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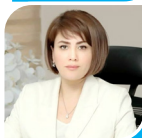
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IMPROVING AUDIT SAMPLING EFFICIENCY THROUGH RISK-BASED STRATIFICATION IN THE INTERNAL AUDIT OF BUDGETARY ORGANIZATIONS

Muqumov Jasur Bosimovich

Researcher, Tashkent State University of Economics

Abstract. The article addresses the issue of improving audit sampling efficiency by stratifying the audited population according to the economic classification of expenditures and risk zones in the audit of budgetary organizations. The research problem is that the widely used “fixed-percentage” approach ignores the risk level of expenditures. The study applies a systematic approach, grouping methods, a risk matrix, scoring, and conditional modelling. As a result, a six-stage methodology is developed that systematically combines risk analysis with stratification. The author’s scientific contribution lies in substantiating a methodology adapted to public audit criteria, in which the risk level, rather than value alone, is used as the main stratification criterion.

Keywords: audit sampling, stratification, risk zone, risk matrix, budgetary organization, economic classification of expenditures, sampling efficiency, public audit, ISA 530, ISSAI 1530.

Аннотация. В статье рассматриваются вопросы повышения эффективности аудиторской выборки посредством стратификации проверяемой совокупности по экономической классификации расходов и зонам риска при проведении внутреннего аудита бюджетных организаций. Исследуемая проблема заключается в том, что широко применяемый подход фиксированного процента выборки не учитывает уровень риска отдельных категорий расходов. В исследовании использованы системный подход, методы группировки, матрица рисков, балльная оценка и условное моделирование. В результате разработана шестиступенчатая методика, комплексно объединяющая анализ рисков и стратификацию аудиторской выборки. Научная новизна исследования заключается в обосновании методики, адаптированной к требованиям государственного аудита, в которой основным критерием стратификации выступает уровень риска, а не только стоимостной показатель.

Ключевые слова: аудиторская выборка, стратификация, зона риска, матрица рисков, бюджетная организация, экономическая классификация расходов, эффективность выборки, государственный аудит, ISA 530, ISSAI 1530.

INTRODUCTION

The effectiveness of audit sampling, which is one of the leading methodological foundations of modern auditing, largely depends on the structure of the audited population. The expenditures of budgetary organizations consist of transactions that differ significantly in volume, nature, and risk level. Alongside uniform and recurring transactions, such as payroll expenses, there are also large and atypical expenditures. In such a mixed population, a sample formed using a single approach may not sufficiently cover all strata. Therefore, dividing the population into homogeneous strata, or stratification, is an important tool for ensuring representativeness and improving sampling efficiency.

The relevance of this issue is also determined by the reforms being implemented in Uzbekistan’s state financial control system. The Decree of the President of the Republic of Uzbekistan No. PF-100 dated July 10, 2024, “On Additional Measures to Strengthen Financial Control over the Use of Budget Funds”, strengthened the risk-oriented approach to control activities, enhanced the internal audit system, and introduced the automated information system “Remote Audit”. In the “Uzbekistan–2030” Strategy, increasing the efficiency of the use of public funds is identified as a priority task. These reforms have significantly increased the need for scientifically grounded and risk-proportionate audit methodologies in public sector auditing.

However, practical analysis shows that in the audit of budgetary organizations, samples are often formed based on the “fixed-percentage” approach, by applying the same percentage to the entire population regardless of the risk level of transactions. Under this approach, high-risk areas may not be sufficiently covered, while low-

risk areas may be over-examined, leading to inefficient allocation of audit resources. Traditional stratification, in turn, is mainly based on the value criterion and does not fully reflect the legality and purposefulness criteria specific to public audit. This problem forms the scientific basis of the present study.

LITERATURE REVIEW

The theoretical foundations of stratification and audit sampling have been extensively developed in foreign scientific literature. The founders of the monetary unit sampling method based their approach on ensuring the coverage of high-value transactions by using the monetary unit as the sampling unit (Leslie et al., 1979).

Neter and Loebbecke conducted an experimental study of the behavior of statistical estimators on audit datasets and demonstrated the effect of population structure on estimation accuracy (Neter and Loebbecke, 1975).

Arens and co-authors described stratification as a tool for reducing population variability and optimizing sample size (Arens et al., 2020).

Empirical research also confirms the practical importance of stratification. Elder et al., in their review of studies on audit sampling, noted that the justification of sample size in heterogeneous populations remains a debatable issue (Elder et al., 2013).

Christensen and co-authors found that risk-based selection has become a priority in the practice of large audit firms (Christensen et al., 2015).

Ganshin developed attribute-based, probability-based statistical, and monetary methods for justifying audit sampling and their algorithms, including stratification algorithms (Ganshin, 2019). However, these studies were mainly conducted within the framework of commercial auditing and do not fully take into account public sector-specific factors.

