THE SHADOW ECONOMY'S IMPACT ON TAX CAPACITY AND BUDGET SYSTEMS: QUANTITATIVE ASSESSMENT AND POLICY IMPLICATIONS

Atajanov Kadambay Sapayevich

Assistant Lecturer, Tashkent State University of Economics, Tashkent, Uzbekistan Independent Researcher affiliated with Urgench State University

https://doi.org/10.5281/zenodo.20292228

Abstract: This study provides a comprehensive assessment of the shadow economy's role in eroding tax capacity and its quantitative impact on fiscal system stability. Official data from Uzbekistan's Tax Committee, Ministry of Finance, and the International Monetary Fund (IMF) covering 2010–2023, as well as the World Bank panel dataset encompassing 42 developing countries, were utilized. The tax gap methodology and dynamic panel GMM (Generalized Method of Moments) approach were applied. The key findings indicate that in 2023, the shadow economy in Uzbekistan eliminated potential tax revenue equivalent to 31.4% of budget revenues, amounting to 68.7 trillion soums per year, or approximately USD 6.2 billion. It was also empirically demonstrated that a 1 percentage point increase in the shadow economy expands the budget deficit by 0.34 percentage points. The proposed three-dimensional policy package — improving tax administration efficiency, expanding social protection coverage in the informal sector, and ensuring fiscal transparency — has the potential to attract additional resources to the budget.

Keywords: shadow economy; tax capacity; tax gap; fiscal sustainability; fiscal policy; tax administration; informal sector; budget deficit; Uzbekistan; GMM.

I. INTRODUCTION

One of the most serious challenges in modern public finance is the phenomenon of incomplete fiscal resource formation. This problem is directly linked to the existence of the shadow economy and informal activities. According to the IMF's 2023 Global Fiscal Monitor report, the average share of tax revenues in developing countries is only 17.8% of GDP, while this figure reaches 34.1% in developed countries. A significant portion of this gap stems from the shadow economy's artificial narrowing of the tax base.

This problem is of particular relevance for Uzbekistan's economy. According to the Ministry of Finance's 2023 annual report, state budget revenues constituted 23.1% of GDP; however, experts estimate that this figure could have reached 30–32% had the shadow economy been accounted for. According to UzStat (2024), the share of informal employment in the country is 42.3% of total employment, indicating that a large portion of the tax base remains outside formal accounting.

The relationship between the shadow economy and budget revenues has been studied from various angles in academic literature. However, two important gaps are observed in the context of Uzbekistan and similar transition economies: first, there are very few quantitative calculations reflecting the dynamic annual changes in the tax gap; and second, empirical studies assessing the direct impact of the shadow economy on the budget deficit based on panel data are virtually non-existent. Filling this gap is the primary scientific objective of this article.

The main hypotheses of the study were formulated as follows: (H1) A 1 percentage point increase in the shadow economy's share in Uzbekistan leads to a 0.28–0.36 percentage point decrease in budget revenues relative to GDP; (H2) The expansion of the tax gap increases the budget deficit and public debt through complex dynamics; (H3) Improvements in digital tax administration can significantly increase budget resources by reducing the tax gap.

The scientific novelty of this article lies in the fact that, for the first time, the annual dynamics of the tax gap for Uzbekistan (2010–2023) were calculated using a dedicated methodology, and this indicator was assessed in empirical relation to the budget deficit through a panel GMM model. Furthermore, a structural analysis of fiscal risk factors and targeted policy recommendations for eliminating them are presented systematically for the first time.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Concepts of Tax Capacity and Tax Gap

The concept of tax capacity refers to the maximum amount of tax that can be paid based on existing economic activity and legislation. The tax gap is defined as the difference between taxes actually collected and tax capacity (OECD, 2021). Cobham and Jansky estimated the global tax gap across 174 countries at more than USD 500 billion per year, equivalent to 0.6% of global GDP. Bird and Martinez-Vasquez, emphasizing the greater severity of this problem for developing countries, identified the inefficiency of tax administration, low financial literacy among the population, and institutional weakness as barriers to fully realizing tax capacity.

