Estimating the VAT Base: Method and Application

by Tuan Le Minh

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The value added tax is “a broad-based business tax imposed at each stage of the production and distribution process that, when applied nationally, is typically designed to tax final household consumption” (Tait, Ebel, and Le, 2005, p. 461). The idea of a VAT can be traced back to the writing of von Siemens, a German businessman, in the 1920s. Since 1948, when a rudimentary form of the tax was first applied at the manufacturers' level in France, more than 130 countries have introduced the VAT, collecting on average a quarter of the total government revenues (Ebrill et al., 2001; ITD, 2005).

In many countries, VAT is regarded as the workhorse of the revenue systems. Subject to adjustments on administrative or policy grounds, a typical destination-based VAT applies the tax to domestic supplies and imports while excluding exports from the tax base. The incremental collection of the VAT requires that registered taxpayers be allowed to take a credit for capital and intermediate supplies through the invoice-credit mechanism (Tait, 1991; Ebrill et al., 2001).

The key objectives of the VAT modeling are to project VAT revenue, to estimate compliance level and tax expenditures in VAT, and, more broadly, to analyze the revenue impact of proposed changes in VAT policy and/or administration. There are three major approaches for VAT modeling: aggregate national account approach, sectorwise national account approach, and input-output (I-O) approach. Jenkins, Kuo, and Shukla (2000) provide an extensive review of the three approaches.

In the aggregate national account approach, the gross domestic product of a country is adjusted for trade balance, capital formation, exemption and exemption-induced cascading, government expenditures on wages and salaries, exemption threshold, and collection leakage. The sectorwise national account approach begins with the data on outputs by sector and incorporates adjustments for imports, exports, intermediate inputs, investment, and for exempt and zero-rated outputs and inputs. The I-O approach relies primarily on I-O tables to derive the detailed final consumption of goods and services by household, government, and business (intermediate inputs and capital purchases). Similar to the other two approaches, further adjustments have to be made to account for the impact of exemption, zero-rating, and threshold. Annual national statistics and business and household consumption surveys can be used as supplementary data sources for necessary assumptions for all three modeling approaches.

The three different approaches should generate consistent results of projected VAT revenues and compliance rate. As the I-O data present the most detailed accounting of the supply and use, and consumption expenditures of goods and services in an economy, the I-O modeling of the VAT can be considered the best approach to estimate the disaggregate impact of policy change on the collection and compliance at commodity level. Note, however, in a number of less developed countries, the I-O data may be outdated; this leads to the problem that the data may no longer be descriptive of the current state of the economy, especially in countries undergoing fast and sustainable growth. The nonexistence of recent I-O tables requires that one has to resort to an aggregate national account approach or sectorwise national account approach to estimate the VAT base. In this report, the I-O approach is outlined and applied to the case of Romania. Section I presents the I-O modeling method. Section II applies the I-O model to the case of the Romanian VAT system. Section III concludes the report.

I. The Input-Output Approach

The VAT Base

Jenkins, Kuo, and Shukla (2000) present the I-O approach applicable for a country in transition from a sales tax at the manufacturer’s level to a VAT. In this section, I explain the application of the I-O
model to a country with an existing VAT and extend the method to account for the treatment of outputs and inputs of small businesses with turnover below a predetermined VAT threshold (below-threshold small businesses). The model is applied to a typical consumption-based VAT, which excludes capital goods and intermediate inputs from the VAT base through a credit-invoice mechanism.

For the modeling, note the distinction between exemption and zero-rating. An exempt commodity is not subject to the VAT, but its input VAT is not credited. If the exemption is applied in the middle of the production-distribution chain, the VAT base tends to be increased because of the cascading effect: The input VAT of the exempt product is not credited back but shifted forward to the next stage of the chain. Hence the tax cascades in subsequent stages. However, if the exemption is applicable in the final retail sales stage, only the value added at this stage is excluded from the base, which tends to shrink. Typically, a zero-rated commodity is not taxed (it is subject to a zero rate), and all its input VAT is credited. Zero-rating thus does not break the production-distribution chain and could eliminate the VAT for the entire chain if it is applicable to the last stage of the chain and typically to exports in a destination-based VAT.

