CONFERENCE PROCEEDINGS ARTICLE

Do Fiscal Convergence Indicators Survive Verification? Tax Burden Dispersion and Sample Integrity in the EU-27, 2011–2023

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Abstract

Convergence indicators built on ratios of tax revenue to gross domestic product are used to monitor fiscal performance across the European Union and read as evidence that member states are becoming more alike. This paper applies to one such indicator the verification an auditor would apply to any reported figure, through three checks: the composition of the sample, the level of government at which the measure is aggregated, and the strength of the inference. The data are Eurostat tax aggregates by receiving level of government for 2011–2023. The extract as delivered contains 403 rows for a panel of 27 member states; 52 rows belong to two statistical aggregates and two non-member states, and removing them leaves 351 observations for 27 countries over 13 years. Dispersion is measured by the coefficient of variation; catch-up by absolute beta convergence. On the corrected sample the coefficient of variation of total tax revenue falls from 0.1691 to 0.1587, a trend significant at $p = 0.035$. The levels of government disagree: central government revenue converges strongly ($p < 0.001$), social security funds only marginally ($p = 0.058$), and local government revenue, starting from a dispersion more than six times that of the total, drifts apart ($p = 0.070$). Catch-up has the expected sign but a confidence interval that includes zero. Romania moves against the aggregate: its gap from the mean widens from 7.24 to 9.23 percentage points. A convergence claim is only as good as its sample and its level of aggregation.

Keywords: coefficient of variation; level of government; catch-up; statistical audit; European Union; Romania
JEL Classification: H20; H77; C23

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1. INTRODUCTION

Fiscal convergence indicators are instruments of oversight before they are objects of research. The European Semester compares member states on them, country-specific recommendations are argued from them, and the reformed framework for budgetary surveillance adopted in 2024 keeps the comparative reading of revenue ratios in place even as it shifts the unit of assessment to medium-term fiscal-structural plans (European Parliament and Council of the European Union, 2024). A tax-to-GDP ratio published by Eurostat and read across twenty-seven countries is therefore a reported figure with

consequences, and the discipline that applies to reported figures applies to it. The population behind the figure must be what its label says. The measure must aggregate what it claims to aggregate. The confidence attached to the conclusion must match the confidence that the estimate can actually bear.

This paper applies those three tests to the convergence of tax burdens across the European Union over the period 2011–2023 and reports what each of them changes. The first test alters the sample: the extract used here, drawn from the Eurostat main national accounts tax aggregates, contains 403 rows for what is described as an EU-27 panel, and 52 of those rows do not belong to any member state. The second test splits a single aggregate result into three that do not agree with one another, because the total tax ratio is the sum of revenue received by central government, local government and social security funds, and the three series behave differently. The third test downgrades a headline claim from established to merely signed, because the catch-up regression that is conventionally reported alongside the dispersion statistic does not reach significance on a cross-section of twenty-seven observations.

None of this amounts to a rejection of the indicator. Dispersion in total tax burdens did narrow over the period, and once the trend is tested with the small-sample distribution appropriate to a series of thirteen annual observations, the narrowing remains significant at the five per cent level. The argument of the paper is narrower and, we think, more useful: an aggregate convergence statement conceals a drift apart at the level of government where fiscal autonomy actually resides, and a reader who stops at the aggregate will draw a conclusion the data do not support. The same reader, working from the uncorrected extract, would have computed every mean and every dispersion measure on a population that includes Iceland, Norway and two aggregates of the countries already in the sample.

The Romanian case gives the exercise a second motivation. Romania has the lowest tax ratio in the Union once the peculiarities of the Irish denominator are set aside, and the national debate on fiscal consolidation is conducted partly in terms of distance from a European average (European Commission, 2024c). Whether that distance has narrowed or widened over the last decade is a question of fact, and the paper answers it: the gap widened, from 7.24 to 9.23 percentage points of gross domestic product, during a period in which the Union as a whole converged.

Three contributions follow. The paper documents, with the arithmetic of a balanced panel, how a sample contamination that passes every plausibility check enters a convergence indicator. It disaggregates the dispersion test by level of government and shows that the verdicts differ in sign, not only in magnitude. It reports the inference in a form that an auditor would recognise, with the statistic, the standard error, the degrees of freedom and the p-value, and it shows that the choice of reference distribution changes two of the four verdicts. The remainder of the paper is organised as follows. Section 2 reviews the literature on sigma and beta convergence, on fiscal convergence in the European Union, on fiscal federalism and on the verification of statistical indicators. Section 3 describes the data, the sample correction and the estimators. Section 4 reports the results for dispersion, for catch-up

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and for Romania. Section 5 discusses what the results imply for users of the indicator, and Section 6 concludes with the limitations of the exercise and the questions it leaves open.

2. LITERATURE REVIEW

2.1 Sigma Convergence, Beta Convergence and the Distance Between Them

Two concepts that policy documents often conflate are kept apart in the convergence literature. Sigma convergence is present when the cross-sectional dispersion of a variable, measured by its standard deviation or by its coefficient of variation, declines over time. Beta convergence is present when units starting from lower levels grow faster than units starting from higher levels, and it is tested by regressing the average growth rate over a period on the logarithm of the initial level (Barro & Sala-i-Martin, 1992). The two were introduced together and the early empirical work treated a significant negative beta as sufficient evidence that disparities were narrowing.

