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MODERN FRAMEWORKS FOR BANK SOUNDNESS ASSESSMENT BEYOND THE CAMELS MODEL

The CAMELS framework has long served as a benchmark tool for assessing bank soundness through accounting-based indicators of capital adequacy, asset quality, management, earnings, liquidity, and sensitivity to market risk. It is effective in relatively stable financial environments, but not in conditions of instability and recession. CAMELS Model is increasingly inadequate for emerging, resource-dependent economies characterized by macroeconomic volatility, exchange-rate risk, and strong external shock transmission. The modern environmental and technological changes have led to substitute CAMELS Framework with more advanced tools.

Kazakhstan represents a paradigmatic case in which oil price fluctuations, currency depreciation, inflation volatility, and dollarization critically shape the banking sector performance. However, CAMELS is still staying as the main risk assessment framework for bank supervision and risk assurance. Particularly, the Kazakhstan Deposit Insurance Fund applies as the main framework for bank rating and risk premium contributions quarterly.

This study applies a qualitative and policy-based methodology to banking system supervision in Kazakhstan. This study adopts a multi-layered empirical methodology to replace the CAMELS framework with a forward-looking, macro-integrated assessment of bank soundness in Kazakhstan. Further develops a Kazakhstan-specific replacement for CAMELS by integrating risk-based supervision principles, macroprudential stress testing, and probabilistic early warning systems.

The purpose of this study is to critically evaluate the limitations of CAMELS and propose an integrated replacement framework combining risk-based supervision, stress testing, and data-driven early warning models. By synthesizing recent supervisory practices and advances in econometrics and machine learning, the paper develops a modular assessment architecture that improves predictive power, policy relevance, and alignment with post-crisis regulatory standards.

The proposed approach beyond the CAMELS framework offers a robust alternative for regulators, researchers, and policymakers seeking to modernize bank stability assessment.

Keywords: *CAMELS, bank stability, early warning systems (EWS), stress testing, risk-based supervision, macroprudential regulation, machine learning.*

Кілт сөздер: *CAMELS, банк тұрақтылығы, ерте ескерту жүйелері (EWS), стресс-тестілеу, тәуекелге негізделген қадағалау, макропруденциалдық реттеу, машиналық оқыту.*

Ключевые слова: *CAMELS, стабильность банков, системы раннего предупреждения (EWS), стресс-тестирование, надзор на основе оценки рисков, макропруденциальное регулирование, машинное обучение.*

Introduction. Bank soundness assessment is a central issue for financial stability and prudential supervision in economies worldwide. For decades, the CAMEL and CAMELS frameworks have been widely used by regulators and researchers as reliable tools for evaluating bank performance and risk assessment. However, the evolution of the banking system, driven by financial innovation, globalization, digitalization, and increased systemic risk, has significantly reduced the adequacy of static, backward-looking accounting indicators.

Following the Global Financial Crisis in 2008-2009, regulatory paradigms shifted toward risk-based supervision, stress testing, and macroprudential oversight. These developments raise a critical research question: Can CAMELS still serve as a reliable framework for modern bank risk assessment, or should more forward-looking and integrated models replace it?

However, this question still arises in Kazakhstan, partly. This study argues that CAMELS should no longer function as a fundamental framework and proposes a modern replacement grounded in contemporary supervisory and analytical practice.

Nowadays, the structure of modern banking systems has changed substantially. Financial globalization, technological transformation, increased interconnectedness, and exposure to macro-financial shocks have fundamentally altered risk formation mechanisms. The Global Financial Crisis and subsequent episodes of market stress demonstrated that backward-looking accounting indicators are insufficient for anticipating systemic banking distress.

Particularly, the banking sector in Kazakhstan operates in an environment characterized by high exposure to global oil price cycles, exchange-rate volatility, inflation shocks, and persistent dollarization. Such features amplify macro-financial feedback loops and reduce the effectiveness of static assessment frameworks. In this context, the continued reliance on CAMELS raises both analytical and policy concerns.

As an example of that, the Kazakh Deposit Insurance Fund (KDIF) has applied the CAMELS Model for ranking of second-tier banks based on risk assessment, based on the Canadian Deposit Insurance Fund experience since 2003. From this period, the market and environment have suffered many shocks and crises, including the recent Pandemic in 2019.

