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The Reverse Method: A New Indirect Technique for Global VAT Compliance Gap Monitoring

Patricio Barra and Polina Prokof'yeva

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Authorized for distribution by Ruud de Mooij

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Abbreviations

AE	advanced economy
AFR	Africa
APD	Asia and Pacific
C-efficiency	final consumption-efficiency
EME	emerging market economy
EU	European Union
EUR	Europe
FAD	Fiscal Affairs Department
FC	final consumption
GDP	gross domestic product
IMF	International Monetary Fund
LIDC	low-income developing country
MCD	Middle East and Central Asia
RA-GAP	Revenue Administration Gap Analysis Program
RM	Reverse Method
TADAT	Tax Administration Diagnostic Assessment Tool
VAT	value-added tax
WHD	Western Hemisphere

I. Motivation and Scope

Tax noncompliance is not directly observable (that is, taxpayers do not disclose their true underreporting), so different statistical techniques must be used to estimate it. This means that establishing the exact value of the compliance gap is impossible, a limitation shared with other disciplines, where the concept of an "accurate measure" must be nuanced toward reasonable, comparable, and consistent estimates.[1] Despite the limitations, the compliance gap estimations provide enormous value to ministries of finance, revenue administrations, and the public by providing data on uncollected tax revenue because of noncompliance, highlighting the potential for improved resource mobilization through better tax administration.

In this context, several countries estimate the compliance gap using different approaches and techniques, continuously seeking to improve the quality of source data, assumptions, and replicability (as illustrated in the next section of this note). However, as already indicated, in many cases the need to compare these results with others obtained through comparable but alternative approaches persists. At the same time, collecting comparable results from other countries is also essential, though this is an enormous challenge given the scope of the task and inherent limits of the achievable comparability.

The IMF's Revenue Administration Gap Analysis Program (RA-GAP) has developed a relatively well-known estimation methodology that has already been applied in more than 45 countries since 2015.[2] The RA-GAP program is considered a robust method because it uses a clear conceptual framework, reliable official data, and a transparent, internationally recognized methodology. Above all, it applies the same estimation model across countries, ensuring a high level of international comparability. Nevertheless, for reasons of cost and feasibility, taking this approach every year for all countries that have value-added tax (VAT) is not viable.

Thus, the central motivation for developing an indirect methodology (the Reverse Method[3]) is a need to create an approach consistent with the RA-GAP framework that offers a global, scalable, cost-effective methodology. It is not intended to provide more precise estimates for each country or year, nor to replace a standard RA-GAP assessment. The note sets out a particular objective: to derive an estimate that, as closely as possible, approximates or simulates the result that would be obtained through a standard RA-GAP estimation, with the realistic understanding that some margin of error—whether acceptable or open to debate—will inevitably be present.

In addition to providing a RA-GAP mirror estimate of the VAT gap across multiple years and countries, this note aims to offer technical support for comparably monitoring global trends, cross-checking standard VAT gap assessments obtained by other production-based top-down techniques, and generating indicative estimates for individual countries where standard estimation is not feasible.

The rest of the note is organized as follows: The next section presents an overview of the methodological approaches in which the proposed method is situated. The following sections illustrate the accounting identity underlying the RA-GAP approaches and introduce the calibrated estimation model. The final sections present the results obtained, a discussion of the limitations and caveats, and a conclusion.

1 Such measurement accuracy is difficult to analyze for activities that involve breaches of norms or typically undisclosed actions—for example, estimating the magnitude of bribes paid, the volume of illicit trade, or other similar phenomena in a country. In such cases, finding consistency, comparability, and contrast from different approaches seems to be the most realistic way to illustrate that the order of magnitude or the trend of these estimates adds value.

2 See https://www.imf.org/en/Topics/fiscal-policies/Revenue-Portal/Analytical-and-Learning-Resources.

3 As discussed later, this is the name given to the method proposed in this note.

II. The Context of Compliance Gap Estimations

A. Direct versus Indirect Estimation Techniques

Different techniques can be used to estimate the tax compliance gap through direct or indirect estimation procedures (Table 1). Direct top-down approaches are based on potential liability estimates, which are compared with actual collections; the difference is attributed to the compliance gap. Direct bottom-up techniques use noncompliance detected in audits and extrapolate it to the universe of taxpayers. Indirect techniques, by contrast, do not attempt to estimate potential liability or noncompliance directly. Instead, they look for traces of noncompliance in correlated variables such as tax collection, C-efficiency, imports, and others. Direct and indirect top-down techniques provide a large-scale view that helps monitor overall compliance gap levels. Conversely, direct and indirect bottom-up methods are better for deeper analysis at the individual level, focusing on risk analysis and audit selection to check audit success.

Table 1. Techniques for Estimating the Compliance Value-Added Tax Gap

Estimation	Approach	Technique	Some references
Direct	Top-down	Integrated production–consumption	IMF's RA-GAP (Hutton 2017)
		Consumption	European Union Commission (2024), countries' own estimates
	Bottom-up	Random audits	Countries' own estimates
		Operational audits: Heckman method, machine learning	IMF's RA-GAP, UNU-WIDER, and countries' own estimates
		Operational audits: extreme values, ad hoc estimations	Countries' own estimates
Indirect	Blended	Production-frontier analysis	Receita Federal do Brasil (2023)
	Top-down	C-efficiency and compliance gap under econometric analysis	Crivelli (2018)
		Imports to consumption ratio under econometric analysis	Morrow, Smart, and Swistak (2019)
		Reverse Method	This technical note

Source: Authors, based on references indicated.

Note: RA-GAP = Revenue Analysis Gap Analysis Program; UNU-WIDER = United Nations University World Institute for Development Economics Research.

Integrated production–consumption techniques use the Supply and Use Tables from national accounts to estimate the potential value-added tax (VAT) from both the production and consumption sides. Consumption-based techniques employ figures for final consumption, intermediate consumption, and investment to estimate the potential VAT. Bottom-up techniques, based on random or operational audits, extrapolate differences between what taxpayers declared and what they should have declared according to legislation. Production-frontier analysis uses individual taxpayer information from revenue administration databases to calculate tax liability at the frontier of maximum compliance. Indirect techniques based on C-efficiency and import ratios examine their effects on the compliance gap through econometric analysis. Finally, the Reverse Method (RM), presented in this note, employs the definition of C-efficiency to estimate the VAT compliance gap residually.

B. What Can an Indirect Technique Be Useful For?

Indirect methods, such as RM, can enable comparable VAT gap estimates across multiple years and countries. The main aim is to obtain broad, comparable estimates for as many countries as possible, rather than collecting country estimates one by one, as would be required with current direct methods. In addition, using public data sets, this method has the significant advantage of being easy to update. It also provides a rough estimation for countries with severely limited data sets. Furthermore, this method serves to cross-check standard VAT gap assessments obtained from other production-based top-down techniques, thereby enhancing the reliability of these estimations. Finally, the RM can serve as a practical tool for policymakers, offering a standardized compliance benchmark that enables meaningful comparisons across countries.

