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Article

Enhancing Insurance Protection of Commercial Banks' Operational and Cyber Risks and an Econometric Assessment of the Impact of Banking Services Volume on Insurance Premiums

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Abstract: This article scientifically substantiates two new directions for strengthening insurance protection in the operations of commercial banks. First, it proposes setting the minimum threshold of the insurance sum for covering banks' operational and cyber risks through insurance institutions at 1.5-3.0% of the bank's Tier 1 capital, differentiated according to the bank's risk profile. Second, using an autoregressive distributed lag ARDL econometric model, the study determines forecast indicators of the impact of the volume of banking services on the volume of insurance premiums for the period up to 2030. According to the model, the long-run elasticity of banking services volume equals 0.88, and insurance premiums are projected to reach approximately 38 trillion soums by 2030. The proposals are supported by actuarial calculations, the Basel III approach and econometric analysis. The findings contribute to strengthening the financial stability of banks, enhancing the management of operational and cyber risks, and developing bank-insurance integration.

Keywords: insurance of banking services, operational risk, cyber risk, Tier 1 capital, Basel III, ARDL model, insurance premium, forecasting, bank-insurance integration.

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1. Introduction

In the modern financial system, the interconnection between banking and insurance institutions is deepening steadily. Under the conditions of digital transformation, the structure of risks associated with commercial banking is changing fundamentally: alongside traditional credit and market risks, operational and cyber risks are becoming the fastest-growing threat to banks. Although covering such risks through insurance institutions bank-insurance integration is widespread in international practice, in Uzbekistan the mechanism for insuring operational and cyber risks has not yet been established, and a scientifically grounded criterion for determining the insurance sum is absent.

At the same time, the banking sector of Uzbekistan has been developing rapidly in recent years: the credit portfolio of commercial banks exceeded 533 trillion soums at the beginning of 2025. The growth of the volume of banking services, particularly through credit and bancassurance channels, directly affects the insurance market. However, the quantitative measurement and long-term forecast of this impact remain insufficiently studied. Decree No. PF-22 of the President of the Republic of Uzbekistan dated 16 February

2026 defined the expansion of the coverage of financial risk protection for individuals and legal entities, as well as the strengthening of the financial stability of insurance organizations, as a priority task [1]. In addition, the Law 'On Guarantees for the Protection of Bank Deposits' adopted in 2025 strengthened the legal basis of bank-insurance relations [2].

The aim of this article is to scientifically substantiate two directions for improving the insurance protection mechanisms of commercial banks: first, determining the insurance sum for covering operational and cyber risks relative to the bank's Tier 1 capital; and second, assessing the impact of the volume of banking services on insurance premiums using an ARDL econometric model and forecasting it up to 2030.

The theoretical foundations of managing banking risks through insurance trace back to deposit insurance theory. Diamond and Dybvig proved that insuring deposits prevents bank runs and ensures the stability of the banking system [3]. The international basis for regulating operational risk capital is established in the documents of the Basel Committee: operational risk is defined as 'the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events' [4]. Within the Basel III framework, operational risk capital is calculated on the basis of the Business Indicator Component and directly affects the bank's capital adequacy.[5] The risk-based premium system is widely applied in the practice of the US Federal Deposit Insurance Corporation [6], and the International Association of Deposit Insurers also recommends a risk-based approach [7].

Contemporary research on cyber risk insurance emphasizes the specific features of this risk type - high correlation, information asymmetry and 'heavy-tailed' distribution. Biener, Eling and Wirfs analyzed the insurability of cyber risk and showed that it only partially satisfies the criteria of traditional insurability [8]. Eling and Schnell note that, although the cyber insurance market is growing rapidly, the methodology for determining the insurance sum remains insufficiently developed [9]. This gap gives rise to the need to link the insurance sum to the bank's capital base.