Friedman (1992) and Quah (1993) showed that the inference does not hold. A negative beta can arise from mean reversion in a distribution whose spread is unchanged, because units at the extremes of any noisy distribution tend to move towards the middle whether or not there is an underlying process of catch-up. Quah named the error after Galton, who had made it in the study of heights, and observed that a regression of growth on initial level is uninformative about the evolution of the cross-sectional distribution unless it is accompanied by a direct measure of that distribution. Sala-i-Martin (1996) accepted the point while defending beta as informative about the speed at which individual units adjust towards their steady states, and Bernard and Durlauf (1996) sharpened the distinction further by showing that the cross-section regression tests a hypothesis that is weaker than the time-series notion of convergence, in which the differences between units disappear in the limit.

The formal relationship between the two measures was made explicit by Young et al. (2008), who derived the condition under which beta convergence coexists with constant or rising dispersion and documented that condition in United States county data. Their result matters for the present paper because it shows that the disagreement between the two tests is a generic feature of noisy panels rather than an artefact of any particular dataset. Phillips and Sul (2007) developed a test of relative convergence based on transition paths that accommodates heterogeneous technology and club formation, and for an oversight framework whose stated objective is cohesion, the survey literature converges on one practical conclusion: sigma convergence is the concept that speaks to whether disparities are actually narrowing, and beta convergence is a statement about the mechanism, to be reported with its confidence interval rather than as a verdict.

2.2 Fiscal Convergence in the European Union

Applying these tools to public finances followed the monetary integration of the 1990s. Kočenda et al. (2008) tested convergence in deficits and debt for the enlarged Union and reported convergence within

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the older member states that did not carry over to the newer ones. Delgado and Presno (2011) turned to fiscal pressure, defined as total tax revenue over gross domestic product, with time-series methods and found convergence in the aggregate ratio that was not uniform across tax categories, with indirect taxation converging faster than direct taxation and social contributions.

One pattern runs through these studies. Each of them found that the aggregate result conceals heterogeneity along some dimension, whether it is the date of accession, the category of tax or the level of government, and none of them reports the composition of the sample beyond the list of countries. The most recent official material continues to present the tax-to-GDP ratio as a single number per country. The Commission's annual taxation report ranks member states by the aggregate ratio and comments on the distance of each from the EU average (European Commission, 2023, 2024c), the OECD does the same for its members (OECD, 2023b, 2024), and the Eurostat statistical article that accompanies the release of the data leads with the aggregate before turning to the structure by type of tax (Eurostat, 2024b). The breakdown by receiving sub-sector of general government is published in the same dataset (Eurostat, 2024a), but it rarely enters the convergence discussion.

Two developments in the policy environment make the question more than academic. The reformed surveillance framework asks member states to commit to a path for net expenditure over four or seven years and assesses the plans partly on revenue projections that are compared across countries (European Parliament and Council of the European Union, 2024; European Fiscal Board, 2023). The Commission's long-term projections, in turn, attach to each member state a revenue-to-GDP ratio that is held broadly constant in the baseline and used to derive sustainability indicators (European Commission, 2024a), while the Fund's own surveillance compares revenue ratios across advanced economies on the same aggregate basis (International Monetary Fund, 2024). Both exercises treat the aggregate ratio as the unit of comparison, and both would be affected by a convergence claim that does not survive disaggregation. The cohesion report is more careful, in that it reports convergence indicators separately for regions and for the national level (European Commission, 2024b), but it does not verify the composition of the underlying panels.

2.3 Fiscal Federalism and the Level of Government

The reason to disaggregate by level of government comes from a different literature. Oates (1999) restated the classical argument that the assignment of revenue to central and subnational authorities reflects constitutional history as much as economic efficiency, and that the resulting arrangements differ across countries in ways that are persistent. The Nordic member states assign a large share of the income tax to municipalities and regions; the unitary states of southern and eastern Europe assign almost nothing beyond property taxes and shared revenues. The revenue-raising autonomy of subnational governments therefore ranges from more than a tenth of gross domestic product to a fraction of one per cent, and the ranking has changed little in two decades (OECD, 2021; OECD & UCLG, 2022; OECD, 2023a).

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For a convergence test the implication is direct. Central government revenue responds to national policy and to the harmonising pressure of the internal market, which has been strongest on value added tax and on the taxation of mobile capital. Social security contributions respond to the design of pension and health systems, which the Union does not harmonise but which face similar demographic pressure everywhere (European Commission, 2024a). Local government revenue responds to constitutional assignments that are not converging at all. Aggregating the three and reporting a single verdict is a measurement decision, and the fiscal federalism literature gives no reason to expect the three components to converge at the same rate or even in the same direction.

2.4 Verification and Audit of Statistical Indicators

A final strand of literature concerns the reported figure itself. Public-sector auditing standards require that any figure used to support a conclusion be traceable to its source, complete for the population it describes and free from misclassification (International Organization of Supreme Audit Institutions, 2019). The Global Internal Audit Standards apply the same principle to information used in the audit of any organisation and require the auditor to assess the reliability of data before relying on it (The Institute of Internal Auditors, 2024). Neither standard was written with convergence regressions in mind, but the requirement they state is the requirement tested in Section 3: that the population behind a figure labelled EU-27 consists of twenty-seven member states and nothing else.

Fiscal statistics have their own verification apparatus. The definitions of general government and of its sub-sectors are set by the statistical manuals (International Monetary Fund, 2014; Eurostat, 2022), and the Court of Auditors reviews the systems that produce the underlying data (European Court of Auditors, 2024). What the apparatus does not do is verify the samples that analysts assemble from the published tables. A dataset downloaded from a public database with the default geographical selection contains aggregates and non-member reporting countries alongside the member states, and an analyst who does not remove them is not misusing the data in any way the producer can detect. The literature on fiscal data revisions has documented how much the reported figures move between vintages (de Castro et al., 2013); the literature on reproducibility in economics has documented how rarely the sample construction behind a published result is verified by anyone other than the author (Christensen & Miguel, 2018). This paper sits between the two. It takes one convergence indicator and asks whether it survives the verification that either literature would require.