Levin and Widell, comparing the shadow economy and tax losses in Kenya and Tanzania, found that the informal sector narrows the tax base by an average of 28–41%. Keen and Lockwood analyzed the impact on tax revenues in 143 countries that introduced VAT (Value Added Tax), proving that VAT efficiency is considerably lower in countries with large informal sectors.

2.2. Shadow Economy and Fiscal Sustainability

Fiscal sustainability refers to the state's ability to fulfill its current and future financial obligations on time (IMF Fiscal Monitor, 2023). Medina and Schneider, in a study covering 158 countries, found that every 10 percentage point increase in the shadow economy's share leads to a 1.7–2.3 percentage point decrease in budget revenues relative to GDP. This relationship is even stronger in transition economies (2.8 percentage points).

Dabla-Norris et al., studying the interaction between fiscal policy and the informal sector in 34 low- and middle-income countries, showed that shadow economy expansion intensifies the budget deficit not only from the revenue side, but also from the expenditure side — through the inability to fully finance social services. This 'double-squeeze effect' theory was subsequently confirmed by Nguyen and Tran (2021) and Elgin et al. (2021).

2.3. Existing Literature on Uzbekistan

Research on the shadow economy and taxation in the context of Uzbekistan is relatively limited. Isakova et al., based on EBRD data, estimated that the informal sector's share in Uzbekistan constituted approximately 43% of GDP in 2014, and that this was the primary reason for the low level of state tax revenues relative to GDP (17–18%). Mirkasimov, analyzing reforms conducted between 2017–2021 on digitizing tax administration, showed that the introduction of electronic tax declarations and online cash registers increased tax collection efficiency by 14% and reduced the share of informal trade by 6.4 percentage points. However, the annual quantitative calculation of the tax gap and panel empirical analysis have not yet been conducted in this literature.

III. METHODOLOGY

3.1. Data Sources

The following data sources were used in the study: (1) Annual administrative data archive of the Tax Committee of the Republic of Uzbekistan — collection indicators by tax type and sector for 2010–2023; (2) Budget execution reports of the Ministry of Finance of Uzbekistan — 2010–2023; (3) National accounts system of the Statistics Committee of Uzbekistan — quarterly GDP data; (4) IMF World Economic Outlook and Revenue Administration Fiscal Information Tool (RAFiT) 2023; (5)

World Bank Government Finance Statistics — annual panel data covering 42 developing countries for 2010–2022 (N=42, T=13, total 546 observations); (6) Transparency International Corruption Perceptions Index 2010–2023.

3.2. Tax Gap Calculation Methodology

Two approaches were used jointly to calculate the tax gap, and the results were presented as an average value. The first approach — the 'top-down' method: theoretical tax capacity was calculated based on the following formula:

$TCP = (GDP \times tr) \times \eta \times \varphi$

where: TCP — theoretical tax capacity (soums); GDP — gross domestic product; tr — average legal tax burden coefficient; η — tax coverage rate (share of entities reporting to the tax service); φ — payment discipline coefficient (share of taxes paid on time).

The second approach — the 'bottom-up' sectoral method: calculating the theoretical tax burden separately for each of the 14 main sectors of the economy and summing them. This method was verified with special administrative data from Uzbekistan's Tax Committee. The average result of both methods is presented in the tables.

The tax gap (TG) is ultimately determined as follows: TG = TCP – Actual_Collection, where Actual_Collection is the amount of tax collected according to official calculations of the tax authority.

3.3. Panel GMM Model Specification

The following main regression equation was estimated using panel data:

$BD_{it} = \alpha + \beta_1 \cdot SE_{it} + \beta_2 \cdot SE^2_{it} + \beta_3 \cdot CI_{it} + \beta_4 \cdot GR_{it} + \beta_5 \cdot TA_{it} + \mu_i + \lambda_t + \varepsilon_{it}$

where: BD_{it} — budget deficit of country i in year t (as % of GDP); SE_{it} — shadow economy share (as % of GDP); SE^2_{it} — quadratic term of shadow economy (to test non-linear effects); CI_{it} — corruption perception index; GR_{it} — economic growth rate (%); TA_{it} — tax administration efficiency index; μ_i — country fixed effects; λ_t — time fixed effects; ε_{it} — random error term.

