RESEARCH ARTICLE

Auditing a Convergence Claim: An Exact Decomposition of Tax Structure Change by Level of Government in the EU-27

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Abstract

A statement that tax burdens in the European Union are converging is a statement about an aggregate, and an aggregate can be reconciled to its parts as an auditor reconciles a reported total to the records behind it. The change in the tax ratio of each member state between 2011 and 2023 is decomposed exactly into the contributions of central government, local government and social security funds, using Eurostat national accounts tax aggregates for the 27 member states; the identity is checked rather than assumed, and a dynamic panel specification measures how quickly tax ratios adjust. The decomposition closes to a maximum absolute residual of 0.0050 percentage points across the 26 countries with complete data, with a mean residual below 0.0002 percentage points. On that panel the mean tax ratio rose by 1.458 percentage points, of which 1.275 came from central government and 0.470 from social security funds, while local government subtracted 0.287. Central government is the largest contributor in 19 of the 26 countries and social security funds in the other 7. Romania moved against the Union, with a fall of 0.761 percentage points that combines a central government contraction of 1.492 with a social security expansion of 1.007. The fixed-effects persistence coefficient is 0.7754; an approximate bias correction raises it to 0.9368 and lengthens the implied half-life from 2.7 to 10.6 years. Convergence indicators certify less than they are taken to certify until the aggregate is decomposed and the decomposition is shown to close.

Keywords: fiscal federalism; dynamic panel; Nickell bias; social contributions; verification; Romania
JEL Classification: H20; H77; C23

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1. INTRODUCTION

A reported total is checked by reconciling it to the items that compose it. This is the most elementary procedure in auditing, and it is applied here to a familiar statement in European fiscal analysis: that the tax burdens of the member states have been converging. The statement is usually supported by a dispersion measure computed on total tax revenue as a share of gross domestic product, and it is then read as evidence that fiscal systems in the Union are becoming alike. Whether that reading is warranted depends on what lies underneath the total, and the total is a sum of three series that respond

to different pressures: the revenue of central government, the revenue of local government, and the contributions collected by social security funds.

The article has a narrow question and a definite method. The question is how much of the change in each member state's tax ratio between 2011 and 2023 is attributable to each of the three levels of government, and what that attribution does to the convergence reading. The method is an exact decomposition, which is possible because the three components are published as ratios to the same denominator and sum to the total by construction of the national accounts. A decomposition of this kind has no residual in principle; in practice the published series are rounded, and the size of the residual that rounding produces is itself a piece of evidence about whether the exercise can be relied on. We report it, country by country in the figure and in summary in the text, because a decomposition that is asserted to close is a weaker thing than one that is shown to close.

A companion paper by the same author, published in the supplement to the previous issue of this journal, established the aggregate result on a verified sample and found that convergence in the total conceals divergence at the local level (Nicolau, 2026). That paper stopped at dispersion and catch-up. It did not attribute the change in the mean to its sources, it did not estimate how persistent tax ratios are, and it did not examine the residuals of its own catch-up regression. Those three tasks are the contribution of the present article, and the companion's results are cited where they are needed rather than reproduced.

The persistence estimate deserves a word of motivation. A convergence claim is implicitly a claim about adjustment speed: if tax ratios return to their long-run levels quickly, then the dispersion observed in any one year is largely transitory, and a narrowing over thirteen years tells us little about structure. If they adjust slowly, the reverse holds. The natural instrument for measuring adjustment speed is a dynamic panel with country and year effects, and that instrument is known to understate persistence in short panels, a problem identified by Nickell (1981) and never entirely resolved in applied work. We estimate the specification, apply the standard large-T approximation to the bias as an illustrative correction, and are explicit about what the correction does and does not deliver.

Three findings result. The rise in the mean tax ratio of the 26 member states with complete data, 1.458 percentage points, is almost entirely a central government phenomenon, and the subnational tier contracted. Romania moved in the opposite direction to the Union on the total and, internally, in opposite directions across levels of government, so that its modest aggregate decline is the net of two larger movements. And the persistence of tax ratios, once the downward bias of the fixed-effects estimator is allowed for, is high enough that a half-life of roughly a decade is a more defensible description than the two to three years the uncorrected coefficient would suggest.

The rest of the article is organised in the conventional way. Section 2 reviews the literature on convergence testing, on the structure of taxation across levels of government, and on the econometrics of short dynamic panels, and it places the audit perspective within that literature. Section 3 sets out the data, the decomposition, the dynamic specification and the diagnostic checks. Section 4 reports the

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results. Section 5 discusses what they imply for the convergence reading and for oversight practice. Section 6 concludes with limitations and directions for further work.

2. LITERATURE REVIEW

2.1 Convergence Tests and What They Certify

The distinction between dispersion and catch-up is the starting point of the modern convergence literature. Barro and Sala-i-Martin (1992) formalised the regression of growth on initial level as a test of catch-up, and the same authors were clear that a negative coefficient in that regression is a necessary but not a sufficient condition for a decline in cross-sectional dispersion. Friedman (1992) and Quah (1993) made the stronger point that the regression can return a negative coefficient in a population whose dispersion is constant or rising, because units at the extremes of any noisy distribution tend to move towards the centre whether or not any structural catch-up is occurring. The regression test is, in addition, uninformative about long-run convergence when the units have distinct steady states, which is the usual case for fiscal ratios set by different constitutions.

Since then the debate has moved on in two directions relevant here. Johnson and Papageorgiou (2020) surveyed what remains of cross-country convergence in income after three decades of testing and concluded that the answer depends heavily on the sample, the period and the specification, so that any single convergence verdict carries less information than its precision suggests. Patel et al. (2021) and Kremer et al. (2022) documented that unconditional convergence in income, absent for most of the post-war period, appeared in the twenty-first century, which is a reminder that convergence is a property of a period rather than a law. For a fiscal aggregate observed over thirteen years, the implication is that the claim should be stated for the period and the sample on which it was tested and not generalised beyond them.