3. METHODOLOGY

3.1 Data Source and Variable Definitions

The data are drawn from the Eurostat dataset Main national accounts tax aggregates (gov_10a_taxag), which reports taxes and social contributions received by general government and by each of its sub-sectors in accordance with the European System of Accounts (Eurostat, 2024a). The variable used is

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total receipts from taxes and social contributions, including imputed social contributions and after deduction of amounts assessed but unlikely to be collected, expressed as a percentage of gross domestic product. This is the definition used in the Commission's taxation report and in the Eurostat statistical article (Eurostat, 2024b; European Commission, 2024c), so the figures here can be reconciled with those publications directly.

Disaggregation by receiving level of government uses the sub-sectors defined in the statistical manuals (International Monetary Fund, 2014; Eurostat, 2022): central government, state government, local government and social security funds. Only the federal member states have a state government sub-sector, and in those countries its receipts are combined here with central government so that every country is described by the same three series. Total tax revenue is the general government total, which within each country equals the sum of the three; taxes received directly by the institutions of the European Union are recorded by the producer outside general government and are not included. The period is 2011 to 2023, the longest span for which the sub-sector breakdown is available on a consistent basis for all member states at the time of extraction. Thirteen annual observations per country is short for time-series purposes, and Section 3.5 returns to what this implies for inference.

3.2 Sample Verification

As delivered, the extract contains 403 rows and 31 reporting entities. Four of those entities are not member states. Two are aggregates, the euro area of twenty members and the Union itself, and two are non-member countries that report to Eurostat under the European Economic Area agreement, Iceland and Norway. The arithmetic is unforgiving: 31 entities over 13 years is 403 rows, and 27 entities over 13 years is 351 rows. Retaining the four extra entities does not produce an error message. It produces a panel whose means are pulled towards the aggregates they already contain, whose dispersion measures include a country with a tax ratio far above the Union's median, and whose charts place Norway inside a frame labelled EU-27.

Restricting the panel to the 27 member states is the correction applied, and it leaves exactly 351 observations, 27 countries over 13 years, with no gaps in the total or in the central government series. The local government and social security series are missing for one member state throughout the period, so that the cross-country statistics for those two levels are computed on 26 countries. This is reported wherever it changes the number of observations, and it has a consequence that is easy to miss: the mean of the three levels does not sum to the mean of the total, because the total is averaged over 27 countries and the levels over 26. All results below are computed on the restricted panel.

Table 1 reports the unweighted cross-country mean of each series in 2011 and 2023, its change, and the standard deviation, minimum, maximum and number of observations in 2023. Central government is the dominant recipient with a mean of 22.4 per cent of gross domestic product in 2023, followed by social security funds at 10.7 per cent and local government at 2.8 per cent, and local government is the only one of the three whose mean fell over the period. The spread across countries

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is wide at every level. In 2023 total tax revenue ranges from 21.76 to 43.59 per cent of gross domestic product, and the social security series ranges from almost nothing, in a member state that funds social protection largely from general taxation, to 24.24 per cent.

Table 1.
Total tax revenue and its distribution by level of government, EU-27

Series	Mean 2011 (% of GDP)	Mean 2023 (% of GDP)	Change (pp)	SD 2023	Min 2023	Max 2023	N 2023
Total tax revenue	34.200	35.431	1.231	5.622	21.76	43.59	27
Central government	21.350	22.404	1.054	5.129	10.72	31.46	27
Local government	3.119	2.832	−0.287	3.121	0.19	11.83	26
Social security funds	10.223	10.693	0.470	4.784	0.02	24.24	26

Note: Unweighted cross-country statistics on the restricted EU-27 panel. Within each country the three levels sum to the total by construction of the national accounts. The means shown do not sum across rows because the total is averaged over 27 member states and the local government and social security series over the 26 member states for which they are reported.

Source: Eurostat, Main national accounts tax aggregates (gov_10a_taxag). Author's own calculations.

Figure 1 shows the distribution of the total tax ratio across the member states in 2023, with Romania highlighted and the unweighted EU-27 mean marked by a dashed line. The purpose of the figure is as much to document the sample as to describe it: every bar corresponds to a member state, and no aggregate or non-member country appears. Romania is the second bar from the left.

