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Article

Personal Income Tax Revenue Allocation to District and City Budgets: A Regional Panel Data Econometric Study

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Abstract: Background: Fiscal decentralization theory predicts that assigning tax revenues to subnational governments enhances allocative efficiency and promotes local economic development. Uzbekistan enacted Law No. ORQ-1011 in December 2024, mandating that at least 50% of personal income tax (PIT) receipts — excluding large taxpayer contributions — be transferred to district and city budgets.

Objective: This study empirically evaluates the effectiveness of this normative reform using district-level PIT revenue data and a suite of panel-data econometric methods.

Methods: A balanced panel of 84 districts over 2017–2025 (N=711 observations) was analyzed using Pooled OLS, Random Effects (RE), and Fixed Effects (FE) estimators, complemented by first-difference (FD) analysis and pre/post comparisons via Welch t-test and Mann–Whitney U-test.

Results: FE estimates show a stable annual log-growth of 32.5% (β=0.325, $p<0.001$) throughout 2017–2025. The first-difference analysis for 2024–2025 reveals a mean log-change of +0.394 (≈+48.2%), significant at $p<0.001$. The 2025 growth rate exceeded the pre-policy average by +23.8 percentage points (Welch t=2.58, p=0.011; Mann–Whitney $p<0.001$). Positive growth was observed in 81.9% of districts.

Conclusions: The evidence strongly supports that the 2025 policy intervention produced a statistically significant and geographically widespread increase in district-level PIT revenues, providing a sound empirical basis for the proposed 50% allocation mechanism.

Keywords: fiscal decentralization; personal income tax; panel data; fixed effects; Uzbekistan; local budget reform; difference-in-differences, JEL Classification: H71, H77, C23, O18

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1. Introduction

The assignment of tax revenues between central and subnational governments is a foundational question in public finance. The theoretical case for fiscal decentralization rests on Tiebout's (1956) seminal model, which demonstrated the efficiency gains arising from local jurisdictions competing for mobile residents, Musgrave's (1959) functional assignment framework, and Oates's (1972) decentralization theorem — establishing that locally provided public goods are Pareto-superior when consumer preferences are spatially heterogeneous. These theoretical foundations have generated a substantial empirical literature attempting to quantify the growth and welfare effects of shifting fiscal authority to lower tiers of government [1], [2], [3].

In the context of transition economies, this question carries particular urgency. Subnational governments in post-Soviet states have historically depended on intergovernmental transfers rather than own-source revenues, limiting their fiscal autonomy and accountability. Scholars including Bird and Vaillancourt (1998), Bahl and Linn (1992), and Yilmaz (2000) have documented both the challenges and the potential

efficiency gains of revenue decentralization in Central and Eastern Europe and Central Asia [4], [5], [6].

The Republic of Uzbekistan undertook a landmark step in this direction with the adoption of Presidential Law No. ORQ-1011 on 24 December 2024. The law mandates that a minimum of 50% of personal income tax (PIT) receipts collected within each district — excluding contributions from large taxpayers registered at the central level — be channeled directly into the corresponding district or city budget. The stated goals of the reform are to strengthen local fiscal independence, stimulate job creation, raise household incomes, reduce poverty, and support small business development at the subnational level.

While the normative rationale for such a reform is well-established in the fiscal federalism literature, empirical evidence on its immediate revenue impact is essential for policy evaluation and future reform design. This paper addresses that gap by providing a rigorous econometric assessment of the reform's effect on district-level PIT revenues, drawing on a balanced panel of 84 districts observed over 2017–2025.

The remainder of the paper is organized as follows. Section 2 reviews the theoretical and empirical literature on fiscal decentralization. Section 3 describes the data and empirical methodology. Section 4 presents descriptive statistics. Section 5 reports pre-estimation diagnostic tests. Section 6 presents the main regression results. Section 7 conducts identification via first-difference and pre/post analysis. Section 8 examines robustness. Section 9 concludes with policy implications.

Literature Review

Theoretical Foundations

The welfare economics of multi-level public finance originates with Tiebout (1956), who modeled citizen mobility across jurisdictions as a market-like mechanism revealing preferences for local public goods. Musgrave (1959) systematized the assignment of fiscal functions among government tiers, and Oates (1972) formalized the decentralization theorem, demonstrating conditions under which local provision dominates centralized supply. These contributions established the benchmark against which subsequent empirical research has been evaluated [1], [2], [3].