In the quantitative assessment of the relationship between banking services and the insurance market, the autoregressive distributed lag ARDL approach is widely used. The bounds testing procedure developed by Pesaran, Shin and Smith allows the identification of long-run relationships among variables of different orders of integration [10]; the error correction mechanism (ECM) is based on the cointegration theory of Engle and Granger [11]. The importance of bank-insurance integration in emerging markets has been substantiated in World Bank research [12]. In Uzbekistan, Abdurasulov analyzed the relationship between insurance reserves and profitability [13], while Akramova examined the role of insurance in managing credit risks [14]. Togayniyazov developed the theoretical foundations of insuring banking services [15]. At the same time, the issues of linking the operational-cyber risk insurance sum to capital and of forecasting the impact of banking services volume on insurance premiums using ARDL remain insufficiently studied. This article is aimed at filling this scientific gap.

2. Materials and Methods

The study employs actuarial insurance-mathematical modelling, a composite risk-scoring method, comparative analysis and econometric modelling. In the first direction, a mathematical model linking the operational and cyber risk insurance sum to the bank's Tier 1 capital was developed and aligned with the Basel III operational risk approach. In the second direction, an ARDL model was constructed on the basis of annual data for Uzbekistan for 2010-2025 insurance premiums and the volume of banking services - the credit portfolio. The stationarity of the variables was tested using the augmented Dickey-Fuller ADF test, and the long-run relationship was assessed through the bounds test and the error correction mechanism ECM. The calculations were performed in the Python statsmodels software environment. The statistical data of the Central Bank of Uzbekistan

and the Ministry of Economy and Finance [16], as well as data of international organizations the Basel Committee, OECD [17], were used as sources.

3. Results and Discussion

1. Linking the insurance sum for operational and cyber risks to capital. Under the conditions of digital transformation, the operational and cyber risks of commercial banks are rising sharply: cyberattacks, internal fraud, disruptions in information systems and operational errors have become a source of large financial losses for banks. Although these risks need to be covered through insurance institutions, in practice there is no single scientific criterion for determining the insurance sum. This article proposes setting the minimum threshold of the insurance sum relative to the bank's Tier 1 capital, because it is precisely Tier 1 capital that constitutes the principal buffer of the bank's loss-absorbing capacity.

The minimum insurance sum for covering operational and cyber risks is determined by the following formula:

$$S_{min} = \alpha \cdot T_1, \qquad \alpha \in$$

where S_{min} is the minimum insurance sum; T_1 is the bank's Tier 1 capital; α is the tariff coefficient defining the ratio of the insurance sum to capital, ranging from 1.5% to 3.0%. The exact value of the coefficient is differentiated according to the bank's operational-cyber risk profile: the level of digitalization, transaction volume, history of operational losses and the maturity of the information security system are taken into account. The risk profile is assessed through the bank's composite operational-cyber risk score ORS, and the coefficient is determined by linear interpolation:

$$\alpha_i = \alpha_{min} + (\alpha_{max} - \alpha_{min}) \cdot \frac{}{(}$$

where ORS_i is the operational-cyber risk score of bank i; α_{min}, α_{max} are the lower and upper bounds of the coefficient for the respective risk class. Banks are divided into three classes according to their risk profile .

Table 1

Classification of banks by operational-cyber risk level and the insurance tariff coefficient (α)[18]

Risk class	Digitalization and transaction volume	Operational loss history and IS maturity	Composite score (ORS)	Coefficient (α)
A - low risk	Moderate	Low losses, strong IS governance	≥ 0.75	1.5-2.0%
B - medium risk	High	Moderate losses, adequate IS	0.55-0.75	2.0-2.5%
C - high risk	Very high (digital bank)	High losses or incidents	< 0.55	2.5-3.0%

From the actuarial standpoint, the insurance sum should cover the bank's maximum expected operational loss (operational Value-at-Risk). Within the Basel III framework, operational risk capital is calculated on the basis of the Business Indicator Component (BIC); therefore, the minimum insurance sum should satisfy the following condition:

$$S_{min} \geq OpVaR_{99.9\%} = \qquad (3)$$

where $OpVaR_{99.9\%}$ is the operational loss at the 99.9% confidence level; *BIC* is the Business Indicator Component; κ is a regulatory coefficient. Linking the insurance sum to capital simplifies this requirement and creates a comparable standard across banks.

The insurance premium is determined as the product of the insurance sum and the operational-cyber insurance tariff:

$$Pr_{op} = S \cdot \tau_{op} \quad (4)$$

where Pr_{op} is the annual insurance premium; τ_{op} is the operational-cyber risk insurance tariff. The dependence of the differentiated insurance sum on the bank's Tier 1 capital is presented in Figure 1.

