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ADVANCING AN INTEGRATED STATISTICAL ASSESSMENT METHODOLOGY FOR COMMERCIAL BANKS' DIGITAL ACTIVITIES AND CREDIT PORTFOLIO QUALITY

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Abstract. This study examines the improvement of the methodology for the integrated statistical assessment of commercial banks' digital activities and credit portfolio quality. A comprehensive system of statistical indicators is developed to evaluate the level of digital transformation and the quality of credit portfolios. Based on these indicators, a new methodological framework is proposed through the introduction of the Digital Activity Index (DAI), the Credit Quality Index (CQI), and the Integrated Banking Performance Index (IBPI). Furthermore, the study discusses the theoretical foundations for applying multivariate statistical and econometric methods and substantiates the practical significance of the proposed methodology for monitoring banking performance, ranking commercial banks, and supporting evidence-based managerial decision-making.

Keywords: commercial banks, digital transformation, digital banking services, credit portfolio quality, statistical assessment, integrated index, Digital Activity Index (DAI), Credit Quality Index (CQI), Integrated Banking Performance Index (IBPI), econometric analysis.

Аннотация. В данном исследовании рассматриваются вопросы совершенствования методологии комплексной статистической оценки цифровой деятельности коммерческих банков и качества их кредитного портфеля. Разработана комплексная система статистических показателей, позволяющая оценить уровень цифровой трансформации банков и качество их кредитных портфелей. На основе предложенной системы показателей сформирована новая методологическая модель, включающая Индекс цифровой активности (Digital Activity Index, DAI), Индекс качества кредитного портфеля (Credit Quality Index, CQI) и Интегральный индекс эффективности деятельности банков (Integrated Banking Performance Index, IBPI). Кроме того, раскрываются теоретические основы применения многомерных статистических и эконометрических методов, а также обосновывается практическая значимость предложенной методики для мониторинга деятельности банков, формирования рейтингов коммерческих банков и принятия управленческих решений на основе статистически обоснованных данных.

Ключевые слова: коммерческие банки, цифровая трансформация, цифровые банковские услуги, качество кредитного портфеля, статистическая оценка, интегральный индекс, Индекс цифровой активности (DAI), Индекс качества кредитного портфеля (CQI), Интегральный индекс эффективности деятельности банков (IBPI), эконометрический анализ.

INTRODUCTION

The ongoing digital transformation of the global financial system is fundamentally reshaping all aspects of commercial banking operations. The widespread adoption of modern information and communication technologies, the rapid expansion of remote banking services, the development of mobile and internet banking platforms, and the application of artificial intelligence (AI), Big Data, and cloud computing technologies have significantly

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improved banking efficiency. At the same time, these technologies are transforming credit portfolio management, risk assessment, and customer service delivery. Consequently, assessing commercial bank performance solely through traditional financial indicators is no longer sufficient. Instead, there is a growing need for a comprehensive statistical framework that integrates digital banking performance with credit portfolio quality.

In recent years, banking digitalization initiatives have substantially transformed the business models of commercial banks. Digital technologies have enabled the automation of loan origination, credit monitoring, customer identification, remote service delivery, payment systems, and risk management processes. At the same time, digital transformation has become an important determinant of credit portfolio quality by influencing the share of non-performing loans, loan repayment performance, debt monitoring efficiency, credit risk exposure, and the overall financial stability of banking institutions. These developments make the statistical investigation of the relationship between digital banking development and credit portfolio quality an increasingly important research issue.

A review of the existing literature indicates that most previous studies have examined commercial bank performance mainly through individual financial dimensions, such as financial stability, profitability, liquidity, capital adequacy, credit risk, or asset quality. Similarly, the level of banking digitalization has often been studied as an independent research topic. However, relatively limited attention has been paid to integrating these two dimensions within a unified statistical assessment framework capable of evaluating the interaction between digital banking performance and credit portfolio quality through comprehensive statistical indicators and composite indices. As a result, existing methodologies provide only a partial assessment of banking performance and do not fully capture the multidimensional effects of digital transformation.