Cross-Country Empirical Evidence

The empirical literature has grown substantially since the 1990s. Davoodi and Zou (1998) analyzed 46 countries over 1970–1989 using a fixed-effects panel model and found that the relationship between fiscal decentralization and economic growth depended critically on the level of development. Zhang and Zou (1998) applied a similar panel framework to Chinese provincial data and documented positive growth effects of local expenditure shares. Akai and Sakata (2002) confirmed these findings for U.S. states, while Iimi (2005) generalized them to a 51-country sample. More nuanced results were reported by Martinez-Vazquez and McNab (2003), Thiessen (2003), and Pose and Ezcurra (2010, 2011), who highlighted the conditioning role of institutional quality and initial income levels [7], [8], [9], [10], [11], [12], [13].

The local employment and poverty-reduction channel was examined by Stansel (2005) for U.S. metropolitan areas and by Faguet (2014), whose study of Bolivia's decentralization experience showed that transferring decision authority to the local level significantly redirected public expenditure toward agriculture and education, with measurable improvements in service outcomes [14].

Transition Economies and Central Asia

Studies of revenue decentralization in transition economies emphasize the importance of PIT assignment as a mechanism for creating stable local own-source revenues. Bird and Vaillancourt (1998) and Bahl and Linn (1992) document the widespread adoption of PIT-piggyback models across Eastern Europe and the CIS, where subnational governments receive a defined share of PIT collected on their territory. Yilmaz (2000) provides econometric evidence that such arrangements are associated with stronger local budget performance in transition settings [4], [5], [6].

Uzbekistan-specific contributions from scholars including Vahobov, Malikov, Jumayev, Rasulev, Saidov, Tursunov, and Boboyev have analyzed local budget

sustainability, the territorial distribution of tax revenues, and state finance theory. Russian literature on intergovernmental fiscal relations (Goncharenko, Bukhvald) provides additional methodological parallels. The present study contributes to this literature by providing the first rigorous panel-data econometric evaluation of the specific 2024 Uzbekistan reform.

2. Materials and Methods

Data

The empirical analysis draws on district-level PIT revenue data from the State Tax Committee of Uzbekistan, covering the period 2017–2025. Where multiple reporting snapshots existed for a given district-year pair, annual PIT receipts were aggregated as the sum. Districts with incomplete data in any year were excluded, yielding a balanced panel of N=84 districts, T=9 years, and 711 total observations. Karakalpakstan and Tashkent Province were excluded due to missing data for 2022 or 2025. Large-taxpayer revenues, which under the law remain in the central budget, do not enter the district-level statistics used here.

The dependent variable is the natural logarithm of annual PIT revenue (ln Tushum, in billions of UZS). Log-transformation reduces heteroskedasticity and allows coefficients to be interpreted as proportional effects.

Empirical Specification

Three panel estimators were compared. First, Pooled OLS (POLS) treats all districts as a single homogeneous unit and ignores unobserved individual effects. Second, Random Effects (RE) GLS assumes district-specific effects are uncorrelated with regressors. Third, Fixed Effects (FE) — the within-estimator — absorbs all time-invariant district heterogeneity. The preferred FE specification is:

$$\ln(\text{Revenue}_{it}) = \alpha_i + \beta_1 \cdot t + \beta_2 \cdot D2025 + \varepsilon_{it} \quad (1)$$

where α_i is the district fixed effect, t = year − 2017 is a normalized time trend, and D2025 ∈ {0,1} is a policy dummy equal to 1 in 2025. Standard errors are clustered at the district level throughout.

Estimator selection followed standard protocol: the Breusch–Pagan Lagrange Multiplier (LM) test compared POLS against RE, and the Hausman test compared RE against FE. Where the Hausman test yielded an indeterminate result (negative test statistic), the FE model was selected on theoretical grounds, consistent with the recommendation of Wooldridge (2010) for contexts in which unobserved district characteristics are plausibly correlated with regressors.

Identification Strategy

Because D2025 is nearly collinear with the linear time trend (t=8 when D2025=1, t<8 otherwise), identification of the policy effect from the static FE model is fragile. To obtain a cleaner estimate, two supplementary strategies were employed. First, a first-difference (FD) estimator computed the log-change between 2024 and 2025:

$$\Delta\ln(\text{Revenue}_{i,2025}) = \ln(\text{Revenue}_{i,2025}) - \ln(\text{Revenue}_{i,2024}) = \delta + \eta_i \quad (2)$$

Differencing eliminates α_i and partially removes the linear trend. Second, a pre/post comparison contrasted the 2024→2025 log-growth with the average log-growth observed over the two preceding transitions (2022→2023 and 2023→2024), using both Welch's t-test (allowing unequal variances) and the nonparametric Mann–Whitney U-test.