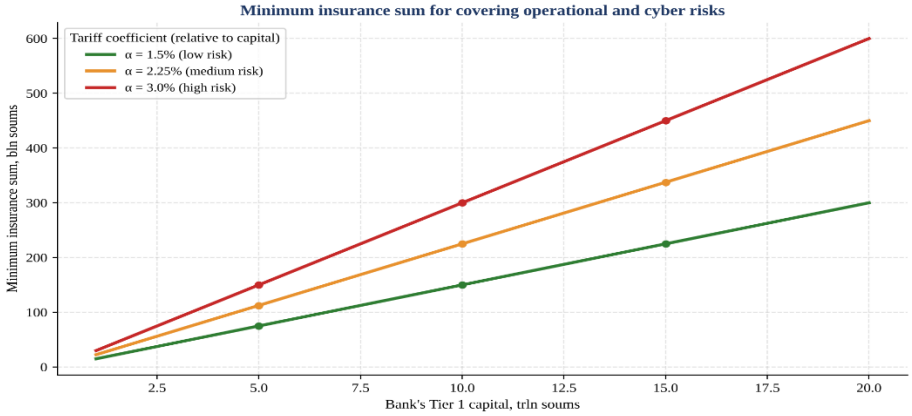

Figure 1. Dependence of the minimum insurance sum for operational-cyber risks on Tier 1 capital

The practical application of the proposal is demonstrated using the example of sample banks. Table 2 presents the minimum insurance sum calculated for three banks with different capital levels and risk profiles.

Table 2

Operational-cyber insurance sum for sample banks (calculation)

Bank	Tier 1 capital, trln soums	Risk class (α)	Minimum insurance sum, bln soums	Annual premium (τ=1.2%), bln soums
Bank A	15.0	A (1.8%)	270.0	3.24
Bank B	8.0	B (2.25%)	180.0	2.16
Bank C	3.0	C (2.8%)	84.0	1.01

The calculations show that the mechanism provides insurance coverage proportional to the bank's capital level and risk degree: a large but low-risk bank (A) has a relatively large insurance sum, yet owing to the low tariff its premium burden remains balanced, whereas a small but high-risk digital bank (C) obtains a higher level of protection relative to its capital. The insurance sums for the sample banks are compared in Figure 2.

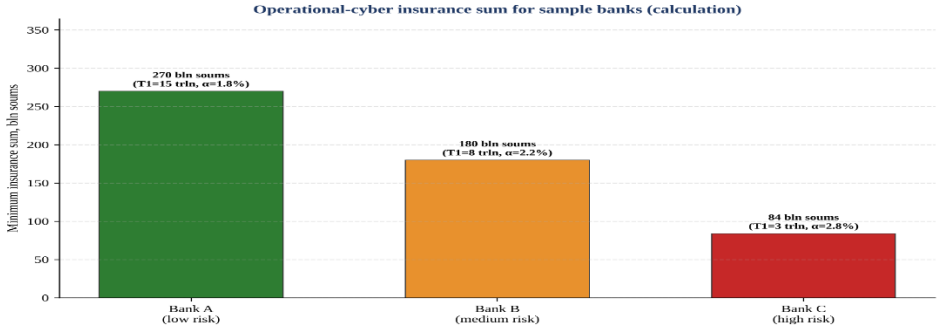

Figure 2. Operational-cyber insurance sum for sample banks

The main advantages of the mechanism are reflected in the practical results confirmed by the implementation certificate: first, it strengthens the operational resilience of commercial banks under digital transformation; second, it covers losses arising from cyberattacks and internal fraud; third, it forms a risk-mitigation mechanism consistent with Basel III requirements; and fourth, it enhances the bank's investment attractiveness in the assessments of international rating agencies. Owing to the insurance coverage, the bank's expected operational loss decreases as follows:

$$\Delta EL_{op} = PE_{op} \cdot LGE_o \quad (5)$$

where ΔEL_{op} is the reduction in expected operational loss; PE_{op} is the probability of an operational event; LGE_{op} is the loss given event; EI_{op} is the risk exposure indicator; c is the insurance coverage coefficient (from 0 to 1).