III. RA-GAP Reverse Method: Accounting Identity

A. C-efficiency and Reverse Method

The Reverse Method builds on the accounting identity of the compliance gap and policy gap as components of C-efficiency. C-efficiency is defined as the ratio of VAT revenue to the product of the standard rate and consumption (Ebrill and others 2001).[4] A practical interpretation of C-efficiency is as a comparator, comparing the revenue that VAT raises with the revenue that would be raised if VAT were perfectly enforced and levied at a uniform rate, equal to the standard rate, on all consumption, with no exemptions and assuming the level or composition of consumption remains unchanged. Keen (2013) develops this standard definition of C-efficiency to imply that it can also be expressed in terms of the compliance gap Γ (the proportion of VAT that is not perfectly enforced to potential) and the policy gap P (the proportion of the VAT difference because of some goods and services not being taxable or being taxable at a different rate from the standard one). Thus, if C-efficiency is represented as a percentage by E_C, then the following identity can be used:[5]

$$E_C \equiv \left(1-\Gamma\right)\left(1-P\right). \tag{1}$$

Equation (1) has a primarily practical purpose: using an estimate of the compliance gap and a measure of C-efficiency to derive an estimate of the policy gap as a residual. In this work, a reverse approach is proposed (hence the origin of the method's name), using equation (1) to input values for C-efficiency and the tax policy gap to estimate the compliance gap as a residual:

$$\left(1-\Gamma\right) \equiv \frac{E_C}{\left(1-P\right)}. \tag{2}$$

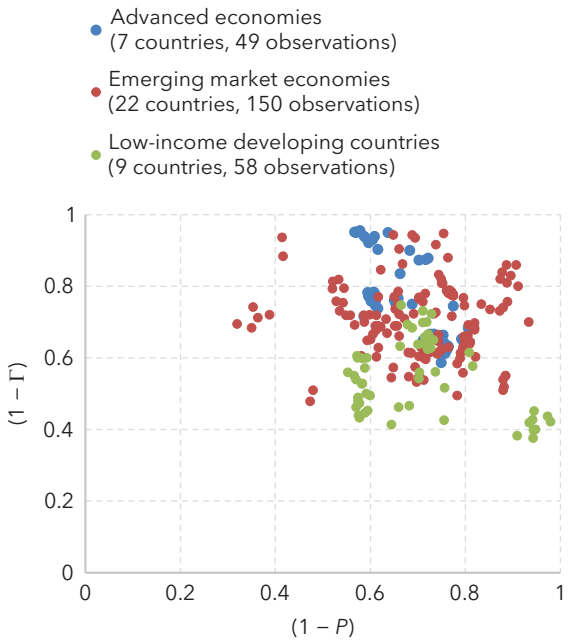
B. C-efficiency in Practice

Equation (2) can be illustrated with data from estimates for 38 countries where RA-GAP standard assessments have been conducted. In these assessments, it is possible to approximate all the variables of equation (2) for a few years (Figure 1).

[4] This is the practical way in which C-efficiency is typically calculated for a country's VAT, based on the values of actual VAT revenue, the VAT standard rate, and the final consumption figure from national accounts. Later in this note, we indicate that this simple application requires some adjustments. For this reason, this simple application will be used as a proxy to represent this variable.

[5] Deriving this expression involves some simple algebraic steps (see Appendix 1).

Figure 1. Components of the C-efficiency



Source: Authors, based on standardized IMF Revenue Administration Gap Analysis Program value-added tax gap assessment missions covering samples of years between 2010 and 2023.

Note: The names of the countries have been excluded.

For each of these observations, the result would allow a direct estimation of the VAT gap. If information on C-efficiency and the compliance gap is available, the policy gap can be derived (this is the original calculation direction indicated by Keen [2013]). Likewise, if C-efficiency and the policy gap are available, the compliance gap can be obtained. As already indicated, this latter calculation serves as the basis for the Reverse Method. One of the observations in Figure 1 corresponds to a year in which the C-efficiency of a country was 32.14 percent, and the estimated VAT policy gap for that country was 24.55 percent to potential. Consequently, the estimated compliance gap is 57.40 percent to potential (equal to 1 − 0.3214/[1− 0.2455]).

IV. RA-GAP Reverse Method: Calibrated Estimation Model

A. A Prior Step

Although ideal, applying the accounting version of the Reverse Method (RM) described in the previous section on a global scale and for many years is impractical.

There is abundant information on countries' C-efficiency figures; however, no estimates are available for the tax policy gap. To address this obstacle, the split of the tax policy gap suggested by Hutton (2017) is helpful: it can be broken down into the tax expenditure gap and the nontaxable goods and services gap. Under this breakdown, the tax expenditure gap to potential is defined as the difference between the potential VAT revenue under full compliance and a normative tax policy structure and the VAT revenue under full compliance and the current tax policy structure, expressed as a percentage of the former. The normative tax policy structure will be one in which all goods and services are taxed at the standard rate, except public administration, public education, and public health.[6] The nontaxable goods and services gap is defined as the difference between the potential VAT revenue under full compliance and a comprehensive tax policy structure compared with the potential VAT collection under full compliance and a normative tax policy structure, expressed as a percentage of the former. The comprehensive tax policy structure would be one in which all goods and services are taxed at the standard rate, with no exemptions. If the tax expenditure gap is denoted by *TEG*, the potential VAT under a normative structure by *PV2*, the nontaxable goods and services gap by *NTG*, and the potential VAT under a comprehensive structure by *PV3*, then:

$$\left(1-\Gamma\right) \equiv \frac{E_C}{\left(1-\frac{TEG}{PV2}\right)\left(1-\frac{NTG}{PV3}\right)}. \tag{3}$$

Equation (3) becomes much more actionable than equation (2) for estimating the compliance gap.[7] The *TEG* component would be the sum of the VAT provisions that should be included in a theoretical tax expenditure report if you define a benchmark where all goods and services, except "nontaxable goods and services," were taxable at the standard VAT rate, under full compliance. This benchmark will be referred to as the universal benchmark in this note. The final consumption of nontaxable goods and services gap, *NTG*, would be the final consumption figure of three sectors from national accounts: public administration, public education, and public health (final consumption is also assumed as a full compliance measure) multiplied by the standard rate. Thus, with this simple transformation, a more actionable way to indirectly estimate a country's VAT compliance gap is obtained.

[6] These three sectors are instrumental in defining a normative VAT structure within the model, referred to as the "universal benchmark" in the terminology of tax expenditure reporting. The three sectors are well identified in the national accounts, usually coded as "O," "P," and "Q" in the economic classification standards for public administration, public education, and public health, respectively. The sector "O," more precisely, also includes defense and the social security contribution system. VAT exemptions on the final consumption of these three sectors are never included as tax expenditure provisions under the current tax expenditure reporting methodologies of all countries, primarily because they cannot be associated with potential resource mobilization. In other words, applying VAT to the final consumption of these three sectors would amount to an internal fiscal transfer of resources. Overall, like any exempt sector, these sectors cannot claim VAT input credits—so that part of the VAT remains embedded in their costs.

[7] Barreix (2012), in a pioneering analysis, separates the components of C-efficiency, distinguishing between (1) *inefficiency as a result of tax expenditure* and (2) *X-inefficiency*. The concept of *X-inefficiency* does not allow for directly estimating the compliance gap as a residual, because it includes not only the compliance gap but also a portion of the policy gap: the nontaxable goods and services gap. Thus, in the approach of this note, the *X-inefficiency* is separated into two components, $\Gamma x PV1$ and *NTG*, with only the former representing the compliance gap amount.

If the exact values of the right-hand variables in equation (3) were available for each country, the compliance gap could be calculated with the same accounting precision shown in Figure 1. Equation (3) applies an accounting approach in a country lacking a standardized tax gap estimate, allowing the construction of an accounting-based estimate of *TEG* and *NTG*, as described in Appendix 3. However, for the purpose of generating a global-scale compliance gap estimate, this accounting method—although feasible—could be highly time-consuming and would also require country-specific information that may not be publicly available (such as tax expenditures, accrued revenue estimates, and other data).

B. Estimation Strategy

The estimation strategy is based on identity (3) expressed in logarithmic terms (note that the fractions in equation (3) determine the expected signs in equation (4)):

$$Log\left(1-\Gamma\right) \equiv Log\left(E_C\right) - Log\left(1-\frac{TEG}{PV2}\right) - Log\left(1-\frac{NTG}{PV3}\right). \quad (4)$$

Given that the objective of this indirect method is to obtain large-scale, comparable estimates for as many countries as possible—and that RA-GAP mission data are not available for every country—the approach is to approximate the variables on the right-hand side of equation (4) and then calibrate the results using information from RA-GAP missions. Thus, this strategy maximizes predictive performance rather than reconfirming an identity.

To apply equation (4) to countries where no RA-GAP data have been produced, alternative sources of information must be used for three variables: E_C, *TEG/PV2*, and *NTG/PV3*. First, the C-efficiency, E_C, can be obtained from various public sources. It can be directly derived from data on actual collections, final consumption, and the standard VAT rate for each country. However, for simplicity and comparability, the IMF's FAD data set will be used,[8] which has already compiled C-efficiency data under standard procedures. The IMF's FAD C-efficiency data set covers several years and is updated regularly.