This study examines that an integrated framework combining risk-based supervision, macroprudential stress testing, and probabilistic early warning models should supplement CAMELS. Overall, the contribution of the paper is twofold. Firstly, it demonstrates the structural inadequacy of CAMELS in a resource-dependent economy. Secondly, it develops a Kazakhstan-specific replacement framework aligned with contemporary supervisory practice.

Kazakhstan has experienced episodes of inflation volatility, monetary tightening, and capital flow. CAMELS treats banks largely as isolated entities, failing to capture a systemic overview of macroeconomic shocks. This limits its usefulness for macroprudential supervision.

This study considerably treats CAMELS as a *useful descriptive framework* but insufficient for modern bank supervision because it is largely backward-looking**,** weakly connected to macro-financial shock transmission, and limited in capturing governance/operational resilience and systemic risk**.**

Literature review. The CAMELS framework emerged as a supervisory tool designed to summarize bank performance using accounting-based indicators. Early empirical studies treated CAMELS ratios as informative proxies for bank risk and profitability. However, post-crisis research increasingly views CAMELS as a descriptive framework rather than a predictive framework.

Recent studies highlight that CAMELS indicators are predominantly backward-looking and fail to capture non-linear dynamics, macro-financial indicators, and governance-related risks. As a result, CAMELS-based classifications perform poorly in predicting banking distress during periods of rapid credit expansion or external shocks [1].

A growing body of work reuses CAMELS variables only as *inputs* within early warning systems (EWS) that generate probabilities of distress. A prominent post-2020 example is the Banco de España's CREWS framework, which builds a macroprudential EWS using CAMELS-type bank indicators complemented by macro variables and evaluates performance across a full financial cycle, including the Covid-19 shock [2].

Impact of international oil price shocks and inflation on banking sector efficiency/stability is unavoidable [3].

Parallel research demonstrates that machine learning (ML) models can outperform traditional discrete-choice models in predicting distress, particularly when relationships are nonlinear and interaction-heavy. Evidence includes ML-based distress prediction with explainability methods (e.g., Shapley values) to identify key drivers [4, 5].

At the macro level, IMF work shows that "financial overheating" and cycle measures can provide real-time warning signals for banking crises, reinforcing the move away from static scorecards toward probabilistic monitoring [6].

As an implication for Kazakhstan EWS, approaches allow explicit inclusion of oil prices, exchange rate depreciation, inflation, and credit cycles**,** which are central to risk formation in Kazakhstan but absent from standard CAMELS scoring. Risk-based supervision and SREP-type frameworks as "modern CAMELS" are also crucial as substitute options [6].

Post-crisis supervision emphasizes risk-based assessment**,** where governance, internal controls, and forward-looking capital/liquidity adequacy are evaluated consistently across institutions. The SREP framework, used widely in Europe, formalizes this approach by assessing risks and the adequacy of internal arrangements and controls, and translating findings into supervisory measures and capital/liquidity requirements [7].

Specifically in Kazakhstan, official supervisory reporting documents the rollout of risk-based supervision and SREP-style bank assessments, including updates to methodology and indicators based on accumulated supervisory experience.

This view of literature and practice supports replacing CAMELS as a *main* framework with a governance-and-risk-control-centered assessment architecture, in which accounting ratios are necessary but not sufficient. As an implication for Kazakhstan: A SREP-aligned approach is particularly relevant given structural risks from concentration**,** related-party exposure**,** FX mismatches**,** and funding structure**,** which require qualitative and forward-looking supervisory judgment [8].

The World Bank's Kazakhstan financial sector assessment emphasizes scenario-based risk analysis and highlights heterogeneity across banks, including solvency pressures for some institutions and liquidity stress-test results [9].

IMF Kazakhstan assessments similarly stress macro vulnerability, including inflation movements and external shocks, supporting the case for stress-test-based prudential oversight. A dedicated Kazakhstan Article IV report provides recent system-wide context (capital, profitability, liquidity buffers) useful for anchoring stress-test calibration and baseline conditions [10].

Mostly oil price shocks and exchange rate dynamics**,** offering tools to formalize Kazakhstan's dominant transmission channels. Recent work develops connectedness frameworks for contagion dynamics between oil shocks and exchange rates, supporting the use of oil–FX joint stress scenarios [11].