2. Econometric assessment of the impact of banking services volume on insurance premiums using the ARDL model. In the second direction, the impact of the volume of banking services (represented by the bank credit portfolio) on the volume of insurance premiums was assessed econometrically. The theoretical relationship is expressed in the following functional form:

$$\ln(SP_t) = \beta_0 + \beta_1 \ln(B \quad (6)$$

where SP_t is the volume of insurance premiums; $BANK_t$ is the volume of banking services (credit portfolio); β_1 is the long-run elasticity coefficient. First, the stationarity of the variables was tested using the ADF test (Table 3).

Table 3

Results of the augmented Dickey-Fuller (ADF) unit root test.[19]

Variable	ADF statistic (level)	p-value	ADF (1st difference)	p-value	Order of integration
ln(SP)	2.285	0.999	−3.448	0.009***	I(1)
ln(BANK)	−1.996	0.288	−2.496	0.116*	I(1)

According to the ADF test, both variables are non-stationary in levels but stationary in first differences, i.e. integrated of order I(1). This provides the basis for applying the ARDL approach. The ARDL model is written in general form as follows:

$$\ln(SP_t) = c + \sum_{i=1}^{p} \varphi_i \ln(SP_{t-i}) + \sum_{j=(}^{q}$$

The error correction mechanism (ECM) combines the short-run and long-run dynamics:

$$\Delta \ln(SP_t) = c + \lambda\, ECT_{t-1} + \sum_i \gamma_i \Delta \ln(SP_{t-i})$$

where λ is the speed of adjustment to equilibrium (ECM coefficient); ECT_{t-1} is the error correction term. The estimation results of the ARDL(1,1) model are presented in Table 4.

Table 4

Estimation results of the ARDL(1,1) model (dependent variable: ln(SP))[20]

Variable	Coefficient	Std. error	t-statistic	p-value
const	−0.140	0.384	−0.364	0.723

ln(SP)t−1	0.859	0.139	6.168	0.000***
ln(BANK)t	−0.364	0.345	−1.058	0.313
ln(BANK)t−1	0.488	0.367	1.329	0.211
R^2=0.982 Adjusted R^2=0.976	Durbin-Watson=1.99		Observations=15	

The model has high explanatory power: $R^2 = 0.982$, and the Durbin-Watson statistic is 1.99 (no autocorrelation). The estimated equation takes the following form:

$$\widehat{\ln SP_t} = -0.140 + 0.859 \ln SP_{t-1} - 0.364 \ln B$$

The long-run elasticity coefficient is computed from the ARDL parameters as follows:

$$\beta_{LR} = \frac{\sum_j \theta_j}{1 - \sum_i \varphi_i} = \frac{-0.36}{1 -}$$

According to the result, the long-run elasticity of banking services volume equals 0.876: a 1% increase in the volume of banking services leads, in the long run, to an average 0.88% increase in insurance premiums. In addition, a simple level (cointegrating) regression also confirms a strong relationship: the elasticity is 0.72 (t = 10.2), the correlation coefficient is 0.94, and $R^2 = 0.88$. The error correction coefficient is negative (−0.14), indicating that short-run deviations return to the long-run equilibrium. The relationship between the two variables is presented graphically in Figure 3.

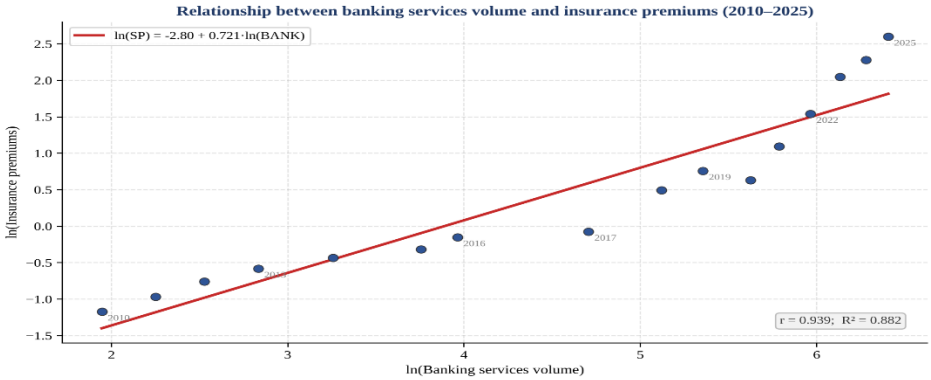

Figure 3. Relationship between banking services volume and insurance premiums (logarithmic scale, 2010-2025)