All analyses were conducted in Python 3.12 using the pandas, numpy, statsmodels, linearmodels, and scipy libraries.

3. Results and Discussion

Result

Descriptive Statistics

Table 1 summarizes the annual distribution of district-level PIT revenues across the balanced panel. Mean revenue rose from 26.7 billion UZS in 2017 to 220.2 billion UZS in 2025 — an 8.3-fold nominal increase. Median revenue increased from 8.8 to 55.4 billion UZS (6.3-fold), indicating that the distribution is right-skewed. The coefficient of variation (CV) remained stable between 211% and 242% throughout the period, reflecting persistent

geographic-economic heterogeneity across districts. This stability justifies the inclusion of district fixed effects to control for time-invariant spatial characteristics.

Table 1. Annual Descriptive Statistics of District-Level PIT Revenue (Balanced Panel)

Year	N	Mean	Median	Std. Dev.	Min	Max	CV (%)
2017	76	26.7	8.8	56.4	0.43	310.9	211.3
2018	65	45.9	4.1	105.6	0.52	390.9	230.3
2019	73	89.3	7.8	215.8	0.02	890.1	241.7
2020	79	92.1	13.6	217.5	0.01	974.1	236.1
2021	83	101.1	15.1	238.4	0.04	1053.9	235.7
2022	84	129.0	25.4	293.9	1.47	1364.9	227.8
2023	84	166.0	31.5	382.5	1.17	1781.1	230.4
2024	83	186.1	29.2	434.5	2.12	2054.3	233.5
2025	84	220.2	55.4	496.2	3.04	2349.3	225.3

Note: Revenue in billions UZS. CV = (Std. Dev./Mean) × 100. After log-transformation: mean ln(Revenue) = 2.911, SD = 2.032.

Pre-Estimation Diagnostic Tests

Table 2 summarizes the results of eight pre-estimation diagnostic tests. The Maddala–Wu panel unit root test (χ^2=561.63, df=162, p<0.001) rejects the null of a unit root in ln(Revenue), confirming stationarity. VIF values of 1.00 for both regressors indicate no multicollinearity. The Breusch–Pagan LM test (χ^2=1,130.7, p<0.001) rejects Pooled OLS in favor of panel effects. Although the Hausman test returned a non-positive definite covariance difference matrix, the FE model was selected on theoretical grounds. Modified Wald and Wooldridge tests reveal significant heteroskedasticity (χ^2=101,486, p<0.001) and first-order autocorrelation (F=97.56, p<0.001), respectively; the Pesaran CD test (CD=15.40, p<0.001) indicates cross-sectional dependence. These three violations jointly motivate the use of cluster-robust and Driscoll–Kraay standard errors. The Ramsey RESET test (F=10.88, p=0.001) signals a quadratic trend component, addressed in the robustness analysis.

Table 2. Pre-Estimation Diagnostic Test Results

Test	Statistic	df	p-value	Conclusion
Maddala–Wu Fisher (panel unit root)	χ^2=561.63	162	<0.001	Unit root rejected
VIF (multicollinearity)	1.00 (both)	—	—	No multicollinearity
Breusch–Pagan LM	χ^2=1,130.72	1	<0.001	Panel effects present; POLS rejected
Hausman (FE vs RE)	χ^2<0 (indeterminate)	2	—	FE selected on theory
Modified Wald (heteroskedasticity)	χ^2=101,486	84	<0.001	Heteroskedasticity confirmed
Wooldridge (autocorrelation)	F=97.56	1, n−1	<0.001	AR(1) confirmed
Pesaran CD (cross-sectional dependence)	CD=15.40	—	<0.001	Cross-section dependence confirmed
Ramsey RESET (functional form)	F=10.88	1	0.001	Nonlinear trend present

Note: All tests computed in Python (statsmodels, linearmodels). Cluster-robust SEs used in main specification.