Neither branch of this literature has much to say about the composition of the variable whose convergence is being tested. That is understandable when the variable is income per head, but total tax revenue is an accounting sum whose components have different determinants, and a convergence verdict on the sum may be silent about, or contradicted by, the behaviour of the parts. This is the gap the decomposition addresses.

2.2 Tax Structure, Competition and the Assignment of Revenue

Theory offers two mechanisms that could drive the tax ratios of member states together, and they operate on different components. The first is tax competition over mobile bases. The standard model predicts that competition for mobile capital drives rates below the level that would be chosen in isolation, and Devereux et al. (2008) found evidence of strategic interaction in corporate rates across OECD countries. The review by Genschel and Schwarz (2011) concluded that competition is real but weaker and more uneven than the simplest models predict, and that its effect on revenue is often offset

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by base broadening. Slemrod (2004) posed the question that bears most directly on the present exercise: whether it is rates or countries that converge, since the answer determines whether convergence in a revenue ratio reflects harmonised systems or merely similar outcomes from dissimilar systems. Keen and Slemrod (2021) illustrate at length how similar revenue outcomes have historically been produced by radically different instruments.

The second mechanism is not competition at all but the assignment of revenue across tiers of government. Oates (1999) restated the case for assigning revenue-raising powers according to the geography of benefits, and observed that constitutional traditions differ so widely across states that no general prediction about subnational revenue shares can be made. The OECD (2022) documents the range: in the European Union, subnational governments raise more than a tenth of GDP in tax in the Nordic countries and almost nothing in several smaller states, and these shares change mainly through discrete reassignments of functions rather than through gradual drift. Nothing in that literature would predict that local government revenue shares should converge across the Union, and the companion paper finds that they did not (Nicolau, 2026).

Social security contributions are a third component with a logic of its own. They are earmarked, they follow the wage bill rather than the business cycle in aggregate demand, and their trajectory is dominated by demographic and labour-market policy. The European Commission (2024a) projects that ageing will raise pension and health expenditure across the Union over the coming decades, and the contribution base is the main instrument through which member states have historically responded. The share of contributions in total revenue varies from close to zero in Denmark, which finances social protection from general taxation, to roughly two fifths in several continental systems (European Commission, 2024b; OECD, 2024). Any convergence statement about total revenue therefore mixes a component that may be driven together by competition, a component with no convergence mechanism, and a component driven by national demographic and labour-market choices.

The macroeconomic environment of the period reinforces the point. The years from 2011 to 2023 contain the fiscal consolidation that followed the sovereign debt crisis, a long interval of low interest rates in which the arithmetic of debt sustainability changed (Blanchard, 2023), and the pandemic and energy shocks whose fiscal treatment differed across member states (International Monetary Fund, 2024). Revenue ratios responded to these episodes at each level of government in different ways, and the decomposition reported below is one way of seeing which level absorbed the adjustment.

2.3 The Companion Result and the Question It Leaves Open

Nicolau (2026) verified the sample behind the convergence claim, restricting a delivered extract to the 27 member states, and found on the corrected panel that the coefficient of variation of total tax revenue fell from 0.1691 in 2011 to 0.1587 in 2023 with a significant negative trend, that central

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government revenue converged strongly while local government revenue diverged, and that the catch-up coefficient had the expected negative sign but a confidence interval including zero. The same paper reported that Romania's gap from the unweighted mean widened over the period. Those results are taken as given here. What they do not contain is an attribution of the change in the mean to its sources, an estimate of persistence, or any diagnostic examination of the catch-up regression, and each of these turns out to alter the reading of the aggregate.

2.4 Dynamic Panels and the Nickell Bias

A convergence claim implies a speed of adjustment, and the speed of adjustment is estimated from a dynamic specification in which the tax ratio depends on its own lag. With country fixed effects and a short time dimension, the within estimator of the autoregressive coefficient is biased downward, because the within transformation induces correlation between the lagged dependent variable and the transformed error. Nickell (1981) derived the bias for the first-order case and showed that for large T it is approximately $-(1 + \rho)/(T - 1)$, where ρ is the true autoregressive parameter; the exact expression involves additional terms that vanish as T grows. Kiviet (1995) obtained higher-order approximations and proposed a corrected least squares dummy variable estimator, and Judson and Owen (1999) showed by simulation that the bias remains material at time dimensions typical of macroeconomic panels, of the order of twenty per cent of the coefficient at $T = 10$ and still non-trivial at $T = 30$. The textbook treatments in Baltagi (2021) and Hsiao (2022) cover the problem and its remedies in detail.

The remedy that has become standard is the generalised method of moments. Arellano and Bond (1991) proposed differencing the model and instrumenting the lagged difference with earlier levels; Blundell and Bond (1998) added the level equation with lagged differences as instruments, which improves precision when the series is persistent, as tax ratios are. Both estimators require a cross-section large enough for the instrument set to be informative, and with 27 countries the proliferation of instruments is a real hazard, as Roodman (2009) documents at length. The approach taken here is more modest and is described as such: the fixed-effects coefficient is reported, the large-T approximation to the bias is applied as an illustrative correction, and the estimation of a system GMM specification on this panel is identified as the next step.

2.5 Verification as a Perspective on Fiscal Indicators

Framing the article as an audit is not a metaphor. Public-sector auditing standards define the auditor's task as obtaining sufficient appropriate evidence that reported information is free from material misstatement, and they give reconciliation of totals to underlying records a central place in that evidence (INTOSAI, 2019). The internal audit standards revised in 2024 extend the same discipline to any information on which decisions are based, whether or not it is financial (Institute of Internal Auditors, 2024). The European Court of Auditors applies these principles to the Union's accounts

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annually and has repeatedly drawn attention to the difference between a figure that is reported and a figure that has been verified (European Court of Auditors, 2024).