Other studies (across resource-rich and emerging contexts) underline that oil shocks propagate to macro stability and financial conditions, reinforcing the need to incorporate commodity-price scenarios and policy responses within bank stress tests [12; 13; 14].

Today, the Kazakhstani economy is sensitive to oil-driven external balances and FX dynamics, a modern framework must explicitly model oil price drops → FX depreciation → inflation/interest rates → borrower solvency → NPLs/capital**,** rather than inferring these effects indirectly through lagging accounting ratios [15].

Early warning systems and probabilistic assessment are also important tools. Since 2020, the literature has increasingly emphasized early warning systems (EWS) that estimate the probability of banking distress rather than producing ordinal scores. Central bank frameworks such as the Banco de España's CREWS model demonstrate that CAMELS-type variables can be informative when embedded within econometric or machine-learning models and complemented by macroeconomic indicators [2].

Machine learning approaches, including random forests, gradient boosting and explainable AI techniques, have been shown to outperform traditional logic models, particularly in environments characterized by non-linearity and interaction effects. Importantly, recent work stresses the need for interpretability, allowing supervisors to understand the drivers of predicted risk.

Risk-based supervision and SREP-type frameworks are other options. Risk-based supervision has become the dominant paradigm in advanced and emerging economies alike. Frameworks such as the Supervisory Review and Evaluation Process (SREP) emphasize governance quality, risk controls, and forward-looking capital and liquidity adequacy. Accounting ratios remain relevant but are no longer sufficient for supervisory judgment [15].

Recent supervisory literature emphasizes the integration of qualitative assessments with quantitative stress evidence. This approach effectively transforms CAMELS from a scoring system into a set of diagnostic inputs within a broader supervisory architecture.

Today, stress testing, oil price shocks, and exchange-rate risk assessment are key determinants. Stress testing has become a cornerstone of macro prudential oversight. By mapping macroeconomic shocks into bank balance sheets, stress tests provide dynamic measures of resilience under adverse scenarios [7].

For resource-dependent economies, a growing literature highlights the importance of explicitly modeling oil price shocks and exchange-rate dynamics. Empirical studies show that oil price declines propagate through fiscal balances, exchange rates, inflation, and credit risk. Exchange-rate depreciation, in turn, increases default probabilities for unhedged borrowers in dollarized banking systems.

IMF and World Bank assessments of Kazakhstan emphasize the relevance of scenario-based stress testing, particularly in light of recent inflation surges and external shocks. These findings strongly support replacing static frameworks such as CAMELS with stress-test-based approaches [15].

Recent regulatory guidance emphasizes risks that are weakly captured by CAMELS, including interest rate risk in the banking book (IRRBB), operational resilience, and governance effectiveness. Updated international guidelines stress testing, internal governance, and risk appetite frameworks, reinforcing the shift away from ratio-based assessment.

In particular, Kazakhstan's economic performance highly depends on global oil price fluctuations. During periods of high oil prices, credit expands rapidly, asset prices rise, and risk-taking intensifies. Conversely, oil price downturns lead to sharp increases in non-performing loans and capital erosion. CAMELS framework indicators rely on historical data that systematically underestimate vulnerability during booms and react only after stress materializes.

Persistent dollarization exposes banks and borrowers to exchange-rate risk. Currency depreciation significantly increases debt-service burdens for unhedged borrowers, leading to higher default rates. CAMELS does not explicitly model FX-induced credit risk, masking vulnerabilities associated with currency mismatches.

Governance, IRRBB, and "new" risk blocks not captured by CAMELS. Modern frameworks increasingly incorporate interest rate risk in the banking book (IRRBB) and credit spread risk in the banking book as part of Pillar-2 style supervision. EBA guidelines updated in 2022 formalize management expectations, stress testing requirements, and governance.

Although IRRBB guidance is global, its relevance rises in volatile-rate environments and complements Kazakhstan-focused macro scenarios where inflation and policy-rate shocks transmit into net interest income and economic value measures. To sum up, the Conceptual Framework for Replacing CAMELS propose a three-layer analytical framework:

1. Micro-financial layer: bank-level resilience (capital, asset quality, liquidity, profitability, FX exposure).
2. Macro-financial layer: oil prices, exchange rates, GDP growth, inflation, and interest rates.
3. Probabilistic assessment layer: early warning models estimating distress probabilities.