RESEARCH METHODOLOGY

The research is based on a positivist philosophy and follows a theoretical and methodological design. First, the statistical foundations of stratification and the requirements of international standards are examined. Then, these principles are combined with the specific characteristics of budgetary organizations, after which a practical methodology is developed and tested using a conditional example. This deductive approach ensures a consistent transition from general theoretical principles to specific practical solutions.

The following methods were used in the research process: a systematic approach, which considers stratification as a holistic system interconnected with audit risk, materiality, and sample size; the grouping method, used to divide expenditures into strata according to economic classification items and risk levels; the risk matrix method, applied to identify risk zones by combining the probability of error with financial impact; the scoring method, used to quantitatively assess risk factors; comparative analysis, applied to compare the proposed methodology with the fixed-percentage approach; and conditional modelling, used to demonstrate the methodology through a typical example.

ANALYSIS AND RESULTS

Stratification is a method of dividing a population into strata with similar characteristics. Its statistical basis lies in reducing population variability: since the elements within each stratum are relatively homogeneous, a smaller sample can provide reliable results. As a result, the total sample size can be reduced while maintaining the same level of reliability, or higher precision can be achieved with the same sample size. Thus, stratification is not only an organizational technique but also a statistically justified tool for improving audit efficiency.

The second important advantage of stratification is that it allows the auditor to apply different approaches to different strata. High-risk strata are tested more intensively, while low-risk strata are covered using a smaller sample. The third advantage is the ability to identify and fully test high-value or significant items, thereby reducing the risk of overlooking material errors. The quality of stratification depends on the proper definition of strata: in ideal stratification, variability within strata is minimal, while differences between strata are maximized. To achieve this, stratification criteria should reflect the natural structure of the population.

Expenditures of budgetary organizations are particularly suitable for stratification. First, expenditures are classified according to the budget classification: the economic classification divides them into natural groups such as wages and equivalent payments, purchases of goods and services, capital investments, and transfers, each of which has its own characteristics and risk level. Second, all transactions pass through a single treasury account and are recorded electronically, which makes it possible to stratify expenditures by type and risk level. Third, the risk level of expenditures is clearly differentiated: public procurement and large capital expenditures form high-risk strata, business contracts form medium-risk strata, while wages and utility payments generally form low-risk strata (Table 1).

Table 1
Budget expenditure stratification criteria¹

Meson	Layers	Purpose of stratification
Economic classification	Wages and equivalent payments; purchases of goods and services; capital investments; transfers	Dividing the collection into natural, homogeneous groups
Cost price	Large; medium; small amount transactions	Separate coverage of high-value elements
Risk level	High; medium; low risk strata	Allocation of selection resources in proportion to risk
Additional criteria	Periodicity (regular/one-time); legal regulation	Clear separation of atypical and periodic operations

The conceptual basis of the proposed methodology is the use of risk as the main stratification criterion. While traditional stratification mainly divides strata by value, this methodology uses the risk of error and irregularity as the key criterion. This approach corresponds to the principles of legality and purposefulness in public audit and is consistent with the risk-based control principles established by Decree No. PF-100 of the President of the Republic of Uzbekistan (2024).

The methodology consists of six stages: identification of the audited population; determination of stratification criteria; assessment of the risk level of each stratum; grouping of strata into risk zones; determination of the sampling approach appropriate for each zone; and distribution of the total sample size across strata.

At the first stage, the auditor determines the full range, boundaries, and scope of the budgetary organization's expenditures. Particular attention is paid to the completeness and accuracy of the population: all expenditure transactions must be covered, while duplicate or incorrect entries must be excluded. Otherwise, the audit conclusion may not apply to the entire expenditure population. Treasury data at this stage allow the auditor to form the population completely and accurately; the auditor compares data from treasury and accounting systems.

At the second stage, the main criterion is the economic type of expenditure and the risk level associated with it, while the amount, frequency, and legal regulation of expenditures are used as additional criteria.

At the third, central stage, the risk of each stratum is assessed according to two dimensions: the probability of error or irregularity and its potential financial impact. Each dimension is rated on a scale from 1 to 5, where 1 indicates the lowest level and 5 the highest. Multiplying these two indicators gives the overall risk score of the stratum, ranging from 1 to 25. To ensure objectivity, the assessment is based not only on the auditor's professional judgment but also on specific risk factors: the unusual nature of the transaction, its connection with public procurement, the state of internal control, deficiencies identified in previous audits, and the share of the expenditure in the total budget, as presented in Table 2.