Fiscal convergence indicators sit inside the Union's surveillance framework. The reformed economic governance rules adopted in 2024 make a member state's fiscal path the object of a multi-year plan assessed by the Commission, with revenue projections and their composition among the inputs (European Parliament & Council of the European Union, 2024). An indicator that feeds that process is a reported figure with consequences, and the three questions an auditor would ask of it are whether the sample is what its label says, whether the total reconciles to its parts, and whether the confidence attached to the conclusion matches the confidence in the estimate. The companion paper addressed the first; the present article addresses the second and the third.

3. METHODOLOGY

3.1 Data Sources and Sample

The data are the Eurostat main national accounts tax aggregates, dataset gov_10a_taxag, which report taxes and social contributions by receiving subsector of general government as a percentage of gross domestic product, compiled under the European System of Accounts 2010 (Eurostat, 2024a). The three receiving subsectors used here are central government (S.1311), local government (S.1313) and social security funds (S.1314); state government (S.1312) exists only in the federal member states and is small in the aggregate, and the totals in the dataset are constructed so that the subsector series sum to the general government figure once the state tier is absorbed into the central figure, which is how the extract used here was delivered. Classification of a receipt as a tax or a contribution, and its attribution to a receiving subsector, follows the rules in Eurostat's manual on government deficit and debt (Eurostat, 2022). Eurostat's own commentary on the series describes the broad movements over the period and confirms the ranking of member states used in the figures (Eurostat, 2024b).

Coverage runs from 2011 to 2023, thirteen annual observations. The cross-section is the 27 member states of the Union as constituted after 2020, and the panel therefore contains 351 country-year observations with no gaps in the total or in the central government series. For one member state the local government and social security series are not published separately over the whole period, and the decomposition, which requires all three components, is therefore computed on 26 countries. The persistence regression uses the total and is estimated on all 27. The distinction between the 26-country and the 27-country panels is kept explicit throughout because the two give different means: on the 27-country panel the unweighted mean total tax ratio rose by 1.231 percentage points between 2011 and 2023, from 34.200 to 35.431 per cent of GDP (Nicolau, 2026), whereas on the 26-country panel used for the decomposition the rise is 1.458 percentage points. The gap between the two is not an error. Its arithmetic implies that the excluded country's total ratio fell by roughly 4.7 percentage points over the period, and removing a large negative change from a mean of small positive ones raises the mean.

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Every reference to the mean change in what follows is to the 26-country figure unless the 27-country figure is named explicitly.

All statistics are unweighted across countries. A GDP-weighted mean would describe the Union as an economy; an unweighted mean describes the member states as a population, and the convergence claim under examination is a claim about the population.

3.2 The Exact Decomposition

Let τ_i denote the total tax ratio of country i, and c_i, l_i and s_i the ratios accruing to central government, local government and social security funds, each expressed as a percentage of GDP. Because the three components share the denominator and sum to the total, the change over the period decomposes without residual, as in Equation (1):

$$\Delta\tau_i = \Delta c_i + \Delta l_i + \Delta s_i \tag{1}$$

where Δ denotes the difference between 2023 and 2011. No weights and no interaction terms are involved, which distinguishes the exercise from a shift-share or a share-based decomposition, where components expressed as shares of a changing total generate a cross term that must be allocated by convention. Equation (1) closes by construction, and its only source of failure is the rounding of the published series to one or two decimal places. We define the residual of the identity, Equation (2), as the difference between the published change in the total and the sum of the published changes in the components:

$$\varepsilon_i = \Delta\tau_i - (\Delta c_i + \Delta l_i + \Delta s_i) \tag{2}$$

and report its maximum absolute value and its mean across the 26 countries. The mean contribution of each level to the mean change in the total is the unweighted average of the country contributions, and by linearity these three averages sum to the mean change. For each country we also record which of the three components has the largest absolute contribution, which is the simplest summary of where the adjustment took place.

The decomposition is accounting, not causal. It attributes the change in a ratio to the tiers that received the revenue, not to the policies that produced it, and a reassignment of a tax from one tier to another appears as a contribution of equal and opposite sign at the two tiers without any change in the total. This is a feature rather than a defect, because it is exactly what a convergence indicator computed on the total cannot see.

3.3 Persistence and the Bias Correction

Adjustment speed is estimated from the two-way fixed-effects specification in Equation (3):

$$\tau_{it} = \alpha_i + \lambda_t + \rho \cdot \tau_{i,t-1} + u_{it} \tag{3}$$

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where α_i is a country effect, λ_t a year effect that absorbs common shocks including the pandemic years, and ρ the autoregressive parameter whose distance from unity measures the speed at which a country's tax ratio returns to its own long-run level. With one lag the estimation sample is 27 countries by 12 years, 324 observations. Standard errors are clustered by country, following Cameron and Miller (2015), which with 27 clusters is at the lower end of what cluster-robust inference tolerates, and the p-values reported should be read with that in mind.

The estimate of ρ from Equation (3) is biased downward. The large-T approximation to the bias derived by Nickell (1981) for the first-order model is given in Equation (4):

$$\operatorname{plim}(\hat{\rho} - \rho) \approx -(1 + \rho)/(T - 1) \tag{4}$$

where T is the number of time periods in the estimation sample, here 12. We apply Equation (4) as an illustrative correction by evaluating it at the estimated coefficient and adding the resulting magnitude back. Two caveats are stated here and repeated where the numbers appear. The expression is an approximation valid as T grows, and at T = 12 the neglected terms are not negligible; and evaluating it at the biased estimate rather than at the true parameter understates the bias, since the numerator rises with ρ. Solving Equation (4) as a fixed point in ρ instead, so that the correction is evaluated at the corrected value, yields a somewhat higher figure, and Section 4.4 reports it. Neither procedure is a substitute for the estimator that addresses the problem directly, and we say so.

The half-life of a deviation from the long-run level follows from the autoregressive parameter as in Equation (5):

$$h = \ln(0.5) \,/\, \ln(\rho) \tag{5}$$

and is reported for the uncorrected and the corrected coefficient, so that the reader can see how much of the difference between a fast-adjusting and a slow-adjusting reading of the data is produced by the correction alone.