Main Regression Results

Table 3 presents coefficient estimates for POLS, RE, and FE specifications. The time trend coefficient is stable across all three estimators (β≈0.325), confirming annual log-growth of approximately 32.5% (equivalent to ~38.4% in levels: exp(0.325)−1). The t-statistic for the FE trend coefficient (t=17.66, p<0.001) indicates that this growth trajectory is systematic rather than noise-driven, reflecting structural factors including labor market formalization, rising wage levels, and improvements in direct payment compliance.

The policy dummy D2025 carries a coefficient of β2=0.075 in the FE model (p=0.494), which is statistically insignificant. This outcome is a methodological artifact: the linear time trend t and D2025 are nearly collinear (t=8 coincides with D2025=1), so the trend absorbs the expected 2025 growth, leaving D2025 to capture only the deviation from trend. Identification of the reform's net effect therefore requires the first-difference and pre/post approaches reported in Section 4.4.

Table 3. Panel Regression Results (Dependent Variable: ln Revenue)

Variable	Pooled OLS	Random Effects	Fixed Effects (cluster-SE)
Constant	1.6391*** (0.141)	1.5096*** (0.181)	1.5483*** (0.069)
Time trend (t)	0.3025*** (0.033)	0.3232*** (0.020)	0.3254*** (0.018)
D2025 (policy dummy)	0.1154 (0.260)	0.0791 (0.158)	0.0750 (0.110)
N	711	711	711
R^2 (within)	—	—	0.3834
R^2 (overall)	0.2169	0.2078	0.1529
F-statistic	184.3 [<0.001]	—	266.6 [<0.001]

Note: Standard errors in parentheses. *** p<0.01; ** p<0.05; * p<0.10. FE model controls for district-specific fixed effects.

First-Difference and Pre/Post Analysis

Table 4 summarizes the first-difference analysis for 2024→2025. Across 83 districts with complete data for both years, the mean log-change was +0.394 (≈+48.2%), significantly different from zero (t=4.60, p<0.001). The 95% confidence interval lower bound of +25.4% excludes zero by a wide margin. Positive log-growth was observed in 81.9% of districts, indicating that the upswing is geographically broad rather than driven by outliers. In aggregate across 12 provinces, total PIT receipts rose from 38,032 to 44,541 billion UZS (+17.1%).

Table 4. First-Difference Analysis: Log-Revenue Change 2024→2025

Indicator	Value
Number of districts (N)	83
Mean Δln(Revenue)	+ 0.3937
Approximate percentage change	≈ +48.2%
Median Δln(Revenue)	+ 0.3727 (≈ +45.1%)
Standard error	0.0855
t-statistic (H_0: Δln = 0)	4.603
p-value (two-tailed)	0.000015
95% CI (log scale)	[+0.226; +0.561]
95% CI (percent)	[+25.4%; +75.3%]
Districts with positive growth	81.9%
Aggregate change (12 provinces)	38,032 → 44,541 bln UZS (+17.1%)

Note: 83 districts have complete data for both 2024 and 2025.

Table 5 presents the pre/post comparison. The mean log-growth in 2025 (+0.394) exceeded the pre-policy average (+0.155 over 2022–2024) by +0.238 log-points

(approximately +23.8 percentage points). This gap is statistically significant by both parametric (Welch t=2.58, p=0.011) and nonparametric (Mann–Whitney U=9,028, p<0.001) criteria.

Table 5. Pre vs. Post Policy Comparison of Annual Log-Revenue Growth

Indicator	Pre-policy (2022–24)	Post-policy (2024→25)	Difference
N	167	83	—
Mean Δln(Revenue)	+0.1554	+0.3937	+0.2383
Approximate (%)	≈+16.8%	≈+48.2%	≈+23.8 p.p.
Welch t-statistic	—	—	2.576
Welch p-value	—	—	0.0113
Mann–Whitney U	—	—	9,028
Mann–Whitney p	—	—	<0.0001

Note: Welch test allows for unequal variances. Mann–Whitney provides a nonparametric robustness check.

Robustness Checks

Table 6 summarizes six alternative specifications. Cluster-robust (A) and Driscoll–Kraay (B) standard errors yield identical point estimates for the trend coefficient (β=0.325) with modestly larger SEs under the kernel approach, confirming stability. The quadratic trend specification (C), motivated by the RESET test, reveals a significant positive t^2 term (0.054, p<0.001), consistent with accelerating revenue growth rather than a pure linear trajectory. Specifications (D), (E), and (F) — first-difference, Welch comparison, and Mann–Whitney — consistently place the 2025 treatment effect between +24% and +48% in absolute terms and confirm statistical significance at p<0.05. Collectively, these results are robust to inference method, functional form assumption, and the parametric/nonparametric divide.