Second, regarding the theoretical *TEG,* countries do not necessarily use the universal benchmark and, for example, measure tax expenditure under current compliance and not full compliance.[9] Therefore, the VAT revenue forgone because of VAT expenditure provisions included in each country's official tax

[8] The FAD C-efficiency data set is based on the following public sources (downloadable from their respective websites): VAT collection data from WoRLD, final consumption data from WEO, and VAT rates from the EY tax guide, EY GST table, and KPMG publications. Of course, this information tends to be the most reliable and comparable, as the way countries compute revenue or calculate their national accounts naturally introduces a degree of caution when making cross-country comparisons. However, the practical assumption—common to all international macroeconomic comparison studies—is that the figures used are kept as up to date as possible.

[9] Certainly, each country prepares its tax expenditure estimates using the benchmark it considers most appropriate, which may involve at least two differences compared with the universal benchmark. For example, it may treat certain taxable goods or services (such as financial services or transactions by sectors below the registration threshold) as part of the benchmark or estimate provisions using assumptions about current noncompliance levels (whereas the universal benchmark is, by definition, based on perfect compliance). The working hypothesis is that the differences between the report figures and the sought concept of TEG are systematic and can be calibrated through coefficients. That is, countries systematically measure current evasion, include financial services, calculate individual expenditures (and not joint ones), and so on. This calibration is performed using data from countries for which we have the true values of TEG, NTG, and the Compliance Gap (RA-GAP missions), and we can obtain calibration factors that correct for differences between the actual reports and TEG.

expenditure report will be an approximation. Once again, a global data set of tax expenditure provisions will be used: the Global Tax Expenditure Dataset. Even though countries' VAT expenditure provisions can vary in terms of coverage and estimation methods, they do not include provisions for VAT exemptions on final consumption of nontaxable goods and services as described earlier.[10] This means that the scope is consistent at least in the sense that *TEG* excludes the policy gap component associated with nontaxable goods and services.

Third, the *NTG* will be estimated using the final consumption of three sectors: public administration, public education, and public health, multiplied by the standard rate. For these figures, no global data set is available, so updated national accounts for each country will be used. Unfortunately, final consumption by commodity (sufficient to distinguish final consumption for public administration, public education, and public health) is available in only a few countries, and is usually limited to one year (when the Supply and Use Table was applied). Given that GDP by commodity is more readily available than final consumption by commodity, it is assumed that a proportion of the GDP of the three nontaxable goods and services can approximate their final consumption. In addition, it is necessary to compile information for estimating *PV2* and *PV3*. *PV2* will be calculated using the accounting definition as *PV3* minus *NTG*. *PV3* is assumed to be obtainable as final consumption, *FC*, minus the official VAT collection, *AV0*, multiplied by the VAT standard rate, *r*. Although this approach does not provide a strictly precise estimation of the potential VAT base under a comprehensive policy structure, it serves as a useful approximation for the intended purpose.

C. Reasonability of Proxies for the Variables

As already discussed, the precise values needed to apply the identity of equation (4) are not widely available, so it is necessary to resort to approximations and then calibrate the differences. The working hypothesis is that these approximations show systematic differences, which will be addressed through adjustment factors assumed to be constant across countries and over time. Systematic differences in Log (C-efficiency) will be represented by a constant factor, μ_1. The first difference is that the C-efficiency numerator should be measured using accrued VAT collection, but E_C^{FAD} is measured using official cash VAT collection, *AV0*. The second difference is that in the C-efficiency denominator, Final Consumption, *FC*, should be adjusted to remove the national accounts VAT collection (to express its VAT base value), but E_C^{FAD} employs official cash collection, *AV0*, for this adjustment. Taking all that into account, the estimator for Log (C-efficiency) will be:

$$\widehat{Log\left(E_C\right)} = \mu_1 Log\left(E_C^{FAD}\right). \tag{5}$$

Analogously, for the term associated with the tax expenditure gap, it is necessary to consider the constant factor, μ_2, to reflect the systematic differences between the variable and its proxy. Considering that an initial difference is that provisions are measured under current compliance, a prior uplift factor is applied to capture

[10] NTG cannot be included in the Global Tax Expenditure Dataset reports because they are based on the "revenue forgone" principle. NTG is, by definition, revenue neutral. When we review the reports of the 100 countries we analyzed, we observe that 12 countries identify provisions in components labeled as "government administration and defense," "health services," and "education services." All report zero value in public administration and defense, eight report a value in education services, and nine in health services. Under the revenue forgone principle, the tax expenditure in those eight to nine countries should correspond to privately provided (not public) education and health services. The reported provisions are significantly lower than the potential VAT of public final consumption of health and education services, suggesting greater reliance on private consumption of education and health services.

the missing portion to full compliance. This is done by an iterative process using the C-efficiency identity to equalize the level of the variables.[11] First, individual VAT expenditure provisions are added, $VAT_p^{ExpProv}$, without including joint effects (over a total of *n* provisions). This could overestimate the *TEG* figure. Second, it is assumed that most VAT expenditure provisions are included in the corresponding Global Tax Expenditure Dataset country report. It is likely that some provisions were not included because of difficulties in estimating them or because of the benchmark set in the country report may have underestimated the *TEG* figure.[12] In a few countries, specific exempt transactions by governments, such as military equipment, are included in VAT expenditure reports, potentially overestimating *TEG*. Another element that introduces differences is the treatment of VAT on financial services. In some countries, financial services are not considered VAT expenditure; in others, they are.[13] On the other hand, the denominator uses NTG, which introduces some imprecision itself. Thus, the estimator associated with the tax expenditure gap component to potential will be:

$$\widehat{Log\left(1-\frac{TEG}{PV2}\right)}=\mu_2 Log\left(1-\frac{\sum_{p=1}^{n} VAT_p^{ExpProv}}{\left(FC-AV0\right)r-NTG}\right). \tag{6}$$

Finally, for the term associated with the nontaxable goods and services gap, a factor constant, μ_3, is used to reflect the systematic differences between the variable and its proxy. The key difference to consider is the use of GDP instead of final consumption for nontaxable goods and services. The GDPs for public administration, education, and health are denoted by GDP_O, GDP_P, and GDP_Q, respectively. Then, the estimator associated with the nontaxable goods and services gap component to potential will be:

$$\widehat{Log\left(1-\frac{NTG}{PV3}\right)}=\mu_3 Log\left(1-\frac{\left(GDP_O+GDP_P+GDP_Q\right)r}{\left(FC-AV0\right)r}\right). \tag{7}$$

[11] To estimate provisions under zero evasion, it is necessary to determine the evasion level. A simplified iterative process has been used. The arithmetic identity is applied using proxies for C-efficiency, NTG, and the original reported provisions multiplied by one plus a compliance rate (iteration variable). The compliance rate is iterated until the C-efficiency identity is verified to the first decimal place. With the equalized value of the compliance rate, $VAT_p^{ExpProv}$ is calculated by multiplying the original reported values by one plus the iterated compliance rate.

[12] It is important to note that the definition of C-efficiency, which underpins not only the RM but also the standard RA-GAP method, assumes that the overall potential base is final consumption and that it operates under a principle of destination. However, in some countries, the design of VAT may differ from these concepts. For example, some countries impose administrative restrictions on VAT credits (such as purchases of investment goods), limit VAT exporter refunds, or even directly impose VAT on certain exports. In such cases, the VAT expenditure report should include negative provisions. However, this is not commonly found in practice, leading to an overestimation of TEG (and consequently an underestimation of the compliance gap). This effect can be partially captured by the calibration process. However, to further enhance this approach, it is necessary to identify each country's VAT legislation based on a different macroeconomic base (such as product or income) or principle (such as origin) and to develop a specialized data set for those countries to be calibrated separately.

[13] Some countries use tax expenditure figures based on the current level of compliance, whereas others use figures based on perfect compliance. In some cases, elasticity assumptions are applied; in others, they are not. Some countries include thresholds in their provisions, whereas others do not. A few countries include provisions to reflect joint effects. All these differences in the computation of tax expenditures (both systematic and random) will be addressed in the calibration procedure.