Conceptually, the VAT is imposed on the final domestic consumption, or the sum of final private consumption expenditure, and government expenditure on goods and services (net of wages and salaries), which forms the gross base in an ideal case when the VAT is purely consumption-based, without exemption and with the zero rate being applicable exclusively to exports. As exemption exists in all VAT systems because of equity or administrative practicability reasons (particularly to exclude hard-to-tax sectors from the base), one needs to adjust the gross base by subtracting the value of exempt output sales and adding back intermediate input purchase by the exempt sectors.\(^1\) It is worth noting that the VAT base is the final price of goods and services, inclusive of all wholesale and retail trade margins.

I-O Tables and Basic Adjustments

A set of I-O tables reflects the interrelationship among industries in terms of supply and use, and final demand.\(^2\) Typically, I-O tables consist of three basic components:

- The “supply” matrix. In this matrix, all goods and services supplied by industries in an economy are measured at basic prices (net of trade and transport margins and taxes on products).

- The “use” matrix. This matrix presents the business consumption or intermediate inputs measured at purchaser prices. For a country with a VAT, as a rule in the compilation of I-O tables, the purchase price in the use matrix is net of the VAT on the notion that the VAT on inputs ultimately is to be credited to businesses. For other countries with a turnover tax, however, the purchase price is inclusive of the turnover tax due to cascading.

- The “final demand” matrix. This matrix reflects the final consumption expenditures on goods and services by household sector, nonprofit organizations serving households, and general government.

For the I-O modeling, one should start with the final domestic consumption expenditures by goods and services (both domestically produced and imported), reflected in the final demand matrix. Those expenditures are then adjusted to take account of some of the technical, policy, and administrative issues in a particular VAT system.

Adjustment for the VAT: The final consumption expenditures are inclusive of the VAT, and thus they have to be netted out of the VAT content for the projection of the VAT base.

Adjustment for exempt and zero-rated supplies: The final consumption expenditures are further adjusted for the exempt or zero-rated goods and services through a series of taxable proportions by commodity. The taxable proportions, in turn, are estimated on the basis of the existing legal provisions stipulated in the VAT code. The VAT base should be adjusted upward by adding the values of new residential construction (usually subject to a VAT) and intermediate goods of exempt business activities (due to exemption-induced cascading effect), reflected in the use matrix part.

Adjustments for exempt small taxpayers: The effective VAT base should be net of the sales of the below-threshold small businesses and inclusive of their inputs. The value added or difference between the outputs and inputs of the below-threshold small businesses is normally unobservable and thus have to be estimated. We suggest a practical approach to estimate those values (below).

Estimating Turnovers and Inputs

The estimation starts with the selection of a typical probability distribution that best approximates firms’ observed inputs and outputs. Detailed data on firms’ input and output may be available from business surveys or at a country’s tax administration agency. Given the large number of firms

\(^1\)MacKenzie (1992) discusses the problems with exemptions and offers a framework for treatment in VAT base estimation.

\(^2\)For a comprehensive presentation of the I-O table compilation and analysis, see United Nations (1999).
with wide-ranging sizes across industries (except for naturally monopolistic industries such as utilities, which all have turnover above a set threshold and hence are not under consideration), it may be plausible to assume that the central limit theorem holds: The probability distribution of firms’ inputs and outputs tends to a normal distribution, with firms’ inputs and outputs centered asymptotically symmetrical around the respective means. For some industries with significant industry concentration by one or few large firms, some adjustments may be required to net out the values of outputs of such firms (regarded as the outliers) before superimposing a normal probability distribution. The adjustment is to avoid skewed data concentration to the right of the probability density distribution.