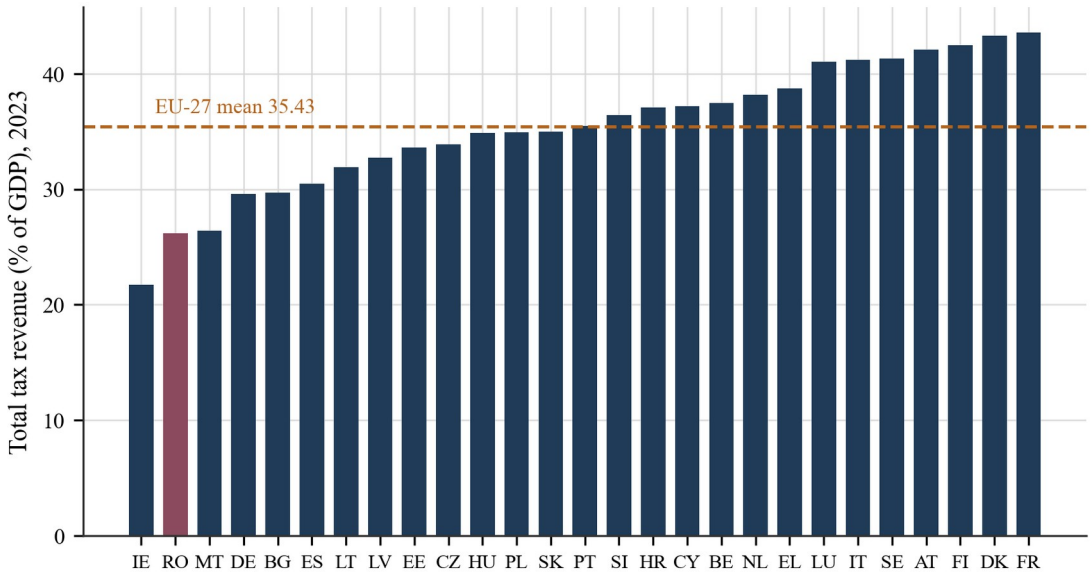


Figure 1. Total tax revenue as a percentage of gross domestic product, EU-27 member states, 2023. Romania is highlighted; the dashed line is the unweighted EU-27 mean. Only member states are included.

Source: Author's own elaboration on Eurostat data.

3.3 Dispersion Test

Sigma convergence is measured by the coefficient of variation of each series across member states in each year, which is the cross-country standard deviation divided by the cross-country mean, as in Equation (1):

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$$\mathrm{CV}_t = s_t \,/\, \bar{x}_t \tag{1}$$

where s_t is the unweighted standard deviation across countries in year t and $\bar{x}_t$ the unweighted mean. The coefficient of variation is preferred to the standard deviation because the four series have very different means and a dispersion measure in percentage points would not be comparable across them. A linear trend is then fitted to the thirteen annual values of each series, as in Equation (2):

$$\mathrm{CV}_t = a + b \cdot t + u_t \tag{2}$$

with t running from 1 in 2011 to 13 in 2023. A negative and significant slope b is read as sigma convergence, a positive and significant slope as divergence, and a slope that is not significant as no verdict. An annual dispersion series is persistent, and ordinary least squares understates the standard error of the slope when the residuals are autocorrelated. The standard errors are therefore computed with the heteroskedasticity and autocorrelation consistent estimator of Newey and West (1987) with a bandwidth of three lags. The change in the coefficient of variation between the first and last year is also reported, as a percentage of the 2011 value, so that the magnitude of the movement can be read directly.

3.4 Catch-up Test

Absolute beta convergence is tested on the total tax ratio by regressing the average annual growth rate over the period on the logarithm of the initial level, as in Equation (3):

$$(1/T) \cdot [\ln(\tau_{i,2023}) - \ln(\tau_{i,2011})] = \alpha + \beta \cdot \ln(\tau_{i,2011}) + \varepsilon_i \tag{3}$$

where $\tau_{i,t}$ is the tax ratio of country i in year t and T = 12 is the number of annual intervals between 2011 and 2023. A negative β indicates that countries with lower initial ratios raised them faster. The cross-section contains 27 observations and the disturbance is unlikely to have constant variance across countries of such different size and fiscal structure, so the standard errors are heteroskedasticity-consistent in the sense of White (1980). The speed of convergence λ and the half-life implied by β follow from the standard transformation in Equation (4):

$$\lambda = -\ln(1 + \beta \cdot T) \,/\, T \;; \quad \text{half-life} = \ln(2) \,/\, \lambda \tag{4}$$

Both quantities are conventionally reported and both are reported here, with the caveat, developed in Section 4.2, that they are arithmetic transformations of a coefficient and carry no more evidential weight than the coefficient does.

3.5 Inference in Small Samples

The trend regression in Equation (2) has thirteen observations and two parameters, which leaves eleven degrees of freedom. A t-statistic of 2.0 has a two-sided p-value of about 0.046 under the normal distribution and about 0.071 under the t distribution with eleven degrees of freedom, and the difference is not cosmetic when a verdict is recorded at the five per cent level. All p-values for the

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trend slopes are therefore computed from the t distribution with eleven degrees of freedom. The catch-up regression has 27 observations and two parameters, hence 25 degrees of freedom, and its p-value is reported under both the asymptotic normal approximation that usually accompanies heteroskedasticity-consistent standard errors and the t distribution with 25 degrees of freedom. Every statistic in Section 4 is given with its standard error so that a reader can reconstruct the test under either reference distribution.

4. RESULTS

4.1 Dispersion: What the Aggregate Hides

Table 2 reports the coefficient of variation of each series in 2011 and 2023, the percentage change between the two years, the fitted trend slope with its Newey and West standard error, the t-statistic and the p-value from the t distribution with eleven degrees of freedom, and the verdict. On the total, the coefficient of variation fell from 0.1691 to 0.1587, a decline of 6.17 per cent, and the fitted trend is negative, with a slope of −0.000792 and a standard error of 0.000329, t = −2.404 and p = 0.035. Read alone, this is a convergence result, significant at the five per cent level though not at the one per cent level.

Table 2.
Dispersion of tax revenue across the EU-27, by level of government

Series	CV 2011	CV 2023	Change (%)	Trend slope	SE	t	p	Verdict
Total	0.1691	0.1587	−6.17	−0.000792	0.000329	−2.404	0.035	convergence (5%)
Central government	0.2538	0.2289	−9.81	−0.002167	0.000339	−6.397	<0.001	convergence (1%)
Local government	1.0968	1.1022	0.49	0.001662	0.000827	2.009	0.070	divergence (10%)
Social security funds	0.4511	0.4474	−0.82	−0.000848	0.000401	−2.113	0.058	convergence (10%)

Note: Coefficient of variation computed across member states in each year; 27 countries for the total and central government, 26 for local government and social security funds. The percentage change is computed on unrounded values. The trend is fitted by ordinary least squares on the thirteen annual values with Newey and West standard errors at three lags; p-values are two-sided from the t distribution with 11 degrees of freedom. A verdict is recorded where the trend is significant at the ten per cent level, with the level of significance in brackets.