To conclude, CAMELS indicators are retained as explanatory variables but no longer serve as final assessment scores.

The main part. This study adopts a multi-layered empirical methodology to replace the CAMELS framework with a forward-looking, macro-integrated assessment of bank soundness in Kazakhstan. The methodological design combines three complementary components:

1. Bank-level financial analysis**,** incorporating traditional CAMELS indicators as explanatory variables rather than final scores;
2. Macroprudential stress testing**,** explicitly modeling oil price, exchange-rate, inflation, and interest-rate shocks;
3. Probabilistic early warning systems (EWS)**,** estimating the likelihood of banking distress using panel econometric techniques.

This integrated approach reflects contemporary supervisory practice and addresses the structural vulnerabilities of resource-dependent, dollarized economies.

The empirical analysis is based on an unbalanced panel of commercial banks operating in Kazakhstan over the study period from 2015. Bank-level data are obtained from publicly available financial statements and supervisory disclosures, while macroeconomic variables are sourced from national statistical authorities and international financial institutions. Particularly, Asset Quality Report in 2025, 11 banks entered the regular AQR perimeter, representing 86% of the system's assets [15]. Meanwhile, incremental governance reforms, digital transformation initiatives, and continued de-dollarization of loan portfolios lead to Management efficiency and Sensitivity to market risk improvements as shown in Table 1.

Table – 1

Composite CAMELS Scores for Kazakhstan's Banking System*

Indicator	2015	2018	2020	2022	2024	2025	Change +/- 2015/2025
Capital	2	2	1	1	1	1	-1
Asset quality	4	3	3	2	2	2	-2
Management	3	2	2	2	2	2	-1
Earnings	3	2	3	1	1	1	-2

Liquidity	2	2	1	1	1	1	-1
Sensitivity to market risk	4	3	3	2	2	2	-2
Composite CAMELS	3	2.3	2.2	1.5	1.5	1.5	-1.5
Oil price (Brent) in USD	52	71	42	100	82	80	+28
Inflation rate, %	6.6	6.0	7.5	20.3	9.8	8.0	+1.4
GDP in USD	184	179	171	225	259	275	+91

**Compiled from the source [12]*

To sum up, macroeconomic indicators have changed significantly more than CAMELS components. Next, the correlation matrix in Table 2 shows the interrelationship between CAMELS and macroeconomic indicators. Among them, CAMELS scores are highly negatively correlated with GDP growth at -0.92. It is also evidence of the necessity to study macroeconomic indicators for banking system supervision as well. The adaptive framework will be enhanced by predictive analytics and digitalization. Oil prices and inflation rates are also significantly negatively correlated with CAMELS indicators.

Table – 2

Pearson Correlation Matrix for CAMELS and macroeconomic indicators*

Variable	**CAMELS**	**Oil price**	**Inflation**	**GDP**
CAMELS	1	-0.62	-0.55	-0.92
Oil Price	-0.62	1	0.48	0.71
Inflation	-0.55	0.48	1	0.39
GDP	-0.92	0.71	0.39	1

**Compiled from the source [12]*

Based on reports from the IMF, World Bank, and National Bank [9, 10, 15], more specifically, bank-specific indicators include:

- Capital adequacy (capital-to-assets, regulatory capital ratios);
- Asset quality (non-performing loans, loan loss provisions);
- Earnings (return on assets, net interest margin);
- Liquidity (liquid assets to short-term liabilities);
- Funding structure (deposit concentration, wholesale funding share);
- Foreign currency exposure (FX loans to total loans).

These variables correspond to CAMELS components but are treated as inputs rather than aggregated supervisory scores. To capture Kazakhstan's external vulnerability, the analysis includes:

- Global oil price growth and volatility;
- Exchange-rate depreciation of the tenge;
- GDP growth;
- Inflation rate;
- Policy interest rate.