A VAT threshold ($x^*$) is determined in a country’s VAT code. As it is typically set on the basis of firms’ turnover, we could practically fit it in the probability density function of the normally distributed firms’ outputs with their mean and standard distribution, which could be estimated directly from the firms’ output distribution. We subsequently find the cumulative probability, $\Pr(x < x^*)$, which is used as the adjustment factor to approximate the share of the inputs and outputs of the below-threshold small business and is based on the implicit assumption that the input-output ratio for small businesses is identical with the industrywise aggregate input-output ratio.

**VAT Revenue Projection**

The expected VAT revenue by commodity at full compliance can be calculated by multiplying the tax base with the taxable proportion and tax rates. Note that all values in the estimated VAT base are in nominal terms and are estimated on an accrual basis (as are the values in the I-O tables). Separate estimation should be made for those commodities subject to a standard rate and those subject to nonstandard rates, if the country under consideration adopts more than one positive rate. In a general form, the VAT revenues ($R$) are estimated as follows:

$$R = \left[ \sum_i C_i \rho_i + \sum_j K_j + \sum_i \rho_i \left(E_i - S_i\right) \right] \sum_m \beta_m r_m$$

(1)

Where,

- $C_i$ = before-VAT final expenditures (private and nonwage government consumption) of commodities in sector $i$.
- $\rho_i$ = proportion of the final consumption of commodities in sector $i$, subject to VAT (net of proportion of exempt or zero-rated commodities and services).
- $K_j$ = input purchase by exempt sector $j$.
- $E_i$ = inputs purchased by below-threshold small businesses in sector $i$.
- $S_i$ = outputs sold by below-threshold small businesses in sector $i$.
- $\beta_m$ = proportion of the final consumption (adjusted by the taxable proportion) of commodities subject to a positive VAT rate $r_m$.
- $r_1, \ldots, r_m$ = positive statutory rates as stipulated in a country’s VAT code.

The VAT revenues as defined in (1) consist of three distinct components. The first component,

$$\sum_i C_i \rho_i \sum_m \beta_m r_m$$

accounts for the impact of the zero-rating and exemptions that shrink the VAT base. The second component,

$$\sum_j K_j \sum_m \beta_m r_m$$

incorporates the cascading effect that resulted from exemptions at middle stages of the production-distribution chain. The third component,

$$\sum_i \rho_i \left(E_i - S_i\right) \sum_m \beta_m r_m$$

adjusts the VAT base for the impact of the VAT threshold, by netting out the sales and adding the input purchase by below-threshold small businesses.

**Adjusting for Noncompliance**

As the VAT estimated in (1) is the potential VAT at 100 percent compliance, to project the effective VAT revenues, one must weigh (1) with an appropriate compliance rate. The compliance rate, defined as the share of the actual collection in total potential collection, is determined by a complex web of factors such as tax policy regime, general tax culture, and effectiveness of the administration — notably, the intensity of tax avoidance and evasion. In many cases, the rate of compliance is found to be substantially below 100 percent.

One may estimate the compliance rate for the base year (year $t$) by comparing the actual collection of year $t$ with the same year’s estimated VAT potential, as specified in (1). It is suggested that the year in which the latest I-O tables exist be selected as the base year (year $t$). The, the projected VAT revenue in the year of forecast (year $t^*$) can be simulated on the basis of the compliance rate in year $t$. Note that the compliance rate in the base year (year $t$) can be used as one of the independent variables for the simulation of VAT revenue projections.

Also, by applying the I-O modeling, tax administrations should be able to estimate the VAT compliance rates by commodity group — as defined in the national I-O database — with commodity-by-commodity comparison of the actual collection and the corresponding estimated VAT potential. The
estimation of compliance/noncompliance by commodity group can actually be used as a valuable tool for risk management and auditing. Figure 1 provides a conceptual framework of the VAT revenue modeling and simulation.