3.4 Diagnostic Checks

The catch-up regression reported in the companion paper regresses the average annual growth rate of the tax ratio over the period on its logarithm in 2011, on 27 observations, and returns a coefficient of −0.01434 with a heteroskedasticity-consistent standard error of 0.01032 (Nicolau, 2026). A regression on 27 observations rests heavily on the distribution of its residuals, and the companion paper did not examine them. We do so here, testing normality with the Jarque and Bera (1980) statistic and the Shapiro–Wilk test and inspecting the residuals against fitted values and against normal quantiles. The purpose is not to rehabilitate or overturn the companion's conclusion, which was already that catch-up is not established, but to determine whether the nominal p-value on which that conclusion rests can be trusted at all, which is the kind of question an audit asks of any reported statistic.

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4. RESULTS

4.1 Closure of the Identity

Everything else depends on the first result. Across the 26 member states with complete data on all three levels of government, the maximum absolute residual of Equation (2) is 0.0050 percentage points, and it occurs for Romania, whose published components sum to a change of −0.766 against a published change in the total of −0.761. The mean residual across the 26 countries is below 0.0002 percentage points in absolute value. These are magnitudes of the order of the last digit to which the series are published, and they are consistent with rounding of each component separately before publication. No country produces a residual that would alter the second decimal place of any contribution reported below. The identity therefore closes to the precision of the data, and the contributions can be read as exact.

We report this before the substantive results because the order matters. A decomposition whose closure has not been demonstrated is an assertion about the data; one whose residual has been computed and found to be at the level of rounding is a reconciliation, and it is the reconciliation, not the assertion, that supports what follows.

4.2 Contributions by Level of Government

Table 1 reports the mean contribution of each level of government to the change in the total tax ratio across the 26 countries, alongside the corresponding figures for Romania. On the 26-country panel the unweighted mean total ratio rose by 1.458 percentage points of GDP between 2011 and 2023. Central government accounts for 1.275 of that, social security funds for 0.470, and local government for −0.287; the three sum to 1.458 with no residual at the mean, because the country residuals are of both signs and average to less than 0.0002. In proportional terms, central government supplied roughly 87 per cent of the net increase, social security funds a further 32 per cent, and local government subtracted about 20 per cent. The increase in the Union's average tax burden over the period was thus a central government increase, partly reinforced by contributions and partly offset by a shrinking subnational tier.

Table 1.
Contribution of each level of government to the change in total tax revenue, 2011–2023, 26-country mean and Romania

Level of government	26-country mean contribution (pp)	Romania contribution (pp)
Central government	1.275	−1.492
Local government	−0.287	−0.281
Social security funds	0.470	1.007
Sum of contributions	1.458	−0.766
Change in total tax revenue	1.458	−0.761
Residual, Equation (2)	0.0000	−0.0050

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Note: Changes between 2011 and 2023 in percentage points of gross domestic product. The mean is unweighted across the 26 member states with complete data on all three levels; the 27-country mean change in the total, which includes one member state without separate local and social security series, is 1.231 pp and is not comparable. The residual row reports the rounding in the published series; the maximum absolute residual across the 26 countries is 0.0050 pp, which is the Romanian value, and the mean absolute residual is below 0.0002 pp.

Source: Author's own calculations on Eurostat (2024a), dataset gov_10a_taxag.

The mean conceals a distribution, and Figure 1 shows it. Countries are ordered by their 2023 total tax ratio, the marker gives the change in the total, and the stacked bars give the three contributions, so that the identity can be read off for each country as the marker sitting at the net height of its bars. Several features stand out. The largest declines in the total, in Ireland and Belgium, are dominated by the central government component. The largest increases, in Slovakia, Cyprus and Luxembourg, are central government increases in Slovakia and Luxembourg, whereas in Cyprus the social security component is the larger of the two. Finland is the case in which the identity is most instructive: a central government contribution of about five percentage points is almost entirely offset by a local government contribution of similar magnitude and opposite sign, which is the accounting footprint of the 2023 transfer of health and social services from municipalities to regional bodies financed from the centre, and the change in the total is small. An indicator computed on the total records Finland as barely moving; the decomposition records a reassignment of roughly five per cent of GDP between tiers.

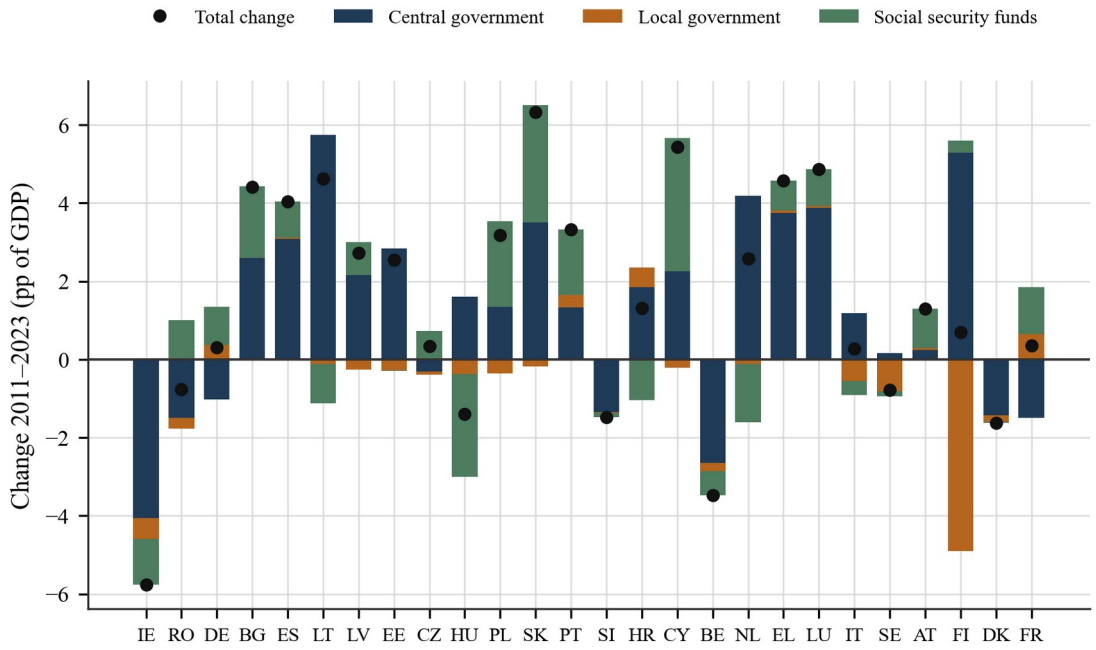


Figure 1. Contribution of each level of government to the change in total tax revenue, 2011–2023, by member state. Countries are ordered by their 2023 tax ratio; the marker shows the total change and the bars its three components.