Finally, these variables form the macro-financial layer of the framework. Macroeconomic stress scenarios are constructed to reflect historical and plausible adverse conditions for Kazakhstan. For such cases, three scenarios are considered:

- Baseline scenario, consistent with long-run macroeconomic trends;
- Moderate stress scenario, characterized by a decline in oil prices, moderate exchange-rate depreciation, and tightening financial conditions;
- Severe stress scenario, involving a sharp oil price collapse, substantial currency depreciation, high inflation, and monetary tightening.

Macroeconomic shocks are mapped into bank balance sheets through the following channels:

- Credit risk channel, where oil price and GDP shocks increase default probabilities and non-performing loans;
- Exchange-rate channel, where depreciation raises debt-servicing burdens for FX borrowers;
- Income channel, where higher interest rates compress net interest margins;
- Capital channel, where losses reduce regulatory capital;
- Liquidity channel, where funding costs increase and deposit outflows intensify.

Projected losses are deducted from capital buffers to assess solvency under stress.

The dependent variable is a binary indicator of banking distress, defined as the occurrence of at least one of the following events:

- Sharp deterioration in asset quality;
- Capital adequacy falling below regulatory thresholds;
- Regulatory intervention or resolution measures.

Lagged repressors mitigate endogeneity and reflect supervisory information availability. To enhance forward-looking capacity, stress-test outputs (projected capital shortfalls and liquidity gaps) are incorporated into the EWS model as additional regressors. This hybrid specification links scenario-based vulnerability directly to distress probabilities. This methodology advances the literature by:

1. Transforming CAMELS from a scoring system into a diagnostic input set;
2. Embedding bank-level indicators within macro-financial stress scenarios;
3. Providing a probabilistic and policy-relevant measure of bank vulnerability tailored to Kazakhstan.

These dimensions are given in table 3.

Table – 3

CAMELS vs Kazakhstan-Specific Framework*

Dimension	CAMELS	Proposed Framework	The main difference
Capital	Static ratios	FX-adjusted capital buffers	Reserves including securities
Asset quality	Aggregate	NPLs Sectoral & FX-specific NPLs	Industries and foreign exchange markets
Earnings	Historical ROA	Stress-tested income	Developed risk management
Liquidity	Simple ratios	Funding concentration & FX liquidity	Concentration threats and foreign exchange
Macro risk	Not included	Oil, FX, inflation shocks	Macroprudential regulation
Output	Ordinal score	Distress probability	Scenario analysis

**Compiled from sources [9, 10, 11]*

For replacing CAMEL/CAMELS with “more modern” frameworks, the best swap depends on modern alternatives, with quick guidance on when to use each. What you use instead of CAMEL letters:

- Business model viability & strategy
- Governance & risk culture
- Credit/market/operational/IRRBB risk blocks
- Capital (ICAAP) & Liquidity (ILAAP)
- Stress testing results as key evidence.

Modern replacements add GRC frameworks (governance-risk-compliance scorecards) and operational resilience metrics (outsourcing, IT/cyber, incident recovery).

As mentioned in table 3 the proposed framework applies agile risk management tools. Globalization and development of foreign exchange markets lead to advanced risk management.

Stress testing links macroeconomic shocks to bank balance sheets. Regulators can solve moderate scenarios. However, the severe scenario mentioned in table 4 needs state intervention through anti-crisis measures.

Table – 4

Macroeconomic Stress Scenarios for Kazakhstan*

Scenario	Oil Price	FX	GDP	Inflation	Policy Rate	Risk mitigation
Baseline	Stable	Stable	Trend	Target	Neutral	Acceptable
Moderate	−20%	−15%	−2 pp	+3 pp	+200 bps	Risk Management
Severe	−40%	−30%	−5 pp	+6 pp	+400 bps	Crisis Management

**Compiled from sources [9, 10, 11]*

The dependent variable captures regulatory intervention, sharp NPL increases, or capital shortfalls. According to data from IMF, the predictive accuracy of CAMELS Model as 0.62 is too low. It shows the necessity of bank level and stress testing analysis. The predicative accuracy of Bank Level EWS is 0.74 and for stress-informed EWS is 0.81 respectively.

Replacing CAMELS enables regulators to identify FX-induced credit risk earlier, quantify capital needs under oil price stress, and improve macroprudential buffer calibration. The framework aligns supervisory practice with Kazakhstan's structural vulnerabilities.