Table 2
Risk factors and their assessment procedure²

Risk factor	Evaluation criteria	Score
Abnormality of the operation	Standard / partially atypical / fully atypical	1 – 3
Related to government procurement	None / partially / fully	1 – 3
Internal control status	Strong / medium / weak	1 – 3
Deficiencies in previous inspections	None / some / many	1 – 3
Financial impact (budget share)	Low / medium / high	1 – 3

Where necessary, individual factors may be assigned weights, and the score may be calculated as a weighted sum.

The scoring is based on the auditor's professional judgment and objective data, including previous audit results and monitoring data. The specific levels assigned to each factor ensure consistency of assessment and help different auditors obtain comparable results.

The results of the risk assessment are documented, which ensures their validity and reproducibility. Risk assessment is a dynamic process and should be revised during each audit period. As the organization's activities, expenditure structure, and risk factors change over time, deficiencies identified in previous audits, changes in the internal control system, and newly emerging risk factors should be taken into account.

¹ Developed by the author

² Author development

Based on the risk scores obtained at the fourth stage, strata are divided into risk zones. At the fifth stage, an appropriate sampling approach is determined for each zone, as presented in Table 3. In this process, the risk matrix visually presents the results of the risk assessment: each stratum is placed along the probability and impact axes, and the risk zone is determined at their intersection.

At the sixth stage, the total sample size is distributed across strata. More sampling units are allocated to high-risk strata, while, when monetary unit sampling is used, allocation is based on the value of each stratum (Table 3).

Table 3
Risk zones and their appropriate selection approach³

Danger zone	Risk score	Relevant Costs (Sample)	Selection approach
High	15 – 25	Public procurement, large and atypical capital expenditures	Full or intensive (high percentage) selection
Medium	7 – 14	Business contracts, purchases of goods and services	Condensed statistical sampling
Low	1 – 6	Wages, utility bills, recurring standard operations	Standard statistical sampling

The practical application of the methodology can be illustrated with a conditional example. Let us assume that a conditional budget organization has four main expense categories: wages (4,000 transactions), utility payments (2,000 transactions), purchases of goods and services (3,000 transactions), and capital expenditures (1,000 transactions). According to the risk assessment, wages and utility payments are included in the low-risk zone (recurring, standard transactions), purchases of goods and services are included in the medium-risk zone, and capital expenditures are included in the high-risk zone. Accordingly, an initial sampling intensity of 3 percent is set for the low-risk zone, 8 percent for the medium-risk zone, and 20 percent for the high-risk zone (Table 4).

Table 4
An example of the application of the stratification method (conditional data)⁴

Layer	Number of operations	Danger zone	Interest	Competition (n)
Salary	4,000	Low	3%	120
Utility bills	2,000	Low	3%	60
Purchase of goods/services	3,000	Medium	8%	240
Capital expenditure	1,000	Up	20%	200
Total	10,000	—	—	620

The example shows that the methodology allocates the sample size in proportion to the risk level of expenditures. Although capital expenditures account for only 1,000 transactions, they are allocated 200 sample units due to their high-risk nature. In contrast, payroll expenditures account for 4,000 transactions, but are covered by 120 sample units due to their low-risk profile. At the initial planning stage, the total sample size is approximately 620 units, or about 6.2% of the population of 10,000 transactions. It should be noted that the 3%, 8%, and 20% coefficients represent initial planning intensities, while the final sample size within each zone is determined using a statistical model that links audit risk, materiality, and the expected error rate.

A comparison with the fixed 5% sampling approach clearly demonstrates the difference. Under the fixed-percentage approach, only 50 samples would be selected from capital expenditures consisting of 1,000 transactions, whereas the proposed methodology allocates 200 samples, which is four times more. This significantly increases the probability of detecting errors in high-risk areas. Conversely, for low-risk payroll expenditures, the methodology allocates 120 samples, while the fixed-percentage approach would require 200 samples, thereby saving audit resources. Thus, with the same overall audit workload, resources are redistributed in proportion to risk: the risk of undetected errors is reduced, and unnecessary checks in low-risk areas are avoided. This can generate significant economic savings for thousands of budgetary organizations nationwide.

³ Author development

⁴ Author development

The methodology has several advantages. First, it allocates audit resources proportionally to risk, increasing coverage in the most risk-sensitive areas. Second, it improves sampling consistency by replacing subjective assessment with objective risk analysis. Third, it directly incorporates the criteria of legality and purposefulness specific to public audit, meaning that it is not an approach mechanically copied from commercial auditing, but one adapted to the public sector. Fourth, since stratification and risk assessment are performed on the basis of clear criteria, the methodology is transparent, fully documented, and strengthens the defensibility of audit conclusions. Fifth, it is flexible: risk factors, weights, the number of zones, and zone boundaries can be adjusted depending on the audit task, as well as the size, sector, and structure of the organization. Sixth, the methodology is compatible with financial, compliance, and performance audits, since risk factors can be adjusted according to the type of audit.