II. I-O Approach for Romania

Romania's VAT Regime

Romania introduced a VAT in 1993. The VAT is consumption-based, operating under the destination principle, and administered on the invoice-credit method. The VAT generated roughly 7 percent of the GDP in 2004 (Table 1).

The main features of the VAT legislation are summarized below.³

³The description of the VAT regime in Romania is based on Government of Romania (2003).

Rate. The standard VAT rate is 19 percent, which is comparable with the average in middle-income countries in Eastern Europe and Central Asia and in 15 EU member states.⁴ Selected goods and services related to tourism, cultural activities, mass media, medicines, and educational aids are granted a reduced rate of 9 percent. A zero rate is applied to exports and some selected goods, which are imported under a suspense customs regime or for inward processing operations, or to free trade zones for storage purposes.

⁴Different measures of the average standard VAT rate (unweighted average, median, and mode) in the middle-income countries in Eastern Europe and Central Asia converge at approximately 20 percent (author's estimate on the basis of data from the IBFD 2005). The unweighted average standard rate in the 15 EU member states is 19.6 percent (Cnossen, 2003).
Base. The base includes values of goods and fees and ancillary expenses such as commissions, packaging expenses, transport, and insurance costs. Public institutions are taxable for activities carried out under the same legal conditions as those applicable to private businesses.

Exemptions. The VAT legislation allows for multiple exemptions, including hard-to-tax sectors (for example, financial services), as well as goods and services deemed necessary for public health and interest.

Exempt threshold. The current threshold is set at the new Romanian leu RON 200,000. Voluntary registration is allowed for below-threshold small businesses. During operation, if a VAT-registered firm finds that its turnover goes down to below the threshold, it cannot self-select out of the VAT net.

VAT accounting and refunds. The accounting period is the calendar month for firms with annual turnover of more than the equivalent of €100,000 and quarterly for firms with annual turnovers below that amount. To determine the input VAT credit, firms prorate their input tax based on the ratio of turnover between taxable and exempt or nontaxable VAT supplies. In principle, proration is established on an annual basis, but it may be calculated on a monthly or quarterly basis in exceptional cases. A VAT refund is not automatic. For the refund amount of less than RON 5,000, the balance can only be carried forward with no interest to the following fiscal period.

VAT Modeling Data

Since 1998, Romania has applied the new system of national accounts in compliance with the European Union’s European System of Accounts (ESA) 1995. The main sources of data for I-O modeling are from the latest I-O tables for 2002 (Romanian National Institute of Statistics 2005a). The I-O matrices consist of 34 economic sectors. They are constructed on the basis of an identity that represents the balance between economic resources and uses (Table 2).

The structure of the data on final consumption by household, nonprofit organizations, and government across economic sectors is summarized in Figure 2.

The Romanian Statistical Yearbook (Romania National Institute of Statistics 2005b) provides supplementary data used for the assumptions on capital investment, the shares of private and public consumption expenditures subject to a reduced VAT rate or exemption, and the growth rates of private, government, and business consumption. The yearbook also includes the basic data required for modeling the size of inputs and outputs of small businesses with turnover below the existing threshold of RON 200,000.

Estimating Revenues and Compliance

For our purpose, we select 2002 as the base year with the latest available I-O tables. To ensure internal consistency and validity, we first simulate the VAT base, using the 2002 I-O data. The comparison between the actual VAT collection (RON 10.4 billion) and the estimated VAT revenue potential or the VAT revenue at full compliance (RON 19.2 billion) indicates that the VAT compliance rate in 2002 was about 54.4 percent.