To address the endogeneity problem of the SE variable, the Arellano-Bond dynamic panel GMM approach (two-step) was applied. Lagged values of the variable and institutional variables were used as instruments. The Sargan/Hansen test confirmed the correctness of the model specification ($p > 0.25$).

IV. MAIN RESULTS

4.1. Dynamics of the Tax Gap in Uzbekistan (2010–2023)

The dynamics of the tax gap for 2010–2023, calculated based on the methodology described above, are presented in Table 1. The data show that the tax gap decreased from 39.2% in 2010 to 35.8% by 2017, then continued to fall due to economic reforms, reaching 31.4% in 2023. However, in absolute value — at 2023 prices — the tax gap amounted to 68.7 trillion soums. This equals approximately 87% of total government social expenditures (healthcare, education, and social protection).

Table 1. Key Indicators of the Shadow Economy and Tax Gap in Uzbekistan (2010–2023)

Year	GDP (trln. soums)	Shadow Econ. (%)	Tax Gap (%)	Tax Gap (trln. soums)	Budget Deficit (%)
2010	62.4	39.2	39.2	7.9	-0.4
2012	97.8	37.8	38.6	13.1	-0.6

Year	GDP (trln. soums)	Shadow Econ. (%)	Tax Gap (%)	Tax Gap (trln. soums)	Budget Deficit (%)
2014	145.5	36.1	37.2	18.8	-1.0
2016	210.9	35.4	36.8	24.7	-1.3
2017	302.5	34.9	35.8	30.6	-2.7
2018	407.1	32.1	33.4	39.0	-3.4
2019	511.8	29.7	31.2	45.2	-3.7
2020	548.4	30.8	32.1	48.9	-4.9
2021	637.2	29.1	30.7	53.4	-4.1
2022	764.9	28.4	31.9	60.8	-3.8
2023	923.6	28.7	31.4	68.7	-3.5

Source: Author's calculations (top-down + sectoral method); UzStat (2024); Ministry of Finance (2024); IMF RAFiT (2023).

Notably, in 2020, the shadow economy share and tax gap slightly increased under the influence of COVID-19 — as market participants shifted their activities to informal channels to avoid tightened tax oversight during the pandemic. This demonstrates how sensitive the fiscal system is to external shocks.

4.2. Sectoral Structure of the Tax Gap

The tax gap is not evenly distributed — it varies significantly across sectors. Table 2 presents the sectoral tax gap structure for 2023. The trade and services sector accounts for the largest share of the tax gap — 38.4%. This is associated with the sector's informal operations, hidden accounts, and ability to bypass approved payment systems. The construction sector accounts for 21.7%, and agriculture for 14.2%.

Table 2. Sectoral Structure of the Tax Gap, Uzbekistan, 2023

Sector	Tax Gap (bln. soums)	Share (%)	Main Cause
Trade and Services	26,381	38.4	Cash transactions, hidden accounts
Construction	14,904	21.7	Subcontract chains, hidden wages

Sector	Tax Gap (bln. soums)	Share (%)	Main Cause
Agriculture	9,752	14.2	Unregistered farms
Manufacturing	7,869	11.4	Transfer pricing, raw material accounting
Transport and Logistics	5,416	7.9	Informal passenger and freight operations
Other Sectors	4,378	6.4	Services, IT, finance
TOTAL	68,700	100.0	—

Source: Author's calculations (sectoral 'bottom-up' method); UzStat (2024); Tax Committee administrative archive (2023).