D. Calibrating Predictions through the RM

If equations (5), (6), and (7) are substituted into equation (4), the resulting calibration equation is

$$Log\left(1-\Gamma\right)=\mu_0+\mu_1 Log\left(E_C^{FAD}\right)-\mu_2 Log\left(1-\frac{\sum_{p=1}^{n} VAT_p^{ExpProv}}{\left(FC-AV0\right)r-NTG}\right)$$
$$-\mu_3 Log\left(1-\frac{\left(GDP_O+GDP_P+GDP_Q\right)r}{\left(FC-AV0\right)r}\right)+\varepsilon, \quad (8)$$

where μ_0 is the intercept; μ_1, μ_2, and μ_3 are the calibration coefficients to be estimated; and ε is the term of error representing the consolidation of random errors associated with the three estimators in equations (5), (6), and (7). If the proxies for the three variables on the right-hand side were exact, then $\mu_0 = 0$; that is, the calibration model could be estimated without a constant and μ_1, μ_2, and μ_3 should identically be 1.

As already mentioned, a unitary elasticities scenario is far from being the case because of foreseeable systematic errors. What makes it possible to estimate the identity is having approximations of the over- or underestimation factors for each term. Equation (8) is estimated using a sample of 208 VAT gap observations from 43 countries, based on the IMF's RA-GAP direct top-down estimates for selected years during the period 2010–23 (Table 2).

Column (a) in Table 2 presents the estimation of the identity without a constant. All three coefficients have the expected signs and are statistically significant, and the overall fit is relatively reasonable; however, the coefficients are lower than 1. The degree to which the estimated coefficients deviate from 1 could be a rough indication of how much each proxy on the right-hand side of equation (8) differs from its corresponding unknown true value.[14]

Following the literature on the estimation of unitary elasticities in macro identities, the inclusion of a constant appears to improve the overall fit and to account for joint systematic differences and statistical errors that cannot be fully captured by the identity specification. It can be observed that in the specifications with a constant (columns (b), (c), and (d) in Table 2), the calibration model maintains significance in the coefficients, the signs remain correct, and the fit improves significantly compared with the pure identity model. However, as noted in the literature on this type of specification, it also results in a loss of interpretability for the coefficients and a certain loss of the desired long-term properties of the model (see Feridhanusetyawan and others 2025).

[14] The arithmetic suggests that $|\mu_1| < 1$ because, systematically, the proxy E_C^{FAD} is greater than the variable E_C, and both the denominator and numerator contribute to that direction—that is, $AV0 > AV4$ and $(FC - AV0)\, r < PV3$. For the other two coefficients, it is not possible to anticipate from the arithmetic whether values below or above 1 would be expected. Another factor that contributes to the inability to anticipate whether the coefficients are lower than one is the inevitable difference in some measurement dates. The $(1-\Gamma)$ values are based on macroeconomic data from RA-GAP missions executed mostly between 2014 and 2020, whereas the right-hand variables in equation (8) use updated 2025 figures. GDP and possibly *FC* (a figure that is in the denominators of several terms) have been revised upward in recent years, but revenue figures remain unchanged.

Finally, it should be noted that the purpose of this calibration is not to retest the identity of equation (4), but rather to achieve the highest possible predictive power. To this end, the RM model has been chosen using columns (c) and (d) of Table 2 (as shown in Figure 2). These columns show results for two subsamples (one for non-EU countries and another for EU countries) and present the best-fitting results relative to the four specifications in Table 2.[15]

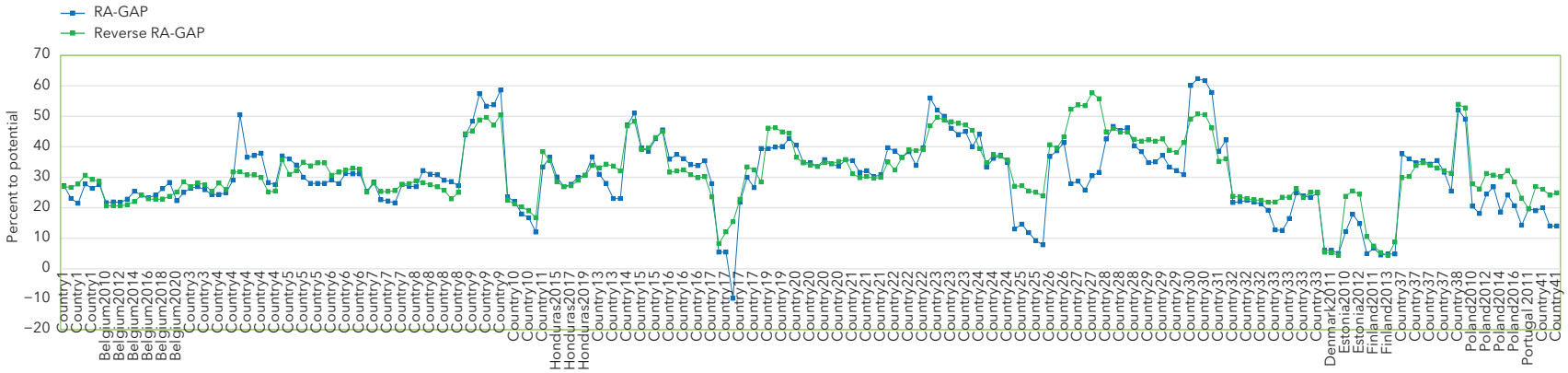
Table 2. Linear Regression Calibration—Dependent Variable: Log (1 − Γ)

	(a) All		(b) All		(c) Non-EU		(d) EU	
Coefficient	Value	Standard error	Value	Standard error	Value	Standard error	Value	Standard error
μ_0	-	-	−.50***	.03	−.40***	.04	−.64***	.07
μ_1	.62***	.03	.53***	.03	.55***	.03	.68***	.06
$-\mu_2$	−.43**	.20	−2.14***	.23	−1.99***	.23	−3.38***	.68
$-\mu_3$	−.30*	.16	−1.87***	.09	−1.26***	.15	−2.23***	.12
R^2 adj.	.56		.84		.80		.92	
No. obs.	208		208		146		62	
No. countries	43		43		31		12	

Source: Authors, based on IMF data sets and national accounts by country.
Note: adj = adjusted; obs. = the number of observations
*p < .10; **p < .05; ***p < .01.

[15] There are common characteristics among EU countries of VAT design, particularly in the treatment of intra-community transactions. This can influence variable measures in a different way than non-EU countries, and its particularity could explain why a separate calibration model has higher predictive power compared with a unified calibration model.

Figure 2. VAT Compliance Gap (Γ)



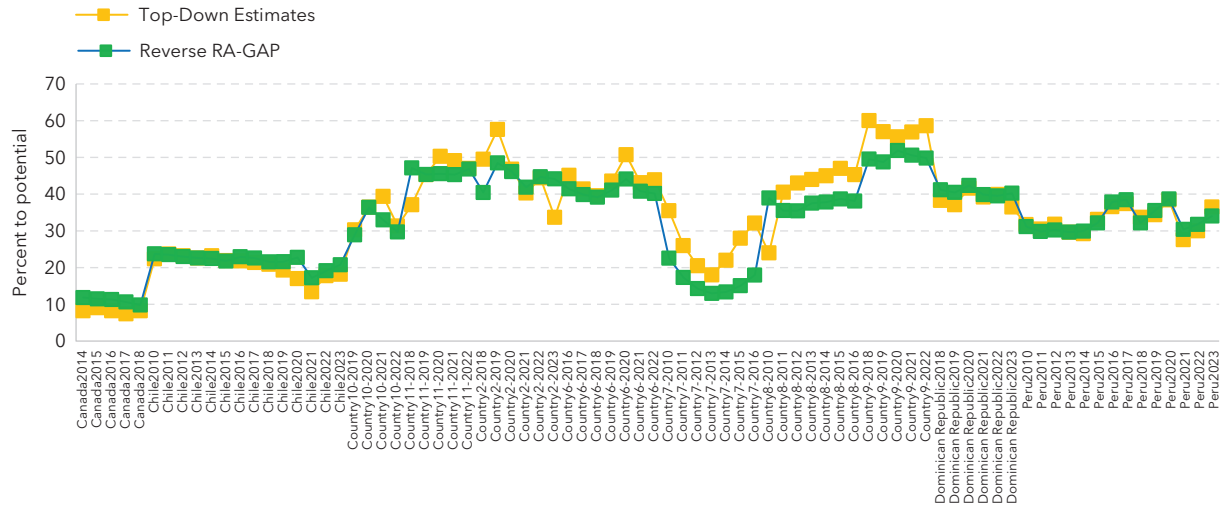
Source: Authors.