The limitations of the methodology should also be considered. Since professional judgment is involved in risk assessment, a certain degree of subjectivity remains. The application of the methodology also requires auditors to have sufficient qualifications in risk analysis and statistical methods, as well as access to a high-quality and complete database. These limitations can be addressed by formalizing risk assessment criteria and weights in a clear methodological document, training auditors, and ensuring data quality through treasury and accounting systems. Thus, these limitations are not barriers to the application of the methodology, but practical tasks to be resolved.

The use of digital technologies is particularly important in implementing the methodology. Since the automated information system "Remote Audit" centralizes data from budgetary organizations, it provides the necessary information base for automatic expenditure stratification and the identification of risk indicators. Integrating stratification and sampling algorithms into this system as a separate module would allow auditors to perform stratification in real time, automatically calculate risk scores, and consistently document the results (Ganshin, 2019). It is advisable to implement this process step by step: first, stratification criteria and risk factors should be formalized as guidelines for auditors; then, the calculation of risk scores should be automated; and, at the final stage, the methodology should be fully integrated into the "Remote Audit" system.

The methodology can be flexibly applied to different budgetary organizations. The size and structure of the organization should be taken into account: large organizations have a greater number of transactions and a more complex structure, which requires broader stratification and a larger sample, while a simpler approach may be sufficient for smaller organizations. Sector-specific characteristics should also be considered in risk assessment. Education, healthcare, construction, and other sectors have their own expenditure structures and risk profiles. For example, in construction, the dominant risk may be the overstatement of work volumes, while in healthcare, procurement of medicines may represent a key risk area. The periodicity of expenditures should also be taken into account: unlike regular transactions, periodic and one-time transactions, such as capital investments and large purchases, usually require deeper examination in a separate stratum due to their higher risk and lower frequency.

In complex structured populations, multi-level stratification may be applied. Within the high-risk zone, the largest expenditures may be further stratified by transaction value, while the most significant items may be isolated and often fully audited. The number and boundaries of risk zones may also be adjusted depending on the audit task. Although three zones are often sufficient, in complex cases the number of zones may be increased. When determining zone boundaries, the auditor should take into account the distribution of risk scores and practical feasibility. Such flexible zoning ensures the applicability of the methodology to different audit objects and characterizes it as an adaptive approach rather than a universal template.

The methodology is also closely linked to other components of the audit process. Stratification and risk analysis are integrated with audit planning, internal control assessment, and substantive testing. They are not isolated activities, but an integral part of the overall audit process. Risk-based stratification also significantly improves the quality of audit planning: at the very beginning of the audit, the auditor can classify expenditures by risk level and allocate resources and attention appropriately. This systematizes audit process management and reduces the likelihood of unexpected issues. The methodology is also integrated with the audit quality management system: since stratification results, risk assessments, and sampling decisions are documented, they can be reviewed as part of quality control, and the validity of the results can be verified.

The discussion of the results shows that the proposed methodology does not contradict existing scientific views, but rather develops them. Although ISA 530 and ISSAI 1530 recognize stratification as a means of improving audit efficiency, they do not specify its detailed criteria and procedure (IAASB, 2023; INTOSAI, 2020). In the literature, the traditional approach is mainly limited to the value criterion (Arens et al., 2020). The scientific novelty of the proposed methodology lies in the systematic combination of risk analysis with stratification. While traditional stratification is mainly based on cost, the main criterion here is the level of risk, which is consistent with the specific requirements of public audit. The prevalence of risk-oriented sampling in the practice of large audit firms also confirms that the proposed direction corresponds to international trends (Christensen et al.,

2015). At the same time, the methodology represents the first link in the overall system: it determines where the sample should be directed, while the statistical model for determining sample size decides how many elements should be examined in each zone. This issue may serve as the subject of future research.

CONCLUSIONS AND RECOMMENDATIONS

The study led to the following conclusions.

First, stratification was shown to be a statistically valid tool for improving sampling efficiency under conditions of heterogeneity in the expenditure population of budgetary organizations. Dividing the population into homogeneous strata reduces variability and makes it possible to reduce the total sample size while maintaining the same level of reliability.

Second, it was substantiated that budget classification, the single treasury account, and the clear differentiation of expenditure risk levels make budgetary organizations particularly suitable for stratification.

Third, a six-stage methodology for stratifying expenditures by risk zones was developed. It includes identifying the population, establishing stratification criteria, assessing the risk of strata based on a two-dimensional scoring system, namely probability and impact within a range of 1–25 points, grouping strata into high-risk, medium-risk, and low-risk zones, determining the appropriate sampling approach for each zone, and distributing the total sample size.

Fourth, the conditional example demonstrated the fundamental advantages of the proposed methodology over the fixed-percentage approach: coverage of high-risk capital expenditures increases fourfold, while audit resources are saved in low-risk areas.

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