a key role in maintaining the stability of the banking system, for two reasons. Firstly, the deposit insurance scheme protects customers and depositors, thereby shielding the monetary authorities from social pressures. The second reason is economic in nature and is of greater importance, falling within the framework of reducing systemic risks and the likelihood of a collapse in the banking system, as trust is a key element in the functioning of the banking system and its ability to continue performing its functions. Deposit insurance therefore helps to limit bank runs, which manifest as depositors rushing to banks to withdraw their deposits, thereby leading to the bank's self-destruction at the hands of its own depositors;
- The lender of last resort: The financial and banking crisis highlighted the role that the central bank can play in restoring banking and financial stability by intervening in the interbank market to inject liquidity, as a liquidity shortage is often the trigger for financial turmoil which, if left unchecked, can escalate into a financial and economic crisis; Furthermore, forced asset sales and contagion, alongside liquidity shortages and inadequate risk management, are considered among the main causes of systemic crises; Consequently, the Central Bank, through its various roles, mitigates these effects by providing liquidity to the market. This intervention allows economic agents in need to utilise this liquidity, whilst, on the other hand, financial turmoil results in the forced sale of assets, particularly for investors who employ a high degree of leverage. and should an investor suffer a liquidity shock, they are forced to dispose of part of their assets; if the markets lack sufficient liquidity, they will incur partial losses in the value of their assets, due to the valuation of balance sheets at market value, Consequently, in such situations, the value of illiquid assets will collapse, and their valuation will be relatively uncertain due to the potential suspension of trading; however, the presence of sufficient liquidity would mitigate the severity of these declines in value.

3. Assessing the stability of the Algerian banking system

The development of the Algerian banking system's activity and capacity is one of the most fundamental factors in providing finance to the economy; consequently, achieving acceptable levels of stability has a direct impact on promoting economic development. Therefore, using

data from the Bank of Algeria as a provider of big data and applying the Z-score method, the degree of stability can be determined as follows:

1.3. Introduction to the Z-score method.

Academic studies use several methods to measure the degree of banking stability, including financial analysis, stress tests and the Kamel indices, Perhaps the most important of these is the z-score, which is considered the best measure of banking stability, as it helps us determine whether a bank is in a stable condition or at risk of default by indicating how far banks are from default.

The z-score indicates the number of standard deviations by which a bank's return on assets must fall below its expected value before equity is depleted and the bank becomes unable to meet its financial obligations or is on the brink of bankruptcy, It thus measures the extent to which the banking system enjoys financial stability; consequently, a high z-score indicates that the bank is less likely to default or go bankrupt, whilst also signalling that the banking system is in a stable condition.

The z-score is calculated by dividing the sum of the average return on assets (ROA) and the average capital adequacy ratio by the standard deviation of the return on assets (σ , ROA), and is calculated using the following formula:

$$z - score = \frac{AveROA + Ave E Assets}{\sigma ROA}$$

The standard deviation (ROA) is calculated according to the following formula: $\sigma ROA = \sqrt{\frac{\sum (ROA - \overline{ROA})^2}{n-1}}$

2.3. Measuring the z-score for the banking system

In order to assess the degree of stability of the Algerian banking system and the extent to which it is protected from bank failure and bankruptcy, the z-score for the Algerian banking system as a whole was calculated for the period 2009–2023. The study thus covered 15 years and therefore exceeds the minimum number of years required for statistical purposes, which is at least four years.

Table 1: Calculation of the z-score for the Algerian banking system for the period 2009–2023

Years	Capital Adequacy (CA)	Return on Assets (ROA)	ROA- $\overline{ROA}$	$(ROA - \overline{ROA})^2$
2009	0.2615	0.0175	-0.00134667	1.81351E-06
2010	0.2364	0.0216	0.00275333	7.58084E-06
2011	0.2377	0.021	0.00215333	4.63684E-06
2012	0.2362	0.0193	0.00045333	2.05511E-07
2013	0.215	0.0167	-0.00214667	4.60818E-06
2014	0.1598	0.0198	0.00095333	9.08844E-07
2015	0.184	0.0192	0.00035333	1.24844E-07
2016	0.1875	0.0183	-0.00054667	2.98844E-07
2017	0.1945	0.0205	0.00165333	2.73351E-06
2018	0.1905	0.0242	0.00535333	2.86582E-05
2019	0.1905	0.0242	0.00535333	2.86582E-05
2020	0.1799	0.0151	-0.00374667	1.40375E-05
2021	0.1917	0.0143	-0.00454667	2.06722E-05
2022	0.216	0.0172	-0.00164667	2.71151E-06
2023	0.2153	0.0138	-0.00504667	2.54688E-05
Total	3.0965	0.2827		0.000143117
Average	0.20643333	0.01884667		

Source: Compiled by the researchers based on reports from the Central Bank of Algeria from 2009 to 2023

Based on this data compiled by the Bank of Algeria, we can calculate the following:

$$ROA = Ave(ROA) = \frac{0.2827}{15} = 0.01884667$$

$$Ave\left(\frac{E}{A}\right) = \frac{3.0965}{15} = 0.20643333$$

$$\sigma_{ROA} = \sqrt{\frac{\sum(ROA - \overline{ROA})^2}{n-1}} = \sqrt{\frac{0.000143117}{15-1}} = 0.00319729$$

$$z_score = \frac{(0.20643333 + 0.01884667)}{0.00319729} = 70.4596590830964$$

The z-score for the Algerian banking sector indicates that profits would need to fall by more than 70.45 times their standard deviation before equity is depleted, rendering the sector unable to meet its financial obligations. We can therefore conclude that the Algerian banking sector enjoys an acceptable level of banking stability, being a long way from default and bankruptcy.

Conclusion:

Through our study of the Algerian banking system, which focused on the role of the Bank of Algeria as a provider of big data in forecasting the degree of Algerian banking stability using the z-score method over the period 2009–2023, we have arrived at the following conclusions:

- Based on the z-score value, we can accept the main hypothesis, which states that the Algerian banking system enjoys an acceptable level of stability when using the **z-score** method, based on data from the Bank of Algeria;

-The study showed that the Bank of Algeria played a key role by providing a vast database that helped to determine the level of banking stability during the period 2009–2023.

-The use of big data, alongside the Z-score method, assists monetary authorities in monitoring banking performance and mitigating unforeseen risks, thereby helping them to make decisions regarding banking stability.

Based on the findings, and with a view to strengthening the Bank of Algeria's role in utilising big data to forecast the level of banking stability using the Z-score method, we propose the following recommendations:

-The Bank of Algeria must develop its analytical capabilities by utilising big data techniques, thereby helping to improve the accuracy of forecasts regarding banking stability using the z-score method.

-It is important for the Bank of Algeria to invest in training specialist staff in quantitative analysis and risk management to ensure the optimal use of big data.

-The Bank of Algeria should expand its big data set in order to identify the strengths and weaknesses of the banking system, achieve a more comprehensive assessment of banking stability.

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