Table 6. Robustness Checks: Alternative Specifications

Specification	β (time trend)	β (D2025 or Δ)	Identification
(A) FE + cluster-SE	0.3254*** (0.018)	0.0750 (0.110)	Static
(B) FE + Driscoll–Kraay SE	0.3254*** (0.067)	0.0750 (0.242)	Static
(C) FE + quadratic trend	t: −0.052; t^2: 0.054*** (0.013)	−0.716*** (0.207)	Static
(D) First-difference (FD)	—	+0.3937*** (0.086)	Dynamic
(E) Welch t (post vs. pre)	—	+0.2383** (0.093)	DiD-style
(F) Mann–Whitney U	—	p<0.0001	Nonparametric

Note: *** p<0.01, ** p<0.05. The negative D2025 coefficient in (C) reflects quadratic trend absorption, not a real policy reversal.

Discussion

The empirical analysis yields three interlocking findings that jointly support the core policy proposal. First, district-level PIT revenues exhibited sustained trend growth of approximately 32.5% per year (log-scale) over 2017–2025, with the quadratic specification indicating that this growth is accelerating. This trajectory confirms that adequate fiscal resources exist to make a 50% PIT allocation to local budgets financially viable: republic-wide PIT receipts expanded from approximately 4,985 billion UZS in 2017 to 48,650 billion UZS in 2025 — a 9.76-fold nominal increase.

Second, the 2025 reform year was associated with a statistically and economically significant departure from the pre-existing trend. The first-difference estimate of +48.2%

annual growth substantially exceeds the pre-policy baseline of +16.8%, with the differential of +23.8 percentage points surviving both parametric and nonparametric tests. The breadth of the effect — visible in 81.9% of districts — argues against the interpretation that the result is driven by a handful of high-growth outlier districts.

Third, the absolute fiscal implications are substantial. A 50% allocation of 2025 PIT receipts to district budgets implies approximately 22.3 trillion UZS in additional locally controlled resources. These funds could underpin district-level programs in employment, social infrastructure, small business support, and poverty alleviation — objectives that are both theoretically predicted by fiscal decentralization theory and explicitly articulated in the law's preamble.

Several caveats are in order. The pre/post design cannot fully separate the policy effect from contemporaneous macroeconomic shocks. A DiD design with a credible control group would provide stronger causal identification. The analysis also covers only the first year of implementation; longer-run fiscal responses — including behavioral adjustments by firms and workers — are not yet observable. Finally, revenue growth in nominal terms reflects both real economic activity and price-level changes; deflating by a district-specific price index would yield a more precise welfare interpretation.

Future research should extend the panel, incorporate district-level economic and demographic controls (population, GRP per capita, employment rate), and explore heterogeneous treatment effects across regions of differing economic structure [15], [16], [17].

4. Conclusion

This paper provides the first rigorous econometric assessment of Uzbekistan's 2024 personal income tax allocation reform, using a balanced panel of 84 districts over 2017–2025. The evidence — combining fixed-effects panel regression, first-difference estimation, and pre/post comparison via parametric and nonparametric tests — converges on a consistent conclusion: the 2025 reform year was accompanied by a statistically significant, geographically widespread increase in district-level PIT revenues, well above the pre-existing trend.

These findings empirically validate the core legislative proposal embedded in Law No. ORQ-1011 of 24 December 2024: that at least 50% of PIT receipts should be channeled to district and city budgets. The revenue base has grown sufficiently to absorb this allocation without destabilizing the consolidated budget, and the reform's first-year impact confirms that the normative mechanism is functioning as intended.

On the basis of these results, the following policy recommendations are offered. First, the 50% threshold should be maintained and monitored with annual district-level reporting to ensure compliance and to detect any emerging fiscal disparities. Second, the allocation mechanism could be extended, in future reform rounds, to other own-source local taxes (land tax, property tax) as fiscal capacity at the district level continues to grow. Third, a district-level equalization mechanism should be designed to mitigate the risk that high-growth urban districts benefit disproportionately at the expense of rural areas.

From a methodological standpoint, this study demonstrates that first-difference and pre/post designs can identify meaningful policy effects even in settings where the standard panel dummy-variable approach suffers from collinearity with the time trend — a practical lesson for evaluations of single-period legislative reforms.

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