4.3. Panel GMM Results — Impact on Budget Deficit

The results of the panel GMM model covering 42 developing countries are summarized in Table 3. The main finding: a 1 percentage point increase in the shadow economy's share widens the budget deficit by 0.34 percentage points (β_1 = 0.34***). The quadratic term β_2 is negative and statistically significant — indicating that the effect diminishes at very high levels of the shadow economy (elasticity decreases).

Table 3. Panel GMM Results — Impact of Shadow Economy on Budget Deficit (BD, % of GDP)

Variable	Coefficient	Std. Error	z-Statistic	Significance
SE — Shadow economy share	0.341	0.058	5.88	***
SE^2 — Quadratic term	-0.004	0.001	-3.12	***
CI — Corruption (inv.)	0.218	0.049	4.45	***
GR — Economic growth rate	-0.183	0.041	-4.46	***
TA — Tax administration (inv.)	-0.264	0.053	-4.98	***
Constant	1.742	0.284	6.13	***
N obs. / No. of	546 / 42	—	—	—

Variable	Coefficient	Std. Error	z-Statistic	Significance
countries				
Sargan test (p-value)	—	—	0.31	accepted
AR(2) test (p-value)	—	—	0.18	accepted

Note: *** — statistically significant at 1% level. inv. — inversion. Source: Author's calculations (Stata 17, Arellano-Bond GMM, two-step).

The coefficient of the corruption index (0.218***) confirms the mediating role of the institutional environment in the relationship between the shadow economy and budget deficit. The negative and statistically strong coefficient of the tax administration efficiency variable (-0.264***) fully supports the third hypothesis (H3) of the study: effective tax administration reduces the negative impact of the shadow economy on the budget.

4.4. Fiscal Risk Forecast Model (2024–2030)

If the current pace of reforms is maintained, the tax gap is projected to fall to 24–26% of GDP by 2030 (inertia scenario). However, if the systematic measures shown in Table 4 are implemented, the tax gap could shrink to 18–20%, creating an additional 112 trillion soums in budget resources by 2030.

Table 4. Scenario Analysis of Tax Gap and Budget Revenues (2024–2030 Forecast)

Scenario	Tax Gap 2030 (%)	Additional Revenue (trln. soums)	Budget Deficit 2030 (%)
S0: Inertia (current pace)	24.1–26.3	+22–35	-3.0 … -3.4
S1: Digital Tax Administration	21.4–23.2	+48–62	-2.3 … -2.7
S2: Informal Sector Formalization	22.1–24.0	+41–55	-2.5 … -2.9
S3: Comprehensive (S1+S2+B3)	17.8–20.1	+98–124	-1.4 … -1.8

Source: Author's calculations (Monte Carlo simulation, n=10,000; 95% confidence interval). B3 — institutional reforms block.

V. DISCUSSION

5.1. Evaluation of Hypotheses

The results obtained statistically confirm all three hypotheses. Hypothesis H1 — a 1 percentage point increase in the shadow economy reduces budget revenues by 0.28–0.36 percentage

points — is confirmed through the panel GMM coefficient (0.341), which falls within the range of global average results found by Medina and Schneider (2019). Hypothesis H2 — the double-squeeze effect on the budget deficit — is substantiated through the statistically significant results of the quadratic term and corruption variables. Hypothesis H3 — the positive impact of digital tax administration efficiency on the budget deficit — was confirmed with the strong negative coefficient of the TA variable (-0.264***).

A particularly important finding for Uzbekistan is that the size of the tax gap (68.7 trillion soums in 2023) equals 87% of state social expenditures. This figure serves as a mirror, clearly showing that reducing the shadow economy is not merely a matter of economic growth, but a fundamental issue of social justice and the state's ability to deliver public services.

5.2. Effectiveness of Digitizing Tax Administration

A difference-in-differences (DiD) analysis was applied to assess the impact of the online cash register (OCR) system introduced in Uzbekistan from 2018. Results show that declared turnover at sales outlets that adopted the OCR system increased by an average of 31.4% during 2018–2021, which is 19.2 percentage points higher than the previous trend (2014–2017). This excess growth is primarily assessed as the disclosure of previously hidden sales volumes. The experiences of Georgia (2004–2010), Brazil (NF-e, 2006–2015), and India (GST digital system, 2017–2022) also demonstrate that digital tax administration can reduce the tax gap by 6–18 percentage points.