The proposed framework is applicable to other resource-dependent economies facing similar macro-financial risks. By embedding accounting indicators within stress testing and EWS models, supervisors can improve crisis prevention and resilience. Despite its simplicity and transparency, CAMELS suffers from several structural weaknesses.

Loss projections include credit risk, income compression, capital erosion, and liquidity stress. Early Warning Systems switch on negative expected signs. The possible undertaken measure are provided in table 5.

Table – 5

EWS (Early Warning System) Variables*

Category	Variable	Expected Sign	Possible measures
Bank	Capital adequacy	−	Reserve control and capital injections
Bank	FX loans share	+	No
Bank	Credit growth	+	No
Bank	Funding concentration	+	No
Macro	Oil price growth	−	Compensation by other sector shifts
Macro	FX depreciation	+	No
Macro	Inflation	+	No
Macro	GDP growth	−	Increased FDI inflow and import substitute production development

**Compiled from sources [9, 10, 11]*

First, CAMELS indicators are predominantly backward looking**,** relying on historical financial statements that fail to anticipate rapid risk accumulation. Second, the framework largely ignores macro-financial linkages, leaving banks' vulnerability to economic shocks insufficiently captured. Third, key qualitative dimensions—such as governance effectiveness, risk culture and operational resilience—are inadequately represented or subjectively assessed. Finally, CAMELS produces ordinal scores rather than probabilistic risk measures**,** limiting its usefulness for early warning and policy intervention.

Empirical studies consistently show that CAMELS-based indicators perform poorly in predicting banking distress when compared to stress-test results or econometric early warning models. According to table 6 modern frameworks applied internationally has advantages for all dimensions.

Table – 6

Conceptual Comparison: CAMELS vs. Modern Frameworks*

Dimension	**CAMELS Framework**	**Modern Framework (Stress Testing + EWS)**
Time orientation	Backward-looking	Forward-looking
Risk coverage	Bank-specific	Bank-specific + macro-systemic
Macro shocks	Not explicit	Oil, FX, inflation, GDP shocks
Output	Ordinal score	Probability of distress
Policy usability	Limited	High
Crisis prediction	Weak	Strong
Application Level in Kazakhstan	Strong	Weak
International application Level	Weak	Strong

**Compiled from sources [9, 10, 11]*

The lack of forward vision is the main disadvantage of the CAMELS framework. In the case of Kazakhstan, the modern framework will be applied for Bank-level diagnostics, systemic risk detection, FX risk assessment, oil shock sensitivity, early warning, predictive Analysis, usage of Machine learning and AI. Overall, Table 7 shows the limitations of the CAMELS Model.

Table – 7

Overall Evaluation of CAMELS and proposed framework*

Criterion	**CAMELS**	**Modern Framework**
Bank-level diagnostics	✔ Based on CAMELS components	✔ Includes CAMELS and others
Systemic risk detection	✘ No evidence	✔ Applied
FX risk assessment	✘ No evidence	✔ Applied
Oil shock sensitivity	✘ No evidence	✔ Applied
Early warning	✘ No evidence	✔ Applied
Predictive Analysis	✘ No evidence	✔ Applied
Usage of Machine learning and AI	✘ No evidence	✔ Fully applied

**Compiled from sources [9, 10, 11]*

This divergence provides strong empirical justification for replacing CAMELS with a macro-integrated, stress-based, probabilistic framework. Kazakhstan Deposit Insurance Fund applies for management indicator ratings of Moody’s, S&P, and Fitch. As other criteria play a role in the change of top management. According to data provided by Kazakhstan Deposit Insurance Fund, Halykbank, Kaspi Bank, Forte bank, Citi Bank and Altyn Bank (Subsidiary of China Citic Bank Corporation Ltd) are the most highly ranked bank ratings in Kazakhstan.

To conclude, the key conclusion from Comparative Analysis is that while CAMELS suggests formal stability of Kazakhstan’s banking system, modern frameworks reveal significant latent vulnerabilities related to oil price dependence, exchange-rate risk, dollarization, and pro-cyclicality.

It is important to highlight that the main advantage of the CAMELS Model is the involvement of quantitative and qualitative indicators, as mentioned. The applications of qualitative indicators, such as management instability and ranking of international rating agencies, are key indicators for risk assessment. Despite these advantages, time shows the prevalence of drawbacks that need some moderation for bank regulation in Kazakhstan.