Source: Author's own calculations on Eurostat data.

Disaggregated, the levels do not agree with each other. Central government revenue converged strongly: its coefficient of variation fell by 9.81 per cent, the slope of −0.002167 has a standard error of 0.000339, and the t-statistic of −6.397 corresponds to a p-value below 0.001. This is the component of the total that the internal market and the coordination of tax policy act upon most directly, and it is the only component whose convergence is beyond reasonable dispute on these data.

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Social security funds show a much weaker movement. The coefficient of variation fell by 0.82 per cent over the period, the slope of −0.000848 has a standard error of 0.000401, and t = −2.113 gives p = 0.058. The trend has the sign of convergence and would have been recorded as significant at the five per cent level under the normal approximation; under the correct reference distribution it is significant only at the ten per cent level, and we describe the result as marginal.

Local government revenue moves the other way. Its dispersion is of a different order from the start, with a coefficient of variation of 1.0968 in 2011 against 0.1691 for the total, more than six times as large, which is the arithmetic expression of the constitutional heterogeneity described in Section 2.3. The coefficient rose to 1.1022 in 2023, a change of 0.49 per cent, and the fitted slope of 0.001662 has a standard error of 0.000827, t = 2.009 and p = 0.070. The trend is positive and significant at the ten per cent level only. The honest summary is that local government revenue did not converge and shows some evidence of drifting further apart, not that divergence is established.

Figure 2 plots the four annual series on a common scale and makes the contrast visible without any regression. All four lines are nearly flat to the eye, which is the first thing to say about a period of thirteen years: the movements that the trend regressions detect are small relative to the levels. Within that flatness the central government line drifts downward, most visibly after 2020, and the total follows it at a lower level. The social security line barely moves. The local government line sits far above the other three, at a coefficient of variation above one throughout, and its slight upward drift over the period is the divergence that Table 2 records at the ten per cent level.

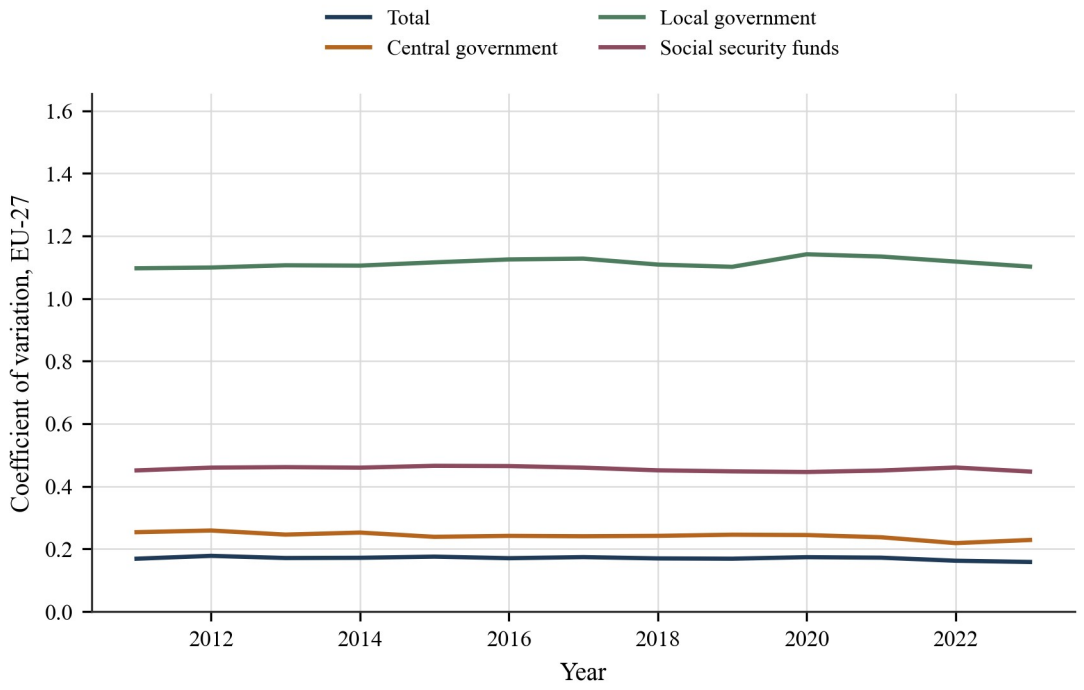


Figure 2. Cross-country dispersion of tax revenue in the EU-27, 2011–2023, measured by the coefficient of variation, for the total and for each level of government.

Source: Author's own elaboration on Eurostat data.

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4.2 Catch-up: A Coefficient That Does Not Reach Significance

Equation (3) estimated on the 27 member states gives a coefficient on the initial logarithm of −0.01434, with a heteroskedasticity-consistent standard error of 0.01032 and a t-statistic of −1.390. Under the asymptotic normal approximation the two-sided p-value is 0.165; under the t distribution with 25 degrees of freedom it is 0.177. The regression accounts for 8.2 per cent of the cross-country variation in average growth rates. The point estimate has the sign that catch-up predicts, and the ninety-five per cent confidence interval computed with the normal critical value, from −0.03456 to 0.00588, includes zero; the interval from the t distribution is wider still. On either reading, catch-up in the total tax ratio is present in sign and absent in significance.

The implied speed of convergence and half-life follow from Equation (4). With $\beta = -0.01434$ and $T = 12$ the speed is 1.57 per cent a year and the half-life is 44.1 years. Both quantities are reported here because they are conventionally reported, and for no other reason. They are transformations of a coefficient that is not statistically distinguishable from zero, and a half-life of 44 years, which on this estimate would place the closing of half of the current gap somewhere in the 2060s, is a statement about the arithmetic of the formula rather than a forecast about the Union.