In particular, there is a growing need to assess banking performance not only through conventional financial indicators but also by incorporating such measures as digital service coverage, the share of electronic transactions, the use of remote banking services, the proportion of loans originated through digital channels, credit portfolio quality, the non-performing loan ratio, portfolio diversification, credit risk, and loan repayment performance into an integrated statistical assessment system. Such an approach enables multidimensional performance evaluation, strengthens the scientific basis of managerial decision-making, and improves early risk detection and forecasting mechanisms.

In Uzbekistan, ongoing reforms aimed at transforming the banking sector, promoting the digital economy, expanding financial inclusion, and aligning banking practices with international standards have further increased the relevance of research in this field. Evaluating the level of digital banking development together with credit portfolio quality through an integrated statistical framework is an important prerequisite for strengthening banking sector stability, improving the efficiency of credit allocation, enhancing risk management, and increasing the competitiveness of commercial banks.

Against this background, improving the methodology for the integrated statistical assessment of commercial banks' digital activities and credit portfolio quality represents an important scientific challenge. The primary objective of this study is to develop a comprehensive assessment methodology by integrating indicators of digital banking activities and credit portfolio quality into a unified statistical framework, identifying their interrelationships using advanced statistical and econometric techniques, and constructing an integrated methodology for evaluating banking performance. The findings of this study contribute to the development of the theoretical foundations of banking performance assessment, the improvement of statistical methodologies, the enhancement of banking supervision and risk management practices, and the formulation of evidence-based recommendations to support strategic managerial decision-making in commercial banks.

LITERATURE REVIEW

The methodology for the statistical assessment of commercial bank performance has developed as an interdisciplinary field at the intersection of financial statistics, banking management, risk management, and econometric modeling. In recent years, the rapid pace of digital transformation in the banking sector has created a need to reconsider conventional statistical assessment approaches. Evaluating banking performance solely through traditional financial indicators is no longer sufficient, as such indicators do not fully reflect the influence of digital banking services, remote banking operations, electronic payments, mobile banking applications, internet banking platforms, and automated credit monitoring systems on overall banking performance. Consequently, the integrated statistical assessment of banks' digital development and credit portfolio quality has emerged as a new and important research direction.

Early studies on banking performance assessment primarily focused on indicators such as profitability, capital adequacy, liquidity, asset quality, and credit risk. These approaches were developed within the frameworks of the CAMELS rating system, the Basel regulatory principles, and other prudential supervisory standards, which provide the theoretical basis for evaluating the financial soundness of commercial banks.

However, these methodologies generally do not consider the level of digital transformation as an independent statistical determinant of banking performance.

The rapid expansion of the digital economy, accompanied by the adoption of financial technologies, artificial intelligence, Big Data, cloud computing, and remote banking services, has significantly broadened the criteria for assessing banking performance. The digital transformation framework proposed by the OECD emphasizes the need to develop new indicator systems for assessing digital transformation across various sectors, including financial services. This framework recommends evaluating digital transformation by linking technological adoption with operational efficiency, organizational performance, and management outcomes.

Recent empirical studies have identified digital transformation as one of the major determinants of credit risk, banking stability, and financial performance. For example, Nguyen and Nguyen examined the effects of digital transformation and Basel III implementation on the credit risk of commercial banks using panel regression techniques. Their findings indicate that technological investment contributes to reducing credit risk. Although their study employed pooled ordinary least squares (OLS), fixed effects, random effects, and feasible generalized least squares (FGLS) estimators, it did not develop an integrated statistical framework combining digital banking development indicators with credit portfolio quality indicators.

Similarly, Jia et al. investigated the impact of digital transformation on banking system stability and found that digital maturity reduces systemic risk by enhancing banking competitiveness. The authors constructed a digital transformation index using multivariate indicators and principal component analysis (PCA). Nevertheless, their proposed index was not integrated with indicators reflecting credit portfolio quality.

Studies evaluating credit portfolio quality have traditionally focused on indicators such as the non-performing loan ratio, loan repayment performance, loan loss provisions, portfolio diversification, credit losses, and capital adequacy. While these indicators effectively measure credit risk and portfolio performance, their statistical integration with digital banking service indicators remains insufficiently developed. Consequently, existing assessment frameworks do not fully capture the interaction between digital transformation and credit portfolio quality.