Source: Author's own elaboration on Eurostat (2024a).

Counting the largest absolute contributor in each country, central government leads in 19 of the 26 member states and social security funds in the other 7. In no country is local government the largest

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contributor, and Finland, where it comes closest, is the exception that confirms the accounting nature of the exercise rather than a case of subnational fiscal expansion. The pattern is therefore general and not a product of a few large economies: the adjustment of tax burdens in the Union over this period was carried by central governments, with social security funds the leading component in a minority of countries, among them Germany, Hungary, Poland and Austria, where the contribution base rather than central taxation did most of the work.

The social security contributions themselves are heterogeneous in sign. They are strongly positive in Slovakia, Cyprus, Bulgaria and Poland, and strongly negative in Hungary and the Netherlands, the former reflecting a sustained reduction in employer contribution rates over the second half of the period. A mean contribution of 0.470 from social security funds is thus the net of expansions and contractions of comparable size, and it would be a mistake to read it as a common drift towards contribution-financed systems.

4.3 Romania

Romania is the second-lowest member state by total tax ratio in 2023, above only Ireland, whose ratio is depressed by a denominator inflated by multinational activity rather than by low domestic taxation, and Romania's aggregate movement against the Union is reported in the companion paper (Nicolau, 2026). What the decomposition adds is the composition of that movement, shown in the right-hand column of Table 1. The change in the total, −0.761 percentage points, is the net of a central government contraction of 1.492 percentage points, a local government contraction of 0.281 and a social security expansion of 1.007. The two largest movements are of opposite sign and each is larger than the total change. An already low tax take therefore became more dependent on contributions at the same time as it declined, and the decline understates the extent of the reshuffling.

The residual for Romania is −0.0050 percentage points, the largest in the panel, and it is consistent with each of the four published series having been rounded independently. It does not affect any of the contributions at the third decimal.

For an assessment of revenue sustainability the composition matters more than the total. Contribution revenue is tied to the formal wage bill and to statutory rates that have been changed repeatedly in Romania over the period, whereas central government revenue draws on value added tax, excise and profit taxes with broader bases. A shift of one percentage point of GDP from the second to the first is a shift towards the narrower and more policy-sensitive base, and an aggregate indicator computed on the total registers it as nothing at all, or, in Romania's case, as a small decline.

4.4 Persistence and the Effect of the Bias Correction

Table 2 reports the estimates from Equation (3) and the correction described in Section 3.3. The fixed-effects coefficient on the lagged tax ratio is 0.7754, with a cluster-robust standard error of 0.0396 and a p-value below 0.001, on 324 observations. Taken at face value it implies, through Equation (5), a

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half-life of 2.7 years: a deviation of a country's tax ratio from its long-run level would be halved in under three years, which describes a fiscal system that adjusts quickly and in which cross-sectional dispersion in any one year is mostly transitory.

Table 2.
Persistence of the total tax ratio and the effect of the bias correction

Quantity	Value
Estimated autoregressive coefficient, Equation (3)	0.7754
Standard error (clustered by country)	0.0396
Observations	324
Annual observations per country (T)	12
Approximate Nickell bias, Equation (4), evaluated at the estimate	−0.1614
Reference value −1/T	−0.0833
Corrected coefficient	0.9368
Half-life, uncorrected (years)	2.7
Half-life, corrected (years)	10.6

Note: The correction applies the large-T approximation of Nickell (1981) evaluated at the estimated coefficient and is illustrative; it is not a substitute for a generalised method of moments estimator, which is identified as the next step in Section 6. The row labelled −1/T is shown only as a scale reference for the order of magnitude of the bias at this time dimension. Solving Equation (4) as a fixed point gives a corrected coefficient of about 0.953 and a half-life of about 14.4 years.

Source: Author's own calculations.

The face value is not the right value. At $\hat{\rho} = 0.7754$ and $T = 12$, Equation (4) gives an approximate bias of −0.1614, and adding that magnitude back raises the coefficient to 0.9368 and the half-life to 10.6 years. The scale of the correction is worth pausing on: the bias is a fifth of the estimated coefficient, and because the half-life is a convex function of ρ near unity, a correction of 0.16 in the coefficient multiplies the half-life by almost four. The row showing $-1/T$, which equals −0.0833 at $T = 12$, is included only to give a sense of the order of magnitude that the phrase "a bias of order 1/T" conveys; the approximation in Equation (4) is about twice that size at this level of persistence, and the difference between the two is the difference between a half-life of about five years and one of about ten.

Even so, the corrected figures in Table 2 are approximate and should be read as such. Evaluating Equation (4) at the biased estimate understates the correction, since the true coefficient is higher than the estimate and the numerator of the bias rises with it. Solving Equation (4) as a fixed point, so that the correction is evaluated at the corrected coefficient, gives approximately 0.953 and a half-life of about 14.4 years. The honest statement is therefore that the uncorrected half-life of 2.7 years is a lower bound that no one should quote, that a correction of the conventional form places the half-life at roughly ten years, and that a more careful version of the same correction places it somewhat higher. What all three have in common is that tax ratios in the Union are highly persistent, and that the fast-adjusting reading is an artefact of the estimator. A definitive point estimate requires

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the system GMM estimator of Blundell and Bond (1998), which we have not estimated on this panel and which is discussed in Section 6.