Figure 3 shows the scatter of average annual growth against the initial logarithm of the tax ratio, with the fitted line. The slope is visibly negative and visibly shallow, and the points are widely scattered around it. Two features of the scatter deserve comment. The countries with the lowest initial ratios are not uniformly the fastest growers, which is what a strong catch-up process would produce: Bulgaria, at the bottom of the initial distribution, raised its ratio at one of the fastest rates in the Union, while Romania and Ireland, its immediate neighbours on the horizontal axis, reduced theirs. Ireland and Malta are the two largest negative observations in the sample and both lie well below the fitted line. The regression is doing what a regression does with such a scatter: it finds a small negative slope and reports that the slope is not distinguishable from zero.

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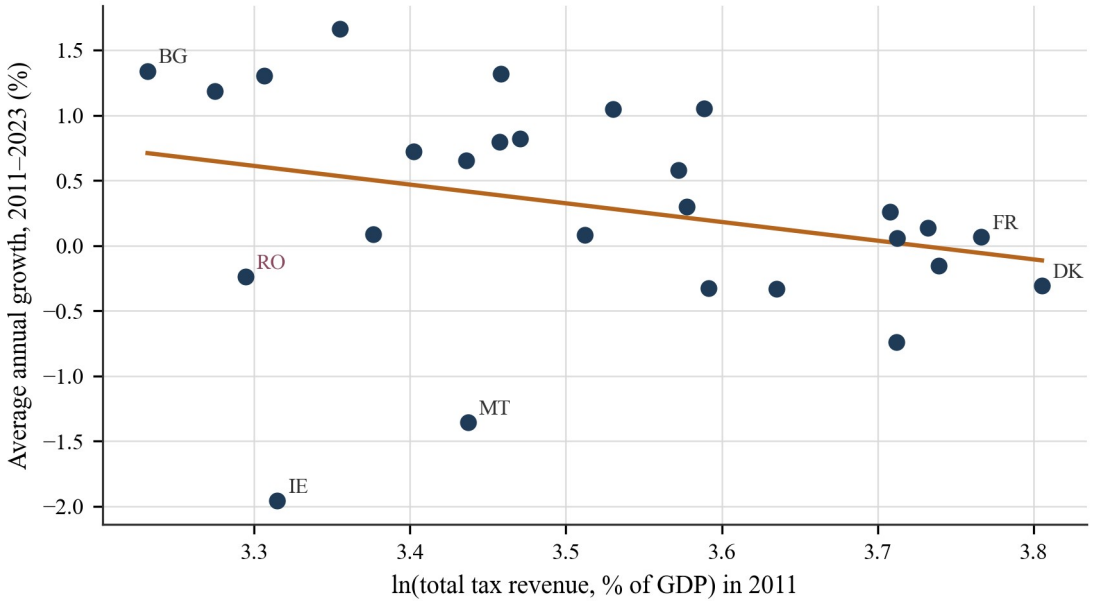


Figure 3. Absolute β-convergence in total tax revenue, EU-27, 2011–2023. Each point is one member state; the line is the fitted regression of average annual growth on the initial logarithm of the tax ratio.

Source: Author's own elaboration on Eurostat data.

Section 2.1 explained why the two tests can disagree. Here they do not disagree so much as answer with different degrees of confidence: dispersion narrowed measurably, catch-up is present in sign but not established. Reporting the second as though it were the first is the error that Friedman (1992) and Quah (1993) warned against, and it is avoided by reporting the confidence interval rather than the point estimate alone. Precision about what the dispersion result does and does not say is also needed. A falling coefficient of variation is consistent with the high-tax countries having reduced their ratios, with the low-tax countries having raised theirs, or with both, and Table 1 shows that the mean rose by 1.231 percentage points over the period. The narrowing therefore occurred around a rising mean, which is the configuration in which a country that held its ratio constant would have fallen further behind.

4.3 Romania: The Gap Widened While the Union Converged

Romania collected 26.96 per cent of gross domestic product in taxes and social contributions in 2011 and 26.20 per cent in 2023, a decline of 0.76 percentage points at a time when the EU-27 mean rose from 34.20 to 35.43. The gap from the mean therefore widened from 7.24 to 9.23 percentage points, an increase of 1.99 percentage points over the period. In 2023 Romania is the second-lowest of the twenty-seven, with only Ireland below it at 21.76 per cent, which is the minimum reported in Table 1.

Figure 4 shows the two series side by side: in panel (a) Romania's ratio against the EU-27 mean, and in panel (b) the gap between them in percentage points. The Romanian series is not monotonic. It rose to a peak of about 28 per cent in 2015, fell sharply over the following two years to a trough of about 25 per cent in 2017, recovered gradually to 2022, and fell again in 2023, so that the

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end-point comparison understates the variation along the way. The gap in panel (b) tells the same story from the other side: it stood at 7.24 percentage points in 2011 and returned to almost exactly that level in 2015, widened abruptly to above 10 percentage points in 2017, narrowed slowly to 2022, and widened again in the final year. At no point after 2015 did it return to its 2011 level.