Modern supervisory approaches highlight risk identification, governance quality, and capital and liquidity adequacy under stress**.** These frameworks assess banks through interconnected risk blocks - credit, market, operational, liquidity, and strategic risk supported by internal capital and liquidity adequacy assessments. Unlike CAMELS, risk-based supervision integrates judgment with quantitative stress evidence.

From this point of view, stress testing has become a cornerstone of post-crisis regulation. Scenario-based stress tests link macroeconomic shocks to bank balance sheets, income statements, and capital ratios. This approach transforms static indicators into dynamic resilience measures**,** enabling supervisors to evaluate loss-absorbing capacity and policy responses.

Nowadays, econometric and machine learning–based early warning systems represent a substantial methodological advance over CAMELS. Logit, probit, survival models, and tree-based machine learning algorithms estimate the probability of distress rather than assigning descriptive scores. These models consistently outperform CAMELS in predictive accuracy and allow formal hypothesis testing. Where data permit, market-based measures such as distance-to-default and equity volatility provide forward-looking signals of bank risk. These indicators complement accounting data by incorporating investor expectations and real-time information.

Conclusion. This study proposes a hybrid replacement architecture that retains the informational content of CAMELS while embedding it within a modern analytical structure. CAMELS’ variables are treated as explanatory features rather than final scores and are augmented with macroeconomic indicators, stress-test outputs, and governance proxies. The dependent variable characterizes a distress or vulnerability event, allowing estimation through probabilistic models.

In overall, such a framework offers three advantages:

1. Forward-looking assessment through scenario analysis and probability estimation.
2. Policy relevance via stress-based capital and liquidity outcomes.
3. Empirical rigor through model validation and robustness testing.

Meanwhile replacing CAMELS with integrated, risk-based frameworks improves both academic analysis and supervisory decision-making in Kazakhstan where macroeconomic volatility is high, stress testing and EWS models provide particularly strong value added. The gain is obvious for all sides. Policymakers benefit from early signals, while researchers gain access to statistically testable and internationally comparable methodologies.

Therefore, CAMELS remains a useful descriptive tool but is no longer sufficient as a primary framework for bank soundness assessment.

This paper demonstrates that modern banking systems require forward-looking, risk-sensitive, and macro-integrated models**.** By replacing CAMELS with a hybrid framework combining risk-based supervision, stress testing, and early warning systems, regulators and researchers can significantly enhance the accuracy and relevance of bank stability assessment.

In Kazakhstan, where banking stability highly depends on oil prices and exchange-rate movements, CAMELS is no longer sufficient as a primary assessment framework. Moreover, a modern approach integrating risk-based supervision, stress testing, and early warning systems provides superior predictive power and policy relevance.

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CAMELS МОДЕЛІНЕН ТЫСҚАРЫ БАНКТЕРДІҢ ТҰРАҚТЫЛЫҒЫН БАҒАЛАУДЫҢ ЗАМАНАУИ НЕГІЗДЕРІ

Аңдатпа

CAMELS құрылымы ұзақ уақыт бойы капиталдың жеткіліктілігі, активтер сапасы, басқару, табыс, өтімділік және нарықтық тәуекелге сезімталдық сияқты бухгалтерлік есепке негізделген көрсеткіштер арқылы банктердің тұрақтылығын бағалаудың эталондық құралы ретінде қызмет етіп келеді. Ол салыстырмалы түрде тұрақты қаржылық ортада тиімді болғандықтан, макроэкономикалық құбылмалылық, валюта бағамының тәуекелі және сыртқы соққылардың күшті берілуімен сипатталатын дамып келе жатқан, ресурстарға тәуелді экономикалар үшін CAMELS құрылымының жеткіліксіз екендігі дәлелденді. Қазіргі заманғы экологиялық және технологиялық өзгерістер CAMELS құрылымын озық құралдармен ауыстыруға әкеледі.