The literature review reveals three major research gaps. First, there is no comprehensive methodology for evaluating digital banking activities and credit portfolio quality within a unified statistical indicator system. Second, methodological approaches for integrating digital transformation indicators and credit quality indicators into composite statistical indices remain limited. Third, there is a lack of comprehensive statistical and econometric models capable of explaining the complex relationship between digital banking development and credit portfolio quality.

To address these research gaps, the present study proposes an integrated statistical methodology that combines indicators of commercial banks' digital activities and credit portfolio quality within a unified analytical framework. Using multivariate statistical and econometric techniques, the proposed methodology evaluates the interaction between these dimensions and develops a comprehensive statistical assessment model for commercial bank performance. Unlike previous studies, this approach integrates two strategic components of banking performance into a single evaluation framework, thereby improving the statistical foundations of banking supervision, early risk identification, and strategic decision-making.

RESEARCH METHODOLOGY

The findings of the literature review indicate that previous studies on the statistical assessment of commercial bank performance have primarily focused on financial indicators, such as capital adequacy, liquidity, profitability, asset quality, and credit risk. Although recent research has examined the relationship between digital transformation, banking performance, and credit portfolio quality, limited attention has been paid to integrating digital banking indicators and credit portfolio quality measures into a unified statistical assessment framework.

Therefore, this study proposes a comprehensive methodology for evaluating commercial banks' digital activities and credit portfolio quality through three composite indices: the Digital Activity Index (DAI), the Credit Quality Index (CQI), and the Integrated Banking Performance Index (IBPI). The proposed methodology applies multivariate statistical and econometric techniques to integrate digital transformation indicators with conventional banking performance measures. This provides a more objective, comprehensive, and scientifically grounded framework for assessing banking competitiveness, financial stability, and overall performance.

ANALYSIS AND RESULTS

The contemporary methodology for evaluating commercial bank performance requires consideration not only of traditional financial indicators but also of the level of digital transformation achieved by banking

institutions. In recent years, the rapid expansion of digital banking services, the widespread adoption of mobile and internet banking platforms, the implementation of digital lending systems, and the increasing use of artificial intelligence (AI) and Big Data technologies have substantially changed the criteria for assessing banking performance. Consequently, evaluating banks solely on the basis of conventional financial indicators is no longer sufficient. Therefore, this study develops an integrated methodological framework that enables a comprehensive statistical assessment of commercial banks' digital activities and credit portfolio quality within a unified analytical system.

The proposed methodology is based on a comprehensive statistical analysis of the interaction between two strategic dimensions of banking performance: the level of digital development and the quality of the credit portfolio. Its primary objective is to integrate multiple statistical indicators into a single assessment framework capable of constructing a composite index that accurately reflects the overall performance of commercial banks and provides an evidence-based analytical tool for managerial decision-making.

At the first stage of the research, a system of assessment indicators was established. To measure digital banking activities, indicators such as the number of mobile banking users, the utilization rate of internet banking services, the volume of electronic transactions, the share of payments conducted through digital channels, the proportion of loans issued through remote banking platforms, and the number of ATMs and POS terminals were selected. Credit portfolio quality was evaluated using indicators including the total credit portfolio volume, the non-performing loan ratio, loan repayment performance, credit risk, loan loss provisions, credit portfolio profitability, and portfolio diversification. These indicators provide a comprehensive representation of both digital banking development and the effectiveness of credit portfolio management.

The next stage involves evaluating the statistical characteristics of the selected indicators. Descriptive statistical analysis is performed to calculate the mean, median, standard deviation, minimum, and maximum values of each variable. This analysis provides valuable information on data distribution, variability, and the presence of potential outliers, while also ensuring the suitability of the dataset for subsequent econometric analysis.

The relationships among the selected indicators are examined using correlation analysis. Pearson or Spearman correlation coefficients are employed to determine the strength and direction of the association between digital banking development indicators and credit portfolio quality indicators. The results of this analysis make it possible to identify significant explanatory variables for inclusion in the econometric model.

To ensure the stability and reliability of the estimated model, multicollinearity diagnostics are conducted using the Variance Inflation Factor (VIF). Variables showing excessive multicollinearity may be excluded or transformed in order to improve the robustness and statistical reliability of the regression estimates.