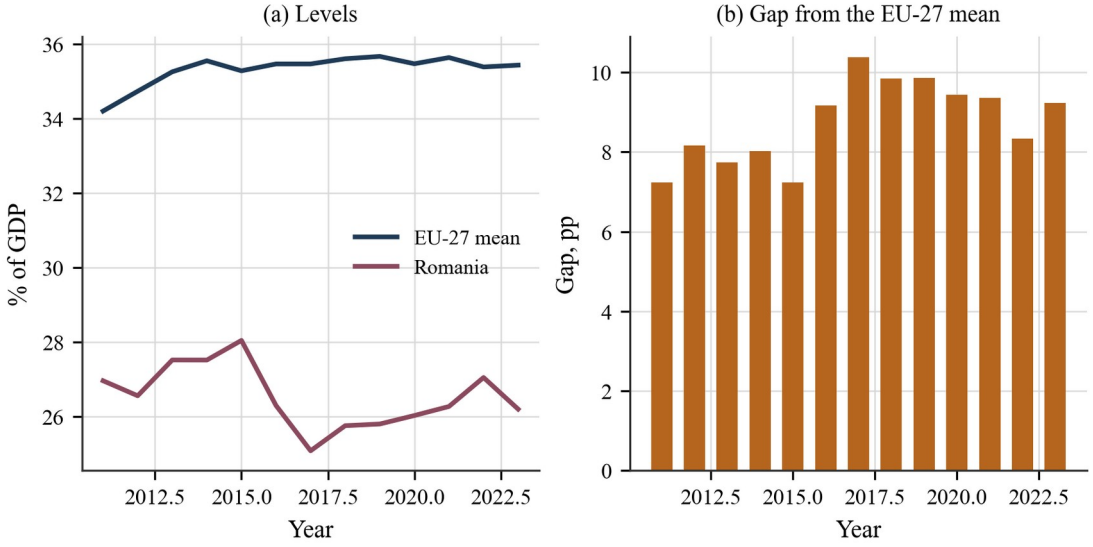


Figure 4. Romania against the EU-27 mean, 2011–2023: (a) total tax revenue as a percentage of gross domestic product; (b) the gap from the unweighted EU-27 mean, in percentage points.

Source: Author's own elaboration on Eurostat data.

The comparison with Ireland requires one sentence of caution. Ireland's ratio is depressed by a denominator inflated by the activities of multinational enterprises rather than by low effective taxation of domestic activity, a point that the Commission's taxation report makes every year when it presents the ranking (European Commission, 2024c). Romania's position at the bottom of the distribution is therefore, in substance, the lowest in the Union. That position was already known. What the panel adds is direction: the Union converged around a rising mean, and Romania moved away from it.

5. DISCUSSION

5.1 The Sample

Of the three results, the first is the least sophisticated and, we would argue, the most consequential for practice. An extract that mixes member states with statistical aggregates and non-member reporting countries will pass every plausibility check that an analyst ordinarily applies. The values are in the right range, the series are complete, the country codes are valid, and the number of rows is a multiple of the number of years. What such an extract produces is wrong means, wrong dispersion measures and a chart that shows a country outside the Union inside a panel labelled EU-27. The contamination in the present case was large in row terms, 52 rows out of 403, and small in effect on the aggregate ratio, because the two aggregates sit close to the mean of the countries that compose them. Its effect on

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the dispersion measures is another matter, since Norway's ratio is far above the Union's median and an aggregate has, by construction, less variance than its components.

What catches the problem costs one line of code and consists of counting. A balanced panel of 27 countries over 13 years has 351 rows, and no other number is acceptable. This is the kind of test that public-sector auditing standards describe as a completeness and classification check on the population (International Organization of Supreme Audit Institutions, 2019), and it is the kind of test that the reproducibility literature finds is rarely performed by anyone other than the original analyst (Christensen & Miguel, 2018). We would add that the default geographical selection in the Eurostat interface includes the aggregates and the EEA countries precisely because they are useful to most users, so the responsibility for the restriction lies with the analyst and cannot be transferred to the producer. The verification reported in Section 3.2 is therefore a statement about how convergence indicators are used rather than about how the underlying statistics are compiled.

5.2 The Level of Aggregation

Turning to aggregation, the second result is that total tax revenue converged while local government revenue drifted apart, and that both statements are true on the same data. They support opposite policy narratives. The first is the narrative of an internal market that harmonises fiscal structures over time; the second is the narrative of persistent and possibly widening institutional heterogeneity in the assignment of revenue to subnational authorities. An oversight framework that reports only the first is not wrong, but it is uninformative precisely where fiscal autonomy differs most across the Union.

This decomposition sharpens what the literature reviewed in Section 2.2 had already found in other dimensions. Delgado and Presno (2011) reported that convergence in fiscal pressure was carried by indirect taxation; the present results show that it is carried, in the dimension of the receiving level of government, almost entirely by central government. The magnitudes are consistent with that interpretation. Central government receives about 63 per cent of total tax revenue in the average member state and its coefficient of variation fell by nearly ten per cent; social security funds receive about 30 per cent and their dispersion barely moved; local government receives about eight per cent and its dispersion rose. The weighted result at the level of the total is what one would expect from those three movements, and the fiscal federalism literature explains why the three differ (Oates, 1999; OECD, 2021). Central government revenue is where value added tax, excise duties and corporate taxation are collected, and those are the taxes the Union has coordinated most closely. Local revenue is where constitutional assignments dominate, and constitutions do not converge because a directive requires it.

There is a further implication for the convergence indicator as an instrument of surveillance. If the reformed framework compares revenue projections across member states (European Parliament and Council of the European Union, 2024), and if those projections are sensitive to the composition of revenue by level of government, then a country whose subnational sector is large will be projected on

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a different basis from a country whose subnational sector is negligible. The aggregate ratio cannot reveal that difference. The disaggregated dispersion measures can, and they cost nothing beyond the breakdown that Eurostat already publishes.