4.5 Diagnostics of the Catch-Up Regression

Table 3 summarises the diagnostic checks on the companion paper's catch-up regression, and Figure 2 shows the residuals. The Jarque–Bera statistic is 14.81 with a p-value below 0.001, and the Shapiro–Wilk test rejects normality at p = 0.007. With 27 observations these rejections are driven by a small number of countries, and the plots identify them: two residuals lie far below the rest, both belonging to member states whose tax ratios fell sharply over the period from a starting point that the regression line would have placed among the risers. The quantile plot in panel (c) shows the remaining 25 residuals lying close to the normal line and the two outliers well beneath it.

Table 3.
Diagnostic checks on the residuals of the catch-up regression

Statistic	Value
Observations	27
Coefficient on initial log tax ratio (Nicolau, 2026)	−0.01434
Heteroskedasticity-consistent standard error	0.01032
p-value	0.165
Share of variation explained (%)	8.2
Jarque–Bera statistic	14.81
Jarque–Bera p-value	< 0.001
Shapiro–Wilk p-value	0.007

Note: The regression is that reported in Nicolau (2026); the diagnostic statistics are computed here on its residuals and were not reported there.

Source: Author's own calculations.

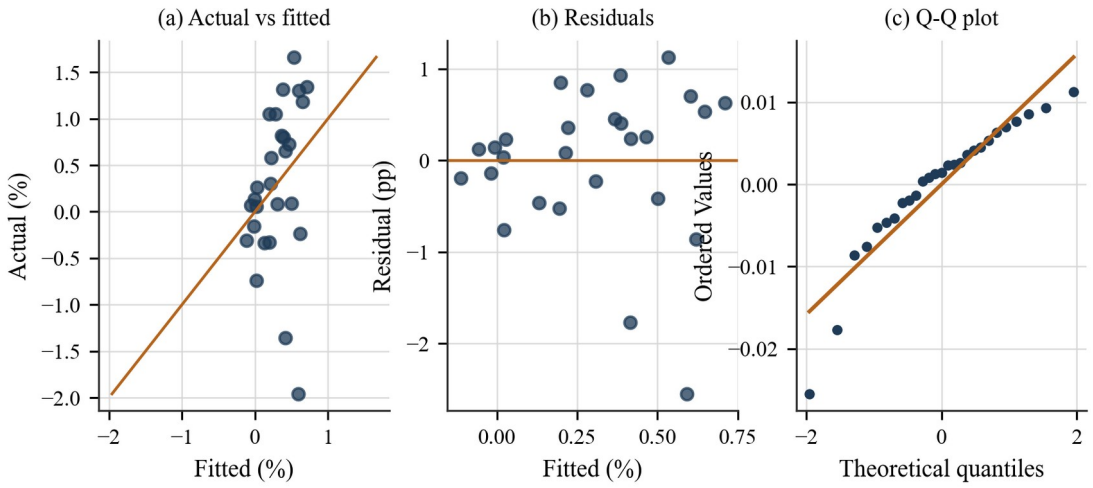


Figure 2. Diagnostics for the catch-up regression of Nicolau (2026): (a) actual against fitted growth rates, (b) residuals against fitted values, (c) normal quantile-quantile plot of the residuals.

Source: Author's own elaboration.

For the companion's conclusion the consequence is asymmetric. That conclusion was that catch-up has the expected sign but is not statistically established, and a non-normal residual distribution on 27 observations means that the nominal p-value of 0.165 cannot be relied on in either direction. A finding of non-significance is not overturned by a diagnostic failure; it is reinforced, because the diagnostic removes whatever residual confidence the point estimate might have carried. Had the companion reported a significant coefficient, the same diagnostic would have required that finding to be withdrawn or re-estimated with a robust method. The verification therefore changes nothing in the verdict and everything in the strength with which it can be stated.

5. DISCUSSION

5.1 What the Decomposition Adds to the Convergence Reading

Section 2.1 reviewed a literature that distinguishes the narrowing of dispersion from catch-up and warns that the second does not imply the first. The results here suggest a third distinction, between convergence in a total and convergence in the structure that produces it. Total tax revenue in the Union became less dispersed between 2011 and 2023, and the companion paper shows that this is statistically real (Nicolau, 2026). The decomposition shows that the rise in the mean which accompanied the narrowing was a central government rise, that the subnational tier moved the other way, and that social security contributions expanded in some member states and contracted in others by amounts that roughly cancel at the mean. A reader who inferred from the dispersion result that the Union's fiscal systems were becoming structurally alike would be drawing a conclusion that the components do not support.

This matters for the mechanisms discussed in Section 2.2. Tax competition, to the extent it operates, operates on central government bases, and it is central government revenue that converged; the assignment of revenue to local government has no convergence mechanism, and local revenue diverged; social security contributions follow national demographic and labour-market policy, and their contributions to the change in the total are of both signs. The decomposition is consistent with each of the three theoretical expectations separately, and it is precisely because they differ that the aggregate is uninformative about any of them. Slemrod's (2004) question, whether rates or countries converge, has an analogue here: what converged was a total, not a structure.

The Finnish case makes the general point concretely. A reassignment of about five per cent of GDP from municipalities to the centre leaves the total almost unchanged and therefore leaves every dispersion measure computed on the total almost unchanged, while altering the fiscal constitution of the country more than any tax reform of the period. An indicator that cannot distinguish that from no change is not measuring structure, and the oversight framework that relies on it should not be described as monitoring structure either.