Note: Each blue point represents one annual observation obtained by a standardized IMF RA-GAP VAT gap assessment mission, and each green point represents the results of the calibrated reversed method for the "CountryX" (using columns (c) and (d) of Table 2). The names of the countries have been included when authorization to publish the RA-GAP mission results has been granted. RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax.

E. Out-of-Sample Predictions

Figure 3 illustrates the out-of-sample predictions of the VAT compliance gap using the RM, compared with country-level estimates obtained from standardized IMF RA-GAP missions and other top-down approaches. It is not straightforward to discuss prediction errors in this exercise, because the variable being predicted is not directly observable; therefore, it is not possible to determine how far the prediction is from a true value. Instead, this is better understood as a comparative exercise against a well-established benchmark. Each point in Figure 3 represents an annual observation for a specific country and year, highlighting the consistency and comparability of the RM's calibrated results. The figure demonstrates how the RM can generate indicative compliance gap estimates for countries and years where direct RA-GAP assessments are not available, thereby supporting broader cross-country analysis and global monitoring of VAT compliance trends.

Figure 3. VAT Compliance Gap (Γ)—Out-of-Sample Prediction

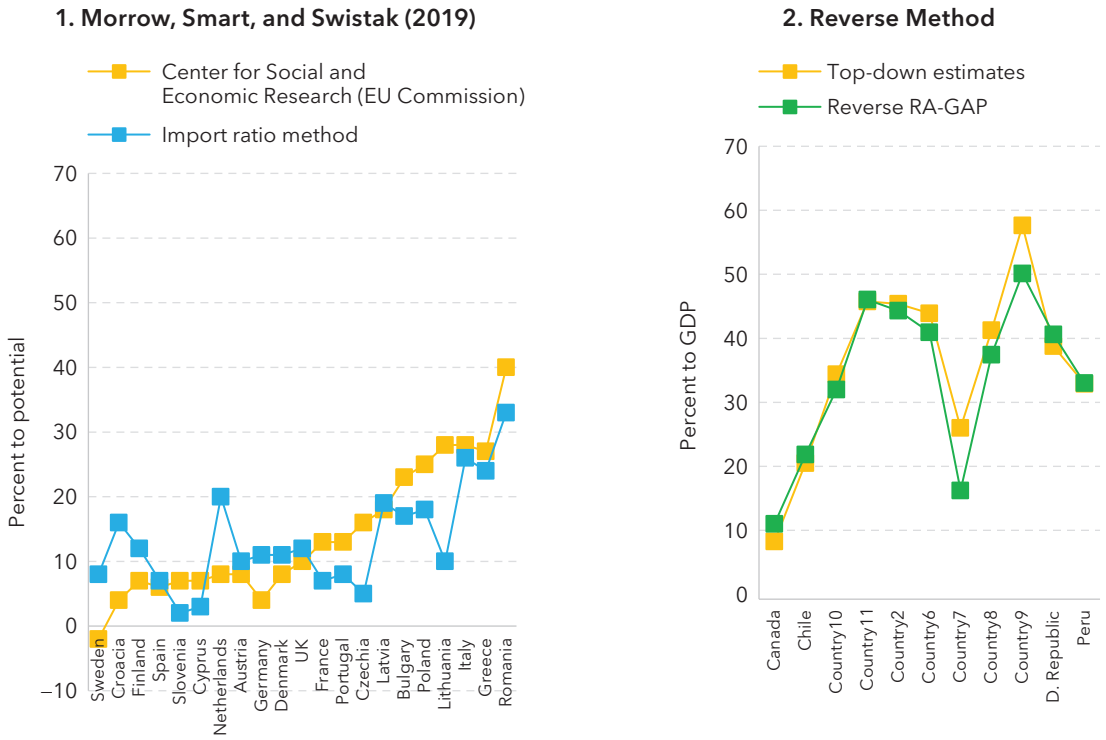


Source: Authors.

Note: Each orange point represents one annual observation obtained by (1) a country's own top-down estimations, (2) a new standardized IMF RA-GAP VAT gap assessment mission, or (3) World Bank estimations using the RA-GAP model. Each green point represents the results of the calibrated reverse method for "CountryX" (using columns (c) and (d) of Table 2). The names of the countries have been included only when authorization to publish the results has been granted. RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax.

Figure 4 compares the VAT compliance gap estimates produced by the RM with those obtained from other indirect techniques, such as a model based on C-efficiency and the import-to-consumption ratio (Morrow, Smart, and Swistak 2019). Again, it is not possible to discuss prediction errors in this exercise; the comparison is made against estimates from a recognized benchmark rather than an observable variable. In the cited study, the comparison is made against the accounting estimates from the Center for Social and Economic Research methodology. For comparability purposes, both charts use country averages for the years with available estimates.

Figure 4. VAT Compliance Gap (Γ)—Reverse Method Versus Other Indirect Methods



Source: Authors, based on Morrow, Smart, and Swistak (2019) (left-hand chart) and authors (right-hand chart).

Note: In the left-hand chart, each orange point represents a gap average calculated using the methodology of the Center for Social and Economic Research (EU Commission). Each light blue point represents the results of an indirect method based on C-efficiency and import-to-consumption ratio. In the right-hand chart, each orange point represents a gap average obtained by (1) a country's own top-down estimation, (2) a new standardized IMF RA-GAP VAT gap assessment mission, or (3) World Bank estimation using the RA-GAP model. Each green point represents the results of the calibrated reverse method for "CountryX." The names of the countries have been included only in cases where authorization for the publication of results has been granted. EU = European Union; RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax.

V. Results on VAT Compliance Global Trends

A. Applying the Reverse Method

The Reverse Method described in the previous section has been applied to 111 countries to produce annual estimates of the value-added tax (VAT) compliance gap for the period 2010–23.[16] The calibration model used corresponds to those defined in columns (c) and (d) of Table 2 from the previous section. The sources of information for all these countries have been previously described and include C-efficiency data from IMF Fiscal Affairs Department data sets, VAT expenditure provisions from the Global Tax Expenditure Dataset, and GDP series for the sectors of public administration, education, and health from national accounts published by each country's national statistics institution.[17] The following sections present individual estimates as well as estimates grouped by income level and by region.