5.3 The Strength of the Claim

The third result is about inference, and it has two parts. The first is the familiar distinction between dispersion and catch-up: the sigma result is significant and the beta result is not, and presenting them together as a single convergence finding overstates what the data establish. The second part is less familiar and emerged during the verification. The trend regressions have eleven degrees of freedom, and the p-values that would be reported under the normal approximation differ from those under the t distribution by enough to change two of the four verdicts. Under the normal approximation, social security funds converge and local government diverges at the five per cent level; under the t distribution, both statements hold only at the ten per cent level. The correction changes no coefficient and no standard error. It changes the reference distribution against which the same t-statistic is judged, and that is enough to move two findings from established to marginal.

We do not think the correction should be read as a reason to dismiss the disaggregated results. A t-statistic of 2.0 on eleven degrees of freedom is evidence, and Figure 2 shows that the local government series behaves differently from the others across the whole period, not only at its end-points. The correction should instead be read as a reminder that a dispersion series of thirteen annual points is a short series, and that a convergence verdict recorded on it must carry its degrees of freedom with it. This is the sense in which the paper's title asks whether the indicator survives verification. It does, in the aggregate and for central government. For the two smaller levels the evidence points in a direction and stops short of a verdict, and an indicator that reports the direction as a verdict has not survived.

5.4 Romania

For Romania the substantive finding is unfavourable and unambiguous. The country reduced its tax ratio while the Union raised its own, and the gap widened by 1.99 percentage points over the period. Whatever convergence the aggregate records, Romania did not participate in it. Two qualifications apply. The first is that a low tax ratio is not in itself a deficiency; the level of taxation is a political choice and the convergence indicator measures similarity, not merit. The second is that the widening of the gap took place around a rising European mean, so that part of it reflects decisions taken elsewhere rather than in Bucharest. Neither qualification changes the arithmetic, and neither changes the observation that the fiscal consolidation now under discussion in Romania starts from a distance to the European mean that is larger than it was a decade ago.

The disaggregated results add a detail that the aggregate hides. Romania's local government sector is small by European standards and its social security contributions are large relative to the

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total, so that the country's distance from the European mean is distributed unevenly across the three levels. A decomposition of the change in the gap into the contributions of the three levels would identify where the widening originated, but it requires an exact accounting identity and a treatment of the dynamic properties of the series that go beyond the descriptive tests used here.

6. CONCLUSIONS

This paper asked whether a convergence indicator built on tax-to-GDP ratios survives the verification an auditor would apply to any reported figure, and it answered in three parts. The sample behind the indicator, as extracted with default settings from the public database, contained 52 rows that did not belong to any member state, and the correction to a balanced panel of 351 observations is a counting exercise that any user of the indicator can perform. On the corrected panel, dispersion in the total tax ratio narrowed from a coefficient of variation of 0.1691 to 0.1587 over 2011–2023, and the trend is significant at the five per cent level once the small-sample distribution is applied. The narrowing is carried by central government revenue, which converged strongly, while social security funds converged only marginally and local government revenue, starting from a dispersion more than six times that of the total, drifted apart at the ten per cent level of significance. Catch-up in the total has the expected sign and a confidence interval that includes zero. Romania moved against the aggregate, and its gap from the European mean widened from 7.24 to 9.23 percentage points.

The practical conclusion is that a convergence claim is only as good as the sample behind it and the level of aggregation at which it is made, and that the confidence attached to it must be stated with its degrees of freedom. None of these requirements is novel. They are the standard requirements for any reported figure, and the point of the paper is that convergence indicators used in fiscal surveillance are reported figures.

Several limitations bound what the analysis can claim. It is descriptive. It measures dispersion and catch-up and does not identify what caused either, and a falling coefficient of variation around a rising mean is consistent with several different combinations of national policy. Absolute beta convergence on 27 observations cannot separate convergence towards a common steady state from convergence towards country-specific ones, and the conditional form of the test, which would add determinants of the steady state as regressors, is not estimable with any precision at this sample size. The period contains both the aftermath of the sovereign debt crisis and the pandemic, whose fiscal treatment differed across member states, and a dispersion series of thirteen points cannot be split into sub-periods without losing what little power it has. The unweighted mean treats Malta and Germany as equal units, which is the convention in the convergence literature but not the only defensible choice. The reliance on end-point comparisons for Romania is mitigated by Figure 4 but not removed.

Each of these limitations points to an extension. The exact decomposition of the change in each country's tax ratio into the contributions of the three levels of government, together with the dynamic properties of the disaggregated series, is left to further work. A longer panel, once the sub-

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sector breakdown is available on a consistent basis for the years before 2011, would allow the trend regressions to be estimated with more degrees of freedom and would permit sub-period analysis. Weighting the dispersion measures by economic size, or replacing the coefficient of variation with a distribution-based measure of the kind proposed by Phillips and Sul (2007), would test whether the verdicts reported here are robust to the choice of statistic. The verification exercise itself could be generalised into a checklist for users of cross-country fiscal indicators, and applying it to other indicators used in surveillance, such as expenditure ratios and structural balances, would show whether the sample and aggregation problems documented here are specific to tax data or general.

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AUTHOR CONTRIBUTIONS

Conceptualisation, A.N.; methodology, A.N.; software, A.N.; formal analysis, A.N.; data curation, A.N.; writing, original draft, A.N.; writing, review and editing, A.N. The author has read and agreed to the published version of the manuscript.

DATA AVAILABILITY

The data are from the Eurostat dataset Main national accounts tax aggregates (gov_10a_taxag), restricted to the 27 member states of the European Union for the years 2011 to 2023. The assembled panel and the estimation code are available from the author on reasonable request.

DECLARATION OF INTEREST

The author is a member of the academic staff of the publishing institution. The manuscript was handled by an independent editor and evaluated through the journal's double-blind peer review process. The author declares no other competing interests.

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