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5.2 Persistence and the Reading of Adjustment Speed

Turning to persistence, the results bear on how a convergence claim should be interpreted over time. If the uncorrected coefficient were taken at face value, a half-life under three years would mean that most of the dispersion observed in any one year is transitory, that the narrowing over thirteen years is the outcome of several complete adjustment cycles, and that policy could expect further narrowing quickly. The corrected figures, whichever version of the correction is preferred, say the opposite: with a half-life of ten years or more, a deviation from a country's long-run tax ratio persists across most of the sample period, so that the dispersion observed in 2023 is largely the dispersion of long-run levels and not of temporary departures from them. The companion paper's catch-up half-life of 44 years, derived from a coefficient not distinguishable from zero, is consistent with this reading in direction if not in precision (Nicolau, 2026).

Beyond this article, the scale of the Nickell correction at T = 12 carries a methodological lesson. Judson and Owen (1999) showed that the bias is material at time dimensions common in macroeconomic panels, and the results here confirm that at the persistence typical of fiscal ratios it is large enough to change the qualitative description of the system. Applied work on fiscal convergence that reports an uncorrected fixed-effects coefficient on a panel of a dozen years, and derives an adjustment speed from it, is reporting a quantity that is biased in a known direction by a known order of magnitude. The remedy, the system estimator of Blundell and Bond (1998), is well established, and its application to a panel of 27 countries requires care over the instrument count (Roodman, 2009), but it is the appropriate instrument, and the arithmetic correction reported here is best understood as a demonstration that the correction is worth making.

5.3 The Audit Perspective

Each of the three procedures applied in this article and its companion is an ordinary audit procedure transposed to a statistical indicator. Testing the population against its label, which the companion did by removing non-member entities from the sample, is the analogue of confirming that a ledger contains only the entity's own transactions. Reconciling the total to its parts and reporting the residual, which Section 4.1 does, is the analogue of agreeing a reported balance to its supporting schedule. Examining whether the confidence attached to a conclusion is supported by the properties of the estimate, which Sections 4.4 and 4.5 do for persistence and for catch-up, is the analogue of assessing whether the evidence obtained is sufficient and appropriate (INTOSAI, 2019; Institute of Internal Auditors, 2024). None of the three is expensive, and each changed what the data could be said to establish.

For the Union's surveillance framework the practical implication is about the level at which recommendations are addressed. Where nine tenths of the change in the average tax burden occurred at central government, a recommendation argued from a convergence trend in the total is a recommendation about central taxation, and it should be labelled as such; where the change in a

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particular member state is a reassignment between tiers, the total is silent about it, and a framework that monitors the total will not see it. The Court of Auditors' recurring observation that reported and verified figures are different things applies here with full force (European Court of Auditors, 2024). A convergence indicator is a reported figure. This article has verified one, and the verification changed the reading.

In Romania's case the implication is more specific. The country's tax ratio is the lowest in the Union in substance, it fell while the Union's rose, and the composition of what remains shifted towards the narrower contribution base. Each of those three facts is visible only at a different level of aggregation, and only the decomposition shows all three at once.

6. CONCLUSIONS

This article set out to reconcile a convergence claim about tax burdens in the European Union to the components that make up the total on which it rests, and to measure how persistent those burdens are once the estimator used to measure persistence is corrected for its known bias. The exact decomposition closes to a maximum absolute residual of 0.0050 percentage points across the 26 member states with complete data, with a mean residual below 0.0002 percentage points, and can therefore be read as a reconciliation rather than an approximation. On that panel the mean total tax ratio rose by 1.458 percentage points between 2011 and 2023, of which central government contributed 1.275, social security funds 0.470 and local government −0.287. Central government is the largest contributor in 19 of the 26 countries and social security funds in the remaining 7; local government leads nowhere. Romania's aggregate decline of 0.761 percentage points is the net of a central government contraction of 1.492 and a social security expansion of 1.007, a reshuffling larger than the total it produced. The fixed-effects persistence coefficient of 0.7754 implies a half-life of 2.7 years that no one should quote; the approximate correction raises it to 0.9368 and the half-life to 10.6 years, and a stricter version of the same correction places it higher still. The residuals of the companion's catch-up regression are not normally distributed, which reinforces rather than weakens the conclusion that catch-up is not established.

The conclusions agree with the results and go no further than them. The narrowing of dispersion in the total is real and is not disputed here; what the decomposition establishes is that it was a central government narrowing, that it coexisted with a contracting and diverging subnational tier and with social security movements of both signs, and that a reading of the aggregate as structural convergence is not supported. The persistence estimates establish that tax ratios adjust slowly, so that the dispersion observed at the end of the period is mostly the dispersion of long-run levels.

Several limitations bound these conclusions. The decomposition is an accounting attribution to receiving tiers, not a causal attribution to policies, and it treats a reassignment of a tax between tiers as a contribution of equal and opposite sign at each, which is correct as accounting and silent as explanation. It rests on 26 rather than 27 member states because the component series are not

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separately published for one country over the period, and the mean change on the 26-country panel is not comparable with the 27-country figure, a distinction we have kept explicit but which a reader comparing the two papers must keep in mind. The persistence coefficient is estimated by fixed effects and corrected arithmetically, and both the approximation used and the point at which it is evaluated are sources of error whose sign is known but whose magnitude is not pinned down; the corrected half-life should be read as an order of magnitude. The diagnostic checks on the catch-up regression identify a departure from normality but do not re-estimate the regression robustly. And the period, which contains a consolidation, a pandemic and an energy shock, is one in which year effects absorb common movements but cannot absorb the heterogeneous fiscal responses that the decomposition itself reveals.

Three directions for future work follow directly. The first is to estimate the persistence of tax ratios with the system estimator of Blundell and Bond (1998), with a collapsed instrument set appropriate to 27 countries, and to compare the result with the arithmetic corrections reported here; the comparison would itself be informative about how much the conventional correction understates. The second is to extend the decomposition to the components within each tier, separating taxes on production and imports, taxes on income and wealth, and social contributions within the central government figure, which would connect the accounting decomposition to the tax competition literature more directly than the tier-level exercise can. The third is to re-estimate the catch-up regression with a method robust to the two outlying observations identified in Section 4.5, or to examine those two member states as cases, since a regression on 27 observations whose conclusion depends on two of them is better treated as a description of 25 countries and two exceptions than as a population estimate. Each of these steps is a further reconciliation of a reported figure to the evidence beneath it, which is the discipline this article has tried to apply.