To reduce the dimensionality of the selected indicators, Principal Component Analysis (PCA) or Factor Analysis is applied. These multivariate statistical techniques transform correlated variables into a smaller number of latent components while preserving most of the original information. Based on this procedure, a Digital Activity Index (DAI) is constructed to represent the overall level of digital banking development. The DAI summarizes digital infrastructure, the availability of electronic services, and customer use of digital banking services into a single composite indicator.

Similarly, a Credit Quality Index (CQI) is developed using the same methodological approach. This index integrates multiple indicators related to credit portfolio stability, the proportion of non-performing loans, credit risk, loan repayment performance, and lending efficiency into a unified statistical measure. Consequently, the CQI serves as a comprehensive indicator of overall credit portfolio quality.

The principal scientific contribution of this study is the integration of the Digital Activity Index (DAI) and the Credit Quality Index (CQI) into a unified statistical assessment framework through the development of the Integrated Banking Performance Index (IBPI). The proposed composite index enables the simultaneous evaluation of commercial banks' digital activities and credit portfolio quality and can be expressed as follows:

$$IBPI=\omega_1 DAI+\omega_2 CQI$$

where ω_1 and ω_2 denote statistically determined weighting coefficients. These weights may be estimated using the Entropy Method, Principal Component Analysis, or the Analytic Hierarchy Process (AHP), depending on the characteristics of the dataset and the selected methodological approach.

The Integrated Banking Performance Index provides a basis for statistically ranking commercial banks according to their overall level of digital development and credit portfolio quality. The resulting rankings enable comparisons among banks, help identify their strengths and weaknesses, and support the formulation of strategic development priorities. Furthermore, cluster analysis may be applied to classify banks into homogeneous groups according to their performance characteristics, distinguishing highly digitalized banks with strong credit

portfolio quality from banks with medium or relatively lower performance. Such classification provides valuable information for differentiated regulatory policies and managerial strategies.

Compared with conventional performance assessment frameworks, such as CAMELS and other prudential supervisory systems, the proposed methodology offers several important advantages. First, it extends the assessment beyond traditional financial indicators by explicitly incorporating digital transformation into the evaluation process. Second, the application of multivariate statistical techniques allows for the construction of composite indices that provide a more comprehensive and objective representation of banking performance. Finally, the integrated methodology improves the reliability of performance assessment, reduces subjectivity in decision-making, and strengthens the statistical foundation for banking supervision, performance monitoring, and strategic management.

Overall, the proposed integrated statistical assessment methodology provides a comprehensive framework for analyzing the relationship between digital transformation and credit portfolio quality in commercial banks. It enables a multidimensional evaluation of banking performance while offering a scientifically grounded basis for improving strategic decision-making, enhancing credit risk management, and supporting the sustainable development and long-term competitiveness of commercial banks.

CONCLUSION AND RECOMMENDATIONS

This study developed an integrated statistical methodology for the comprehensive assessment of commercial banks' digital activities and credit portfolio quality. The findings demonstrate that evaluating banking performance solely on the basis of traditional financial indicators does not adequately reflect either the level of digital transformation or the quality of credit portfolios. Therefore, integrating digital development indicators and credit portfolio quality indicators into a unified statistical framework enhances the accuracy, reliability, and comprehensiveness of commercial bank performance assessment.

Within the scope of the research, a methodological framework based on three composite indicators—the Digital Activity Index (DAI), the Credit Quality Index (CQI), and the Integrated Banking Performance Index (IBPI)—was proposed. This approach enables a comprehensive evaluation of banks' digital development and credit portfolio quality, facilitates comparative performance analysis, and provides a scientific basis for evidence-based managerial decision-making.

Based on the research findings, the following recommendations are proposed:

Implement an integrated statistical assessment system that combines digital banking activity and credit portfolio quality indicators to monitor the performance of commercial banks.

Incorporate composite indices, such as the DAI, CQI, and IBPI, alongside conventional financial indicators into commercial bank performance evaluation and ranking systems.

Strengthen managerial mechanisms aimed at accelerating digital transformation in order to improve credit portfolio quality and reduce credit risk.

Promote the wider application of multivariate statistical and econometric methods by the Central Bank and commercial banks for comprehensive banking performance assessment.

The proposed methodology contributes to improving the scientific and methodological foundations of statistical banking performance assessment, strengthening the stability of the banking sector, and supporting effective managerial decision-making in an increasingly digitalized financial environment.

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