B. Results in Selected Countries

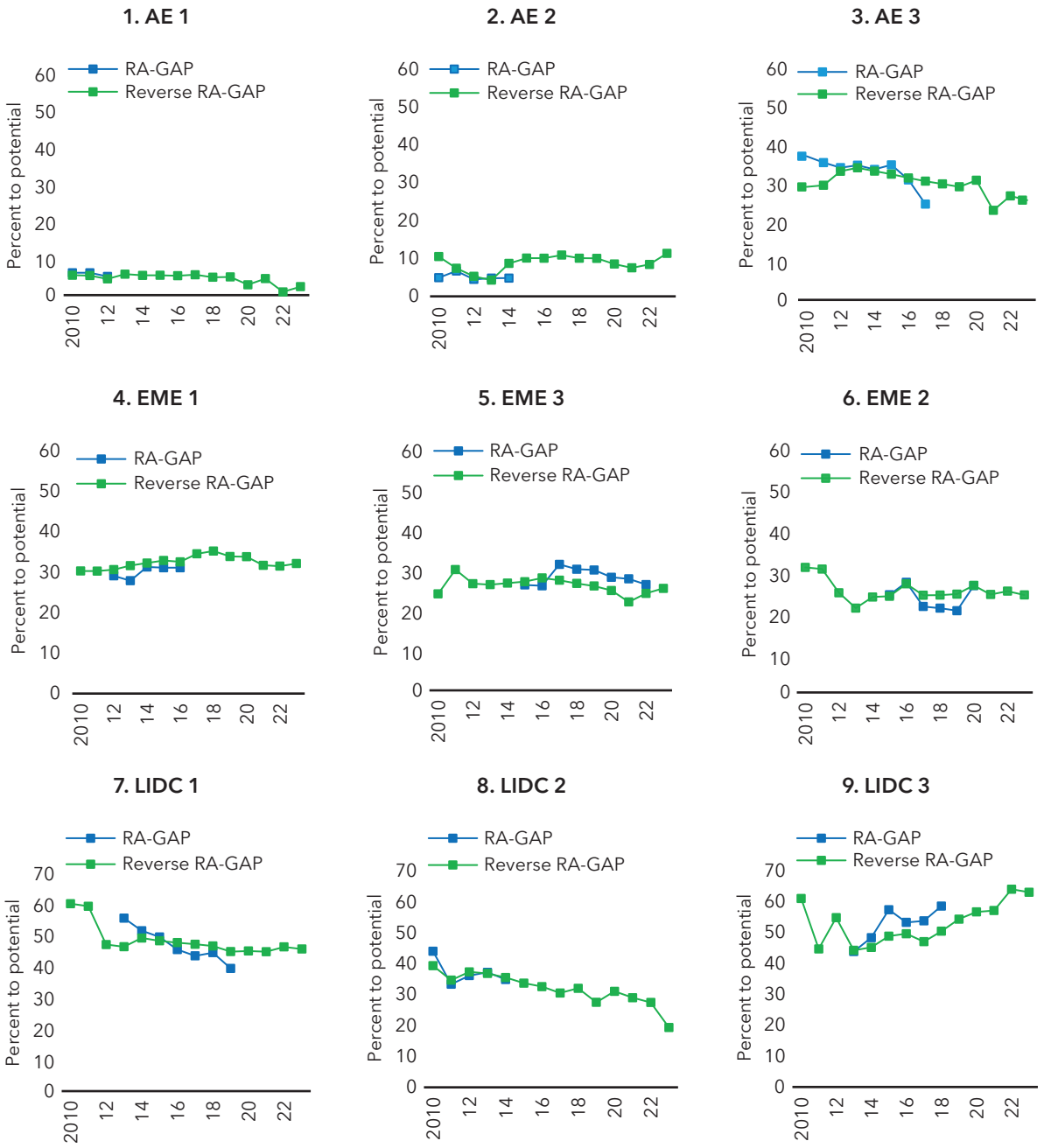
Figure 5 presents the individual compliance gap results (green points) for selected countries. The selection is random, except that it comes from countries with an IMF Revenue Administration Gap Analysis Program (RA-GAP) mission estimate (blue points). Given that the method was calibrated using RA-GAP mission results, the consistency of their values is not surprising. However, for other types of estimates, it is natural to expect greater differences, given that the RA-GAP missions do not always produce results comparable to those from other techniques (see Table 1).

It should be reiterated that the purpose of including these individual results is solely to demonstrate how the method works and its outcomes in specific cases. The value of applying this method lies mainly in creating a comprehensive database of estimated compliance gaps, which can be used to present a global picture of trends and variations, as well as for research. Naturally, for an individual country aiming to apply this method with high precision, it should use reliable figures from a well-prepared tax expenditure report and apply the identity to infer the compliance gap as a residual (see Appendix 3) or conduct a standardized RA-GAP assessment. In summary, this method can provide an order-of-magnitude estimate and a sense of trend, rather than a precise estimate for individual cases.

[16] The inclusion of these countries is based on the availability of extended compliance information for countries that have received either a RA-GAP estimate, a Tax Administration Diagnostic Assessment Tool assessment (a standardized, objective tool used to assess the performance of a country's tax administration system), or both. This number includes 10 advanced economies (AEs), 55 emerging market economies (EMEs), and 46 low-income developing countries (LIDCs). The lower number of AEs is a result of fewer AEs with Tax Administration Diagnostic Assessment Tool or RA-GAP assessments. In the future, this sample could be expanded because the calibration process based on standard RA-GAP VAT gap assessments currently does not include most of the larger AEs, such as those belonging to the G-20.

[17] There are 12 countries (all LIDC) that do not report to the Global Tax Expenditure Dataset; in these cases, the average VAT expenditure of five closely related global comparator countries was used. Although extrapolating the tax expenditure assessments from other countries can be a source of error—because it depends on policy design rather than economic fundamentals—it was decided to include them in the sample for the value of estimating figures for all countries with a Tax Administration Diagnostic Assessment Tool assessment, especially in cases like this where they were LIDC and EME. Noting this caveat, it should be indicated that the close global comparison group comprises countries similar to the country in aspects such as the contribution of agriculture, forestry, and fishing to GDP, annual GDP growth, GDP per capita (at purchasing power parity), population size, and the percentage of trade in GDP. To identify countries with similar economic fundamentals, the IMF databases are used, and a similarity score is calculated based on the Mahalanobis distance between the country and the others.

Figure 5. VAT Compliance Gap—Reverse Method Versus Standard RA-GAP Assessment Estimates



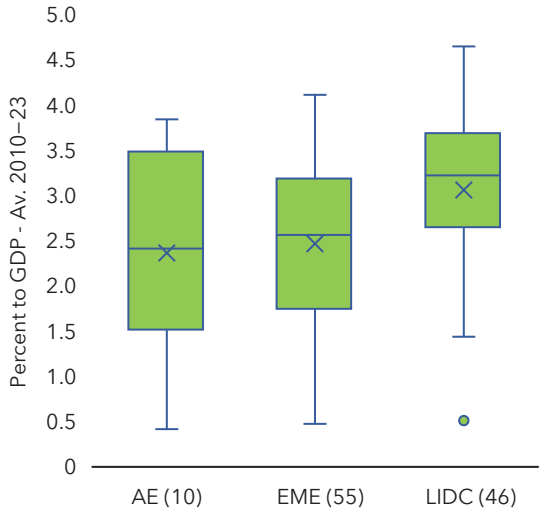
Source: Authors.

Note: Country names have been omitted, considering that in several cases the standard RA-GAP assessment is not publicly available. AE = advanced economy; EME = emerging market economy; LIDC = low-income developing country; RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax.

C. VAT Compliance Gap Trends by Income Level

The AEs show an average VAT compliance gap of 2.4 percent of GDP (Figure 6). For emerging market economies, the average VAT compliance gap is 2.5 percent of GDP. The LIDC group shows an average VAT compliance gap of 3.1 percent of GDP. Overall, the results highlight the differences in VAT compliance gaps across the three economic groups.[18] In terms of the compliance gap to potential and its trend from 2010 to 2023 (Figure 7), LIDCs show a downward trend, starting at about 44 percent in 2010 and gradually decreasing to approximately 40 percent by 2023. The figure for emerging market economies remains relatively stable, fluctuating slightly about 31 percent, suggesting that VAT compliance in this group has not changed significantly over the years. AEs show a decline from about 26 percent in 2010 to 21 percent by 2023, indicating a steady improvement in VAT compliance, similar to that of LIDCs.

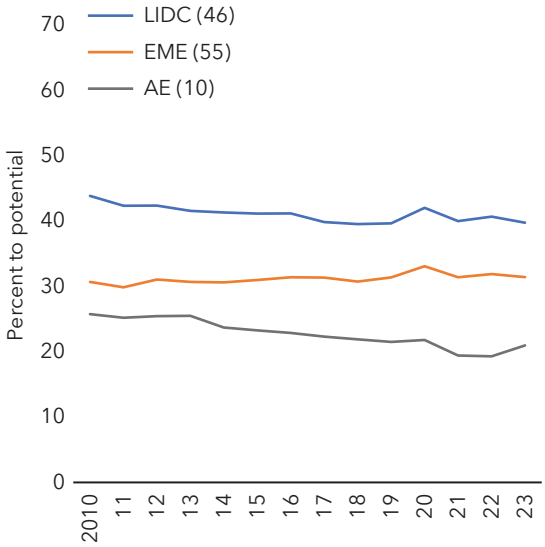
Figure 6. VAT Compliance Gap—Reverse RA-GAP



Source: Authors.

Note: RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax. Number of countries in parentheses; *X* indicates the mean.

Figure 7. VAT Compliance Gap—Reverse RA-GAP



Source: Authors.