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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 panel is built from the Eurostat dataset gov_10a_taxag, Main national accounts tax aggregates, restricted to the 27 member states of the European Union for the years 2011 to 2023 and to the receiving subsectors central government, local government and social security funds. 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. This article extends a

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conference proceedings paper by the same author published in the supplement to the previous issue of this journal, cited here as Nicolau (2026); the results of that paper are cited and not reproduced. The author declares no other competing interests.

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REFERENCES

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, *58*(2), 277–297. https://doi.org/10.2307/2297968

Baltagi, B. H. (2021). *Econometric analysis of panel data* (6th ed.). Springer.

Barro, R. J., & Sala-i-Martin, X. (1992). Convergence. *Journal of Political Economy*, *100*(2), 223–251. https://doi.org/10.1086/261816

Blanchard, O. (2023). *Fiscal policy under low interest rates*. MIT Press.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Cameron, A. C., & Miller, D. L. (2015). A practitioner's guide to cluster-robust inference. *Journal of Human Resources*, *50*(2), 317–372. https://doi.org/10.3368/jhr.50.2.317

Devereux, M. P., Lockwood, B., & Redoano, M. (2008). Do countries compete over corporate tax rates? *Journal of Public Economics*, *92*(5–6), 1210–1235. https://doi.org/10.1016/j.jpubeco.2007.09.005

European Commission. (2024a). *2024 Ageing Report: Economic and budgetary projections for the EU Member States (2022–2070)* (Institutional Paper No. 279). Publications Office of the European Union.

European Commission. (2024b). *Taxation trends in the European Union: Data for the EU Member States, Iceland, Norway and the United Kingdom, 2024 edition*. Publications Office of the European Union.

European Court of Auditors. (2024). *Annual reports concerning the financial year 2023*. Publications Office of the European Union.

European Parliament, & Council of the European Union. (2024). Regulation (EU) 2024/1263 of the European Parliament and of the Council of 29 April 2024 on the effective coordination of economic policies and on multilateral budgetary surveillance and repealing Council Regulation (EC) No 1466/97. *Official Journal of the European Union*, L, 30 April 2024.

Eurostat. (2022). *Manual on government deficit and debt: Implementation of ESA 2010, 2022 edition*. Publications Office of the European Union.

Eurostat. (2024a). *Main national accounts tax aggregates (gov_10a_taxag)* [Data set]. Eurostat. https://ec.europa.eu/eurostat/databrowser/view/gov_10a_taxag

Eurostat. (2024b). *Tax revenue statistics* (Statistics Explained). Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tax_revenue_statistics

Friedman, M. (1992). Do old fallacies ever die? *Journal of Economic Literature*, *30*(4), 2129–2132.

Genschel, P., & Schwarz, P. (2011). Tax competition: A literature review. *Socio-Economic Review*, *9*(2), 339–370. https://doi.org/10.1093/ser/mwr004

Hsiao, C. (2022). *Analysis of panel data* (4th ed.). Cambridge University Press.

Institute of Internal Auditors. (2024). *Global Internal Audit Standards*. The Institute of Internal Auditors.

International Monetary Fund. (2024). *Fiscal Monitor: Fiscal policy in the great election year* (April 2024). International Monetary Fund.

INTOSAI. (2019). *ISSAI 100: Fundamental principles of public-sector auditing*. International Organization of Supreme Audit Institutions.

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Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters*, *6*(3), 255–259. https://doi.org/10.1016/0165-1765(80)90024-5

Johnson, P., & Papageorgiou, C. (2020). What remains of cross-country convergence? *Journal of Economic Literature*, *58*(1), 129–175. https://doi.org/10.1257/jel.20181207

Judson, R. A., & Owen, A. L. (1999). Estimating dynamic panel data models: A guide for macroeconomists. *Economics Letters*, *65*(1), 9–15. https://doi.org/10.1016/S0165-1765(99)00130-5

Keen, M., & Slemrod, J. (2021). *Rebellion, rascals, and revenue: Tax follies and wisdom through the ages*. Princeton University Press.

Kiviet, J. F. (1995). On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. *Journal of Econometrics*, *68*(1), 53–78. https://doi.org/10.1016/0304-4076(94)01643-E

Kremer, M., Willis, J., & You, Y. (2022). Converging to convergence. *NBER Macroeconomics Annual*, *36*, 337–412.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica*, *49*(6), 1417–1426. https://doi.org/10.2307/1911408

Nicolau, A. (2026). Do fiscal convergence indicators survive verification? Tax burden dispersion and sample integrity in the EU-27, 2011–2023. *Internal Auditing & Risk Management*, *21*(73, Suppl.), 1–19. https://doi.org/10.67276/4pz5ja0uy2

Oates, W. E. (1999). An essay on fiscal federalism. *Journal of Economic Literature*, *37*(3), 1120–1149. https://doi.org/10.1257/jel.37.3.1120

OECD. (2022). *Fiscal federalism 2022: Making decentralisation work*. OECD Publishing.

OECD. (2024). *Revenue statistics 2024: Health taxes in OECD and beyond*. OECD Publishing.

Patel, D., Sandefur, J., & Subramanian, A. (2021). The new era of unconditional convergence. *Journal of Development Economics*, *152*, 102687. https://doi.org/10.1016/j.jdeveco.2021.102687

Quah, D. (1993). Galton's fallacy and tests of the convergence hypothesis. *The Scandinavian Journal of Economics*, *95*(4), 427–443. https://doi.org/10.2307/3440905

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, *9*(1), 86–136. https://doi.org/10.1177/1536867X0900900106

Slemrod, J. (2004). Are corporate tax rates, or countries, converging? *Journal of Public Economics*, *88*(6), 1169–1186.

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