On the basis of the estimated ARDL model, forecast indicators for 2026-2030 were determined. An average annual growth of 13% in the volume of banking services was assumed, and the model recursively forecast the volume of insurance premiums (Table 5).

Table 5

Forecast of the volume of insurance premiums up to 2030

Year	Banking services volume (BANK), trln soums	Insurance premiums (SP), trln soums	Annual growth, %
2025 (base)	605.0	13.46	—
2026	683.6	17.14	27.3
2027	772.5	21.42	25.0
2028	873.0	26.33	22.9
2029	986.4	31.91	21.2
2030	1,114.7	38.21	19.7

According to the forecast results, under conditions of stable growth in the volume of banking services, insurance premiums will increase from 13.46 trillion soums in 2025 to approximately 38.2 trillion soums by 2030, that is, almost threefold over five years. The actual and forecast dynamics of the volume of banking services and insurance premiums are presented in Figure 4.

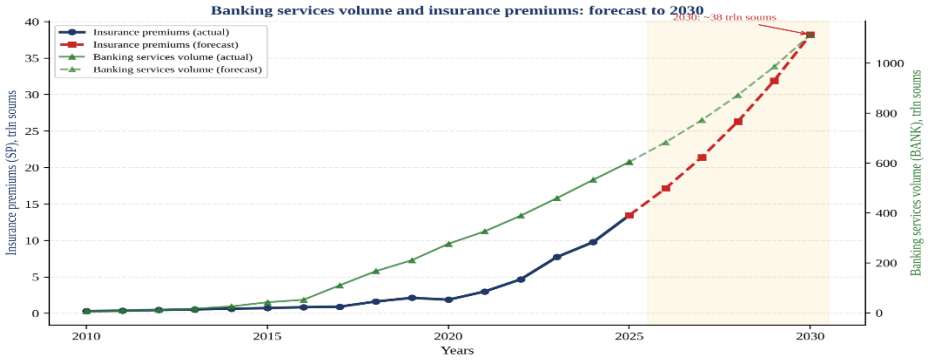

Figure 4. Banking services volume and insurance premiums: forecast to 2030

The econometric analysis quantitatively confirms the long-run equilibrium relationship between the banking and insurance sectors and makes it possible to forecast, in a scientifically grounded manner, the dynamics of insurance premiums attracted through the bancassurance channel. This is of considerable importance for the strategic planning of insurance companies and regulatory authorities.

4. Conclusion

As a result of the study, two new directions for improving the insurance protection mechanisms of commercial banks have been scientifically substantiated.

The first proposal is to set the minimum threshold of the insurance sum for covering banks' operational and cyber risks through insurance institutions at 1.5-3.0% of the bank's Tier 1 capital, differentiated according to the risk profile. This mechanism strengthens the operational resilience of banks under digital transformation, covers losses from cyberattacks and internal fraud, forms a risk-mitigation mechanism consistent with Basel III requirements, and enhances the bank's investment attractiveness.

The second proposal is to assess the impact of banking services volume on insurance premiums using an ARDL econometric model and to forecast it up to 2030. The model showed that the long-run elasticity of banking services volume is 0.88 and that insurance premiums will reach approximately 38 trillion soums by 2030. This makes it possible to quantitatively assess the long-run equilibrium between the banking and insurance sectors and to forecast the growth of the insurance market in a scientifically grounded manner.

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[19] Author's calculations using Python/statsmodels; primary data obtained from the Central Bank of the Republic of Uzbekistan [16]. *** indicates significance at the 1% level; * indicates significance at the 10% level.

[20] Author's calculations using Python/statsmodels; primary data obtained from the Central Bank of the Republic of Uzbekistan [16]. *** indicates significance at the 1% level.