Note: AE = advanced economy; EME = emerging market economy; LIDC = low-income developing country; RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax. Number of countries in parentheses.

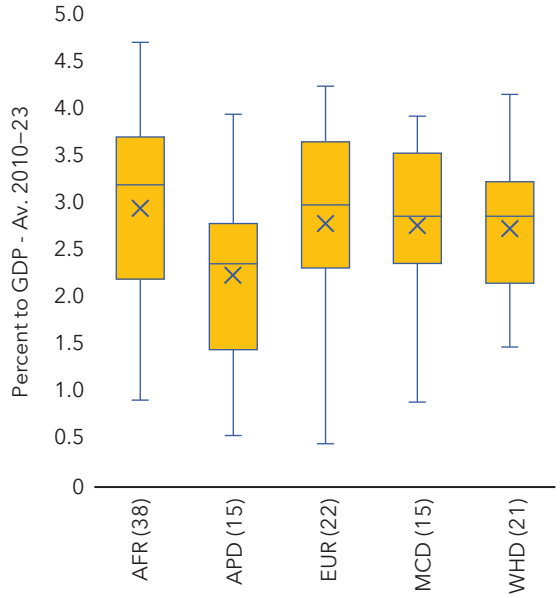
D. VAT Compliance Gap Trends by Region

Figure 8 shows the VAT compliance gap relative to GDP, averaged over 2010–23, for five regions: Africa (AFR), Asia and the Pacific (APD), Europe (EUR), the Middle East and Central Asia (MCD), and the Western Hemisphere (WHD). The average VAT compliance gap to GDP is 2.9 for AFR, 2.2 for APD, 2.8 for EUR and MCD, and 2.7 for WHD. In terms of the compliance gap to potential and its trend from 2010 to 2023 (Figure 9), almost all regions show an improvement in compliance levels. The AFR group shows a decreasing average VAT compliance gap from 43 percent in 2010 to 41 percent in 2023. The APD group also shows a decreasing trend, with the average VAT compliance gap falling from 36 percent to 33 percent over the same period. The EUR group shows a decline from 26 percent in 2010 to 23 percent by 2023. The WHD group maintains

[18] It should be noted that this indicator quantifies lost revenues to GDP because of noncompliance and does not necessarily reflect better or worse performance in terms of compliance, because this value will depend on the legal design of the base and tax rate in each country. The compliance gap indicator, as a percentage of potential (also presented here), is a better approximation of compliance performance.

a relatively stable level of about 33 percent from 2010 to 2023. The MCD group is the only one showing an increase in the compliance gap, from 32 percent to 34 percent.

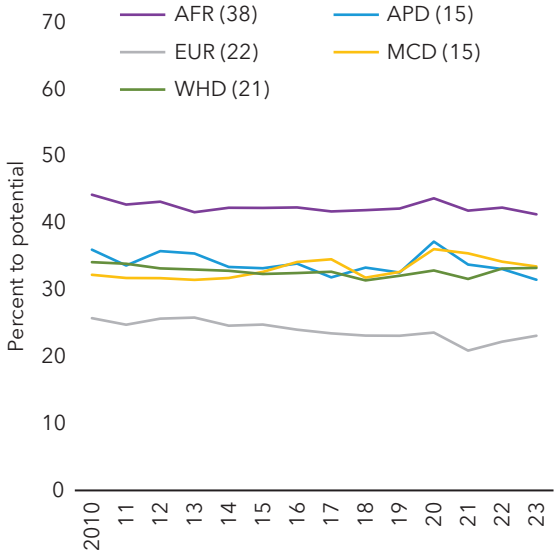
Figure 8. VAT Compliance Gap—Reverse RA-GAP



Source: Authors.

Note: AFR = Africa; APD = Asia and Pacific; EUR = Europe; MCD = Middle East and Central Asia; RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax; WHD = Western Hemisphere. Number of countries in parenthesis. *X* indicates the mean.

Figure 9. VAT Compliance Gap—Reverse RA-GAP



Source: Authors.

Note: AFR = Africa; APD = Asia and Pacific; EUR = Europe; MCD = Middle East and Central Asia; RA-GAP = Revenue Administration Gap Analysis Program; VAT = value-added tax; WHD = Western Hemisphere. Number of countries in parenthesis.

VI. Limitations and Caveats

The value-added tax (VAT) compliance gap estimates, regardless of the technique or approach used, come with some limitations and caveats. First, the figures are estimates rather than measurements. The compliance gap, for obvious reasons, is a variable that cannot be easily observed, which introduces uncertainty into any methodology. The concept of C-efficiency used in these estimations has inherent limitations and may not fully capture the complexities of VAT compliance. For example, the design of VAT in a few countries exhibits characteristics that deviate from the consumption macroeconomic base (restrictions on refunds, restrictions on credits, and so on), and in those cases, the compliance gap defined in terms of final consumption could be biased as a result of the use of a different macroeconomic VAT base.[19] Similarly, compiling tax expenditure provisions across countries with different concepts poses its own challenges and may not accurately reflect their true effects on the C-efficiency identity (for example, differences in the treatment of financial services). In the Reverse Method, those disparities are intended to be captured by the calibration process, but naturally, the effects cannot be entirely represented.[20] As a result, the error associated with this methodology is inherited—typically linked to the reliance on national accounts as the primary input, which are subject to periodic revisions and therefore require continuous updates to the tax gap estimates.

[19] Although the model has calibrated the systematic differences between proxy variables and their actual values using the Revenue Administration Gap Analysis Program mission sample, only a few countries in this sample implicitly exhibit a different macroeconomic VAT base. In the future, if more Revenue Administration Gap Analysis Program missions are added, it will be possible to test for distinctions in this type of VAT design, where the base is not final consumption.

[20] One of the most important limitations concerns advanced economies, because the number included in the calibration process is limited. Standard Revenue Administration Gap Analysis Program gap assessments currently do not include most of the larger advanced economies, such as those belonging to the G-20.

VII. Conclusions

The goal of the Reverse Method is to approximate, as closely as possible, the result that a standard RA-GAP assessment would have produced if it had been conducted. Thus, this method serves as a leading indicator of the VAT compliance gap. It is not intended to provide highly precise estimates for each country or each individual year, nor to replace a standard RA-GAP assessment. The primary contribution of this note is the introduction of a new technique for producing VAT compliance gap estimates, which enables broad results with a high degree of comparability across countries. Like any top-down technique, the main advantage of this method is that it covers all forms of tax gaps, whereas bottom-up techniques are better suited for detailed segmentation but less accurate at estimating the overall value of tax compliance. Other advantages of the Reverse Method are:

- It provides VAT gap estimates for many years and countries using the same tool.
- It is based on public data sets, offering several advantages for running updates.
- It allows for rough estimation in countries with severely limited data sets.
- It enables a cross-check of standard top-down VAT gap assessments.

In summary, the results presented in this note provide tax gap analysts with a standardized approach to assess and compare compliance levels across countries, enabling more consistent benchmarking across jurisdictions. The next steps to refine this methodology include (1) adding more and diverse RA-GAP estimation cases in the calibration process to enhance the precision of the results; (2) incorporating increasingly complete and standardized tax expenditure estimates;[21] (3) keeping the estimates as up to date as possible by using the latest versions of various global databases and, if possible, extending the historical information series before 2010; and (4) developing a deep analysis of results compared with other techniques, which requires compiling detailed information on those other techniques.

[21] This work used the Global Tax Expenditure Dataset, which is currently the most comprehensive source of tax expenditure data. The information is self-reported by countries, and estimation techniques may vary across cases, so errors and discrepancies are possible. However, in the future, greater methodological consistency, improved data quality, and continued cooperation and technical assistance from international organizations could help strengthen the reliability of this information.