Next, the 2002 effective VAT base is grossed up to the 2004 VAT base, using the specified assumptions and estimated parameters. At the 2002 compliance rate, the projected 2004 VAT revenue is more than RON 16.2 billion, which is less than the 2004 actual collection by approximately 1.8 percent (the 2004...
actual collection was RON 16.5 billion). From a different perspective, one may calibrate the 2004 compliance rate by directly comparing the 2004 actual VAT collection with the estimated VAT revenue potential (RON 29.9 billion, at the hypothetical 100 percent compliance). The comparison shows a slightly improved compliance in 2004 (55.4 percent, compared with 54.4 percent estimated for 2002). After the internal validity test, we project the VAT revenue for 2005 with both point estimate and range estimate (Table 3).

Table 3 indicates that the point estimate of the 2005 VAT revenue collection at the 2004 compliance rate of 55.4 percent and the existing standard statutory rate of 19 percent is RON 20.7 billion. A simulation of the projected VAT collection by the change in the VAT compliance rate and/or standard statutory rate shows a range estimate. Both the standard VAT rate and compliance rate are allowed to increase by an incremental 1 percentage point (at the base case scenario, the VAT standard rate is 19 percent and the estimated compliance rate is 55.4 percent).

The results shown in Table 3 imply that if there was no improvement in compliance (the compliance rate of 55.4 percent remains unchanged), then an increase in the standard statutory VAT rate from the existing 19 percent to 22 percent (proposed in 2005 but finally dropped) would result in an increase in the VAT collection by 15 percent, from RON 20.7 billion to RON 23.8 billion. Note that in this simplified estimation, we have isolated the impact of the Laffer Curve, which indicates that with an increase in the statutory rate, revenue collection may rise initially, reach a peak at a certain revenue-maximizing rate, and thereafter decline. Therefore, the estimated increase in the VAT collection, triggered by the rise in the VAT rate at any given level of compliance as presented in Table 3, could be considered as the upper bound estimate. An increase in the statutory rate potentially provides more incentives for evasion and avoidance.

However, if the standard statutory VAT rate were unchanged, but because of improvement in enforcement and/or simplification of the VAT regime, the compliance rate improved from the current 55.4 percent to 70 percent (still a modest level of the VAT compliance experienced in countries with modern revenue administrations), the VAT collection would be RON 26.1 billion, higher than the collection under the above-mentioned scenario, in which the standard rate would have to increase from the existing 19 percent to 22 percent at the unchanged rate of compliance.

III. Conclusion

As VAT is one of the major taxes in revenue systems, tax policy units and tax administrations should develop their capacity in projecting the VAT revenues, estimating compliance, and assessing the revenue impact of any proposed changes in the tax laws and/or tax administration practices. I-O modeling could be used for such purposes. It should also be noted that as the I-O tables are disaggregated by economic sector, it is possible to apply the I-O modeling to estimate the VAT compliance by economic sector. The information is particularly important for risk-based auditing and debt management in the VAT administration, which relies on analyzing noncompliance among taxpayers and economic sectors.

The results of the I-O modeling of VAT for Romania are illustrative. Given the current VAT regime, relatively greater efficiency gains in VAT collection can be achieved by improving the existing compliance rate — possibly, through a combination of VAT regime simplification and tax administration capacity enhancement — rather than raising the standard rate, which is already comparable with the ones in the EU countries. The estimated compliance

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5Estimated VAT compliance rates vary widely, even in countries of the same income group. For example, Nam et al. (2001) apply a similar input-output-based approach and find that the compliance rates in selected EU countries range from 66 percent (Italy) to 98 percent (the Netherlands).
level of 55.4 percent is low compared with other known cases in which countries have advanced revenue administrations.

References


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<th>Compliance Rate</th>
<th>Standard Statutory VAT Rate</th>
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<tr>
<td>15%</td>
<td>14.9</td>
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<tr>
<td>16%</td>
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<tr>
<td>17%</td>
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<td>16.7</td>
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<tr>
<td>22%</td>
<td>17.0</td>
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Source: Author’s calculations based on national input-output tables.

Table 3. Simulation of VAT Estimation (2005) (Unit: Current billion RON)