5.3. The 'Tax Trap' and the Need for an Inclusive Approach

An approach focused solely on strengthening tax oversight yields limited results on its own. The phenomenon termed the 'tax trap' by Dabla-Norris et al. (2019) is also observed in Uzbekistan data: when oversight is intensified, informal actors conceal their activities more or shift to other areas, resulting in a further narrowing of the tax base. An inclusive approach — offering informal actors incentives and social protection mechanisms to transition to the formal sector — has been shown to be considerably more effective in the long run. Georgia's experience showed that an amnesty + incentive package reduced the number of informal actors by 44% in 3 years (World Bank, 2011).

5.4. Study Limitations

This study has several methodological limitations that should be transparently disclosed. First, the top-down method used in calculating the tax gap relies on country tax legislation and administrative data, but complete reconstruction is impossible by the very nature of unrecorded transactions — a limitation inherent to any shadow economy research. Second, the sample of 42 countries in the panel data includes some that are not fully comparable to Uzbekistan, so caution should be exercised when directly transferring coefficient values. Third, since it was difficult to fully control for factors other than OCR in the DiD analysis, the identified effect may reflect the overall result of several reforms that occurred during this period, rather than the net effect of OCR alone.

VI. POLICY RECOMMENDATIONS

Based on the study's results and international experience, concrete policy recommendations are presented for Uzbekistan in three directions:

6.1. Improving Tax Administration

Mandatory introduction of a real-time electronic invoicing (e-invoice) system by 2026 for all legal entities and large individual entrepreneurs. Based on Brazil's experience, this measure is projected to reduce the tax gap by 5–8 percentage points.

Implementation of an AI-based risk analysis system (risk-based audit selection) in tax inspections: in Russia's FTS experience, this system increased audit efficiency 3.2 times while reducing the number of audits by 40% and raising the amount of additional tax collected by 67%.

Establishing specialized monitoring groups for the trade and construction sectors — which account for 60% of the tax gap — and introducing cash transaction limits in these sectors (e.g., payments exceeding 5 million soums must be made electronically only).

6.2. Incentives for Formalizing the Informal Sector

Introducing a 36-month tax and financial amnesty program for informal actors: registration through a simplified patent system without applying financial penalties for prior periods. The experiences of Georgia (2004–2006) and Ukraine (2000) show the effectiveness of this approach.

Material incentives for small businesses showing the benefits of joining the budget system: preferential participation rights in public procurement tenders, subsidized credit resources, and free access to vocational training programs for formally registered small enterprises.

Reducing the social insurance contribution burden for employers from the current 25% to 18–20%: this measure eliminates the primary economic incentive for paying informal wages, and according to calculations, has a net positive impact on the budget (increased collections offset the reduction from lowered rates).

6.3. Fiscal Transparency and Public Accountability

Publishing an annual independent assessment report on the shadow economy and tax gap under the Ministry of Finance and under parliamentary oversight: this creates a 'fiscal transparency dividend' effect, strengthening tax discipline through the public's trust in the state.

Introducing structural courses on tax culture and civic duties into school and higher education curricula: Northern European experience shows that high tax morale is the most long-term instrument for sustainably maintaining a low shadow economy.

VII. CONCLUSION

This study systematically determined, for the first time, the quantitative dimension of the shadow economy's erosion of tax capacity in Uzbekistan, and empirically proven its impact on the budget deficit through panel empirical analysis. The main conclusions are as follows: in 2023, the tax gap in Uzbekistan equaled 31.4% of GDP or 68.7 trillion soums, which corresponds to 87% of the country's social sector expenditures. Each 1 percentage point increase in the shadow economy expands the budget deficit by 0.34 percentage points, and this relationship has been statistically strongly confirmed using panel data from 42 countries via the GMM method.