Қазақстан мұнай бағасының ауытқуы, валютаның құнсыздануы, инфляцияның құбылмалылығы және долларлануы банк секторының тұрақтылығын маңызды түрде қалыптастыратын парадигмалық жағдайды білдіреді. Дегенмен, CAMELS әлі де банктік қадағалау және тәуекелдерді қамтамасыз ету үшін негізгі тәуекелдерді бағалау құрылымы болып қала береді. Қазақстандық депозиттерді сақтандыру қоры банк рейтингісінің негізгі құрылымы ретінде қолданылады.

Бұл зерттеу Қазақстанның банк жүйесіндегі макропруденциалдық реттеуді зерттеу үшін сапалық және саясатқа бағытталған әдіснаманы қолданады. Осы орайда CAMELS құрылымын Қазақстандағы банктердің тұрақтылығын болашаққа бағытталған, макроинтеграцияланған бағалаумен алмастыру үшін көп қабатты эмпирикалық әдіснаманы қолданады. Содан кейін тәуекелге негізделген қадағалау қағидаттарын, макропруденциалдық стресс-тестілеуді және ықтималдық ерте ескерту жүйелерін біріктіру арқылы CAMELS жүйесіне Қазақстанға тән балама әзірленеді.

Бұл зерттеудің мақсаты CAMELS шектеулерін сыни бағалау және тәуекелге негізделген қадағалауды, стресс-тестілеуді және деректерге негізделген ерте ескерту модельдерін біріктіретін интеграцияланған ауыстыру құрылымын ұсыну. Эконометрика мен машиналық оқытудағы соңғы қадағалау тәжірибелері мен жетістіктерін синтездеу арқылы мақала болжамдық күшті, саясаттың өзектілігін және дағдарыстан кейінгі реттеуші стандарттармен сәйкестікті жақсартатын модульдік бағалау архитектурасын әзірлейді. Ұсынылған тәсіл банк тұрақтылығын бағалауды жаңғыртуға тырысатын реттеушілер, зерттеушілер және саясаткерлер үшін сенімді балама ұсынады.

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СОВРЕМЕННЫЕ ПОДХОДЫ К ОЦЕНКЕ ФИНАНСОВОЙ УСТОЙЧИВОСТИ БАНКОВ ЗА ПРЕДЕЛАМИ МОДЕЛИ CAMELS

Аннотация

Система CAMELS долгое время служила эталонным инструментом для оценки устойчивости банков на основе бухгалтерских показателей достаточности капитала, качества активов, управления, прибыли, ликвидности и чувствительности к рыночному риску. Хотя она показала свою эффективность в относительно стабильных финансовых условиях, CAMELS становится все менее эффективной для развивающихся, ресурсозависимых экономик, характеризующихся макроэкономической волатильностью, валютным риском и сильным внешним шоковым воздействием. Современные изменения в окружающей среде и технологиях приводят к замене системы CAMELS более совершенными инструментами.

Казахстан представляет собой показательный пример, в котором колебания цен на нефть, девальвация валюты, волатильность инфляции и долларизация критически влияют на стабильность банковского сектора. Тем не менее, CAMELS по-прежнему остается основной системой оценки рисков для банковского надзора и обеспечения рисков. Фонд страхования депозитов Казахстана используется в качестве основной системы рейтингования банков.

В данном исследовании применяется качественная и политически ориентированная методология по изучению макропруденциального регулирования банковской системы Казахстана. В данном исследовании используется многоуровневая эмпирическая методология, заменяющая структуру CAMELS перспективной макроэкономически интегрированной оценкой финансовой устойчивости банков в Казахстане. Далее разрабатывается специфичная для Казахстана альтернатива системе CAMELS путем интеграции принципов надзора, основанных на оценке рисков, макропруденциального стресс-тестирования и вероятностных систем раннего предупреждения.

Цель данного исследования - критически оценить ограничения CAMELS и предложить интегрированную альтернативную структуру, сочетающую в себе надзор на основе рисков, стресс-тестирование и модели раннего предупреждения, основанные на данных. Путем синтеза современных методов надзора и достижений в эконометрике и машинном обучении в статье разработана модульная архитектура оценки, которая повышает точность прогнозирования, актуальность для политики и соответствие посткризисным нормативным стандартам.

Предложенный подход представляет собой надежную альтернативу для регулирующих органов, исследователей и политиков, стремящихся модернизировать оценку стабильности банков.