APPENDIX 1. Synthesis of Variables

Appendix Table 1.1 Variables, Descriptions, Estimation, and Source

Variable	Description	Estimation/source
E_C	C-efficiency—defined as the ratio of accrued actual VAT collection to the product of the standard rate and final consumption (net of VAT collection compiled in national accounts)	IMF's FAD C-efficiency data set
Γ	Compliance gap to potential *PV1*—proportion of VAT that is not perfectly enforced to potential	Estimated by the Reverse Method
P	Policy gap to potential *PV3*—proportion of the VAT difference because of some goods and services not being taxable or being taxable at a different rate than the standard one	Not estimated directly
PV1	Potential VAT revenue under full compliance and the current tax policy structure	Not estimated directly
PV2	Potential VAT revenue under full compliance and a normative tax policy structure	Estimated as the difference between *PV3* and NTG
PV3	Potential VAT revenue under full compliance and a comprehensive tax policy structure	Estimated by final consumption, *FC*, minus the official VAT collection, *AV0*, multiplied by the VAT standard rate, r
TEG	Tax expenditure gap. Equal to the difference between *PV2* and *PV1*.	VAT revenue forgone because of VAT expenditure provisions included in each country's official tax expenditure report as an approximation
NTG	Nontaxable goods and services gap. Equal to the difference between *PV3* and *PV2*.	Estimated using the final consumption of three sectors: public administration, public education, and public health
AV0	Official actual VAT collection	IMF's FAD C-efficiency data set
AV	Accrual actual VAT collection	Not estimated directly
AV Nat.Acc.	National Accounts actual VAT collection	National Accounts
r	Standard VAT rate	IMF's FAD C-efficiency data set
FC	Final Consumption	IMF's WoRLD data set
E_C^{FAD}	C-efficiency—defined as the ratio of official actual VAT collection to the product of the standard rate and final consumption (net of official actual VAT collection)	IMF's FAD C-efficiency data set
$VAT_p^{ExpProv}$	Official tax expenditure report provision "*p*" (from a total of "*n*" VAT provisions)	GTED
GDP_x	GDP of sector *x* (*x* = O, for public administration and defense; *x* = P, for public education; and *x* = Q, for public health).	Official GDP by sector from the country's national accounts institution

Source: Authors.

Note: GTED = Global Tax Expenditure Dataset; VAT = value-added tax; a more detailed explanation of these variables can be found in the IMF's RA-GAP model (https://www.imf.org/en/Capacity-Development/Training/ICDTC/Schedule/OL/2023/VGAPxOL23-164)

Deriving the C-efficiency identity:

$$AV = PV3 - (\Gamma \times PV1) - (P \times PV3) \quad (1)$$

$$E_c = \frac{AV}{PV3} = 1 - \left(\Gamma \times \frac{PV1}{PV3}\right) - P \quad (2)$$

$$PV1 = PV3 \times (1 - P) \quad (3)$$

Replacing (3) in (2),

$$E_c = 1 - \Gamma \times \left(\frac{PV3 \times (1-P)}{PV3}\right) - P \quad (4)$$

Thus,

$$E_c = 1 - \Gamma\,(1-P) - P \quad (5)$$

Or,

$$E_c = (1 - \Gamma) \times (1-P) \quad (6)$$

APPENDIX 2. Standard RA-GAP Assessment Mission

The Revenue Administration Gap Analysis Program (RA-GAP) is an initiative led by the IMF's Fiscal Affairs Department to help countries assess and improve the performance of their revenue administrations. Its core objective is to estimate the gap between potential and actual tax revenues, thereby identifying areas of noncompliance and inefficiencies in tax policy and administration.

What Is an RA-GAP Mission?

An RA-GAP mission is a structured engagement between IMF experts and national revenue authorities to diagnose the "health" of a country's tax system. These missions typically focus not only on specific taxes—most commonly Value-Added Tax—but also on Corporate Income Tax, Personal Income Tax, and Excise Taxes. The mission involves collecting and analyzing statistical and administrative data to estimate the tax gap, which is the difference between the revenue that should be collected under full compliance and what is actually collected. Missions can be conducted in person or remotely and often include preengagement meetings, intensive work sessions with national statistics and customs officials, and follow-up activities. A key feature is the Assisted Self-Assessment model, in which local authorities apply the RA-GAP methodology with IMF guidance, fostering ownership and capacity building.

How Is RA-GAP Applied?

The RA-GAP methodology uses a top-down approach to estimate potential revenue based on macroeconomic data (for example, GDP, Supply Use Tables, and Input-Output matrices) and compares it with actual tax collections. The process includes:

- Data-readiness assessment to ensure sufficient quality and availability.
- Sectoral analysis to identify compliance gaps across industries.
- Capacity development through training and collaborative analysis.
- Integration with other diagnostic tools like the Tax Administration Diagnostic Assessment Tool, International Survey on Revenue Administrations (ISORA), and Revenue Administration Fiscal Information Tool (RA-FIT) for a holistic view of tax administration performance.

The program is tailored to each country's context, ensuring relevance and feasibility. It also supports reform planning by providing empirical benchmarks and identifying priority areas for improvement.

What Are the Advantages?

RA-GAP missions offer several strategic benefits:

- Diagnostic Insight: Quantifies compliance gaps and reveals systemic weaknesses.
- Policy Guidance: Informs tax policy and administrative reforms with evidence-based recommendations.
- Capacity Building: Enhances local expertise in data analysis and tax gap estimation.
- Governance Support: Provides external stakeholders with transparent assessments of tax administration effectiveness.
- Monitoring and Evaluation: Facilitates tracking of reform outcomes over time.

By aligning with broader IMF capacity development efforts and integrating with other tools, RA-GAP strengthens the foundation for sustainable revenue mobilization and improved fiscal governance.

APPENDIX 3. Applying the Reverse Method's Accounting Approach under a Country-Specific Purpose

This methodological option of the Reverse Method would require precise measurements of *Ec*, the tax expenditure gap (*TEG*), *PV2*, the nontaxable gap (*NTG*), and *PV3*. With these values, it would be possible to directly input them and obtain a reverse accounting estimate of the compliance gap. For this, the following information inputs are especially key:

1. A precise accrual measurement of the C-efficiency:
   - Accrual value-added tax (VAT) collection
   - National Accounts VAT collection
   - Precise portion of the National Accounts VAT collection embedded in the Final Consumption

2. VAT expenditure report based on a à la Keen benchmark (final consumption, destination principle, standardized rate) to measure tax expenditure gap (TEG)
   - Including provisions not reported when a different VAT benchmark is applied (for example, financial services, final consumption related to dwelling ownership, negative provisions, and so on)
   - Adjusting provisions to full compliance, if needed
   - Adjusting for joint effects (all provisions), if needed

3. National accounts for final consumption for the economic sectors O, P, and Q (typically available from Supply Use Tables) to measure nontaxable gap (NTG):
   - Sector O: Public administration and defense
   - Sector P: Public education
   - Sector Q: Public health

APPENDIX 4. Descriptive Statistics

Appendix Table 4.1 Calibration Model (Table 2 and Figure 1)

	Count	Mean	Median	Std	Min	Max
$\widehat{DEC\_E_C}$	219	.497101	.482712	.11955	.221691	1.112384
$DEC\left(\widehat{1-\frac{NTG}{PV2}}\right)$	218	.881607	.886648	.034936	.774704	.938301
$DEC\left(\widehat{1-\frac{TEG}{PV2}}\right)$	208	.879166	.88128	.027381	.798921	.944712
DEC_(1 − Γ) RA-GAP	218	.699076	.698674	.121945	.376757	.955201

Source: Authors.

Note: DEC indicates variables expressed in decimals. RA-GAP indicates figures from a RA-GAP tax gap assessment mission. RA-GAP = Revenue Administration Gap Analysis Program.

Appendix Table 4.2 Applying the Calibration Model to All Countries (Figures 2, 3, 4, 5, and 6)

	Count	Mean	Median	Std	Min	Max
$\widehat{DEC\_E_C}$	1,436	.4684	.462833	.151097	.097479	1.23702
$DEC\left(\widehat{1-\frac{NTG}{PV2}}\right)$	1,436	.886219	.892201	.040755	.703911	.991762
$DEC\left(\widehat{1-\frac{TEG}{PV2}}\right)$	1,436	.886511	.885657	.031604	.784336	.974866
DEC_(1 − Γ) ReverseMethod	1,436	.654464	.661208	.128326	.310491	.997226

Source: Authors.

Note: DEC indicates variables expressed in decimals. RA-GAP = Revenue Administration Gap Analysis Program.

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