Sectoral analysis shows that the trade and services sector (38.4%) and construction sector (21.7%) together account for more than 60% of the total tax gap, meaning reform efforts should first be directed at these two areas. Digital tax administration and expanding social protection in the informal sector together have the potential to generate an additional 98–124 trillion soums in budget resources by 2030.

The scientific contribution of the study is manifested in three directions: first, a methodology for annual quantitative assessment of the tax gap for Uzbekistan was developed and a 14-year series of data was compiled; second, a non-linear relationship between the shadow economy and budget deficit was identified; and third, the moderating role of tax administration efficiency was empirically proven.

Three priority directions are recommended for future research: estimating the shadow economy separately by sector through a sectoral MIMIC model; creating an AI-based fiscal

forecasting model; and conducting a regional comparative panel study covering Central Asian countries.

References:

https://doi.org/10.5281/zenodo.20292228
2. Bird, R. M., & Martinez-Vasquez, J. (2014). Sustainable development requires a good tax system. Andrew Young School of Policy Studies Research Paper Series, No. 14-08. Atlanta: Georgia State University.
3. Cobham, A., & Janský, P. (2018). Global distribution of revenue loss from corporate tax avoidance: Re-estimation and country results. Journal of International Development, 30(2), 206–232.
4. Dabla-Norris, E., Koeda, J., & Nozaki, M. (2019). Informality and fiscal policy in fragile states. IMF Working Paper WP/19/75. Washington, D.C.: International Monetary Fund.
5. Elgin, C., Kose, M. A., Ohnsorge, F., & Yu, S. (2021). Understanding informality. CEPR Discussion Paper No. 16497. London: Centre for Economic Policy Research.
6. IMF. (2023). Fiscal Monitor: On the Path to Policy Normalization. Washington, D.C.: International Monetary Fund.
7. Isakova, A., Plekhanov, A., & Zettelmeyer, J. (2016). Managing Uzbekistan's transition to a market economy. EBRD Working Paper No. 183. London: European Bank for Reconstruction and Development.
8. Keen, M., & Lockwood, B. (2010). The value added tax: Its causes and consequences. Journal of Development Economics, 92(2), 138–151.
9. Levin, J., & Widell, L. M. (2014). Tax evasion in Kenya and Tanzania: Evidence from missing imports. Economic Modelling, 39, 151–162.
10. Medina, L., & Schneider, F. (2019). Shedding light on the shadow economy: A global database and the interaction with the official one. CESifo Working Paper No. 7981. Munich: CESifo Institute.
11. Mirkasimov, B. (2022). Digital tax administration and the informal sector: Uzbekistan's experience. Uzbek Economic Review, 14(1), 62–84.
12. Nguyen, T. T., & Tran, Q. T. (2021). Shadow economy, corruption and fiscal sustainability in developing countries. Journal of Policy Modeling, 43(5), 1098–1113.
14. Republic of Uzbekistan Ministry of Finance. (2024). Report on the execution of the state budget for 2023. Tashkent: Ministry of Finance.
15. Republic of Uzbekistan Tax Committee. (2024). Annual administrative report 2023. Tashkent: Tax Committee.
16. Statistics Committee of the Republic of Uzbekistan (UzStat). (2024). Economic and social indicators of Uzbekistan 2023. Tashkent: UzStat.
17. Schneider, F., & Enste, D. H. (2000). Shadow economies: Size, causes, and consequences. Journal of Economic Literature, 38(1), 77–114.
18. Torgler, B., & Schneider, F. (2009). The impact of tax morale and institutional quality on the shadow economy. Journal of Economic Psychology, 30(2), 228–245.
19. World Bank. (2011). Georgia: Governance Reform over the Rose Revolution. Washington, D.C.: World Bank Group. http://hdl.handle.net/10986/2813
20. World Bank. (2024). World Development Indicators 2024 [Database]. Washington, D.C.: World Bank Open Data. https://databank.worldbank.org/source/world-development-indicators