# A Methodological Note on VATSIM-DF (I)

## VAT Micro Simulation Model for Italy

*Valerio Ferdinando Calà* Silvia Carta*, Marco Manzo*e Luca Signorelli**

**Ministry of Economy and Finance, Department of Finance*

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## VAT modelling and performance

The VATSIM-DF is a simulation model developed by the Department of Finance (DF) with the aim of assessing the effects of VAT reforms, regarding both the quantification of changes in revenues and the distributive effects of tax incidence variations on households' disposable income. VATSIM-DF consists of three modules:

- VATSIM-DF (I) is the module which simulates VAT revenues for all the components of the demand for final and intermediate goods and services;
- VATSIM-DF (II) is the non-behavioural microsimulation module, which analyses revenue and distributive effects for Italian household final consumption;
- VATSIM-DF (III) is the behavioural module, which addresses changes in expenditures for every good and service made by Italian households, in response to price and income variations due to changes in VAT rates, measured in a context of partial economic equilibrium.

This methodological note aims to explain how the VATSIM-DF (I) works. By following a meso-economic approach, this module simulates VAT revenues under current legislation on the three (3) principal components of demand. Firstly, household final consumption, that is the "pure" VAT component; secondly, the non-deductible purchases of goods and services (both intermediate and capital goods) made by firms which operate in the market and non-market sectors ("impure" VAT); lastly, the adjustment to VAT tax base due to sales and purchases made by firms below-threshold, not subject to VAT application.

The structure of this methodological note is the following:

- The first chapter explains the different approaches existing in literature for VAT modelling, focusing on the input-output approach (I-O). We will also introduce, at the end of this section, a measure of VAT performance (C-efficiency) and its decomposition into policy gap (tax erosion) and compliance gap (tax evasion).
- In chapter 2, we explain in detail how the model quantifies all the components of the theoretical VAT for Italy, namely: household final consumption; household investments; intermediate consumption and investments made by firms operating in both market and

non-market sectors; purchases and sales made by firms operating in the simplified fiscal regime (below-threshold).

- The third chapter addresses the issue of how to estimate effective VAT. This requires explaining how VAT taxable basis is forecasted for future periods and how to estimate VAT evasion.
- The last chapter deals with the derivation and subsequent decomposition of C-efficiency as a VAT performance measure.

## 1.1. The approaches for VAT modelling

There can be different objectives for VAT modelling, such as estimating and projecting VAT revenues for the years of the Budget Law, analysing the revenue impact of changes in VAT policy or estimating compliance and efficiency level of the policy implementation.

The main approaches for VAT modelling are the aggregate, the sectoral and the input-output approaches.

The aggregate national account approach starts from the Gross Domestic Product of the economy and gets the VAT base by adding imports and subtracting exports and adjusting for capital formation, exemptions – including exemption threshold – and government expenditures on wages and salaries. The US Department of Treasury[2] and IMF[3] currently use this approach.

The sector wise national account approach estimates the VAT base as the sum of the value added generated by each sector in the economy, quantified starting from the data on outputs by sector and then netting out intermediate inputs, capital purchases, imports and exports. This approach may present some difficulties due to the lack of official statistics on imports/exports broken down by sector.

The input-output or I-O approach is based on the assumption of equivalence between the VAT base and a retail sales tax levied only on final selling price. The starting point is the information contained in input-output tables, used to derive the detailed final consumption of goods and

[2] Department of Treasury in the U.S., Tax Reform for Fairness, Simplicity, and Economic Growth, Volume 3, Value-Added Tax, The Treasury Department Report to the President, (November 1984).
[3] See, e.g., H.H. Zee and J.P. Bodin, "Aspects of Introducing a Value-Added Tax in Sri Lanka", paper prepared for the International Monetary Fund, Fiscal Affairs Department, (August 1992).

services by households, business and government. As in the previous approaches some adjustments are needed to account for exemptions, zero-rates and thresholds. The I-O approach may be challenging when data from the input-output tables are outdated and no longer represent the current economic situation (Minh Le – WB – Estimating the VAT – page. 203).

### 1.1.1. The input-output tables

The I-O tables are a set of matrices by sector and product, from the supply and use sides. Those tables provide detailed information on the supply of goods and services by domestic production and imports and the use of goods and services for intermediate and final consumption. The use table also shows the generation of the components of value added by economic sector in the domestic economy. Thereby, supply and use tables show a detailed picture of the production processes, the interdependencies in production, the use of goods and services and the generation of income[4].

The use table shows uses of goods and services by product and institutional sector, describing the gross value added components and the intermediate consumption at purchase prices. The purchase price is the price actually paid by the buyer of the product, including taxes, trade and transport margins and excluding credit interests, discounts or ancillary expenses.

The supply table represents the total availability of resources classified by product and sector and it is usually shown at basic prices, which is the price received by the producer from the buyer for the produced good or service, net of taxes on the product and trade and transport margins.

### 1.1.2. I-O approach: application

Minh Le (2007) presents an application of the I-O model to a typical consumption-based VAT[5]. The expected revenue can be calculated by multiplying the tax base with the taxable proportion and tax rates. In a general form, VAT revenues are estimated as follows:

[4] Eurostat., Manual of Supply, Use and Input-Output Tables, (2008).
[5] Minh Le (2007), "Estimating the VAT Base: Method and Application", Tax Notes International vol. 46, number 2.

$$V_t = \left[\sum_i C_i\rho_i + \sum_j K_j + \sum_i \rho_i(E_i - S_i)\right]\sum_m \beta_m r_m \qquad (1.1)$$

where,

$C_i$ = before-VAT final expenditures of commodities in sector $i$;

$\rho_i$ = proportion of the final consumption of commodities in sector $i$ subject to VAT;

$K_j$ = input purchase by exempt sector $j$;

$E_i$ = inputs purchased by below-threshold small business in sector $i$;

$S_i$ = outputs sold by below-threshold small business in sector $i$;

$\beta_m$ = proportion of the final consumption of commodities subject to a positive rate $r_m$.

The VAT revenues as defined in (1.1) 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 results from exemptions at middle stages of the production-distribution chain. The third component,

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

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

## 1.2. C-efficiency

C-efficiency is a summary indicator of the performance of the VAT and has become the main diagnostic tool for assessing its efficiency, measured through the comparison of actually raised

revenues (actual VAT) with revenues which would be raised with a uniform standard rate on all consumptions and with no exemptions (benchmark VAT).

Denoting with $V_t^e$ the revenue actually raised in the period $t$ and with $V_t^\beta$ the benchmark VAT, the C-efficiency can be defined as:

$$E_t^c = \frac{V_t^e}{V_t^\beta} \tag{1.2}$$

### 1.2.1. Decomposing C-efficiency

To get a closer look to the meaning of C-efficiency, it is useful to introduce as well the theoretical VAT - noted $V_t$ - which can be defined as the VAT which would be raised with no evasion and is given by:

$$V_t = \sum_j B_{jt}\tau_j \tag{1.3}$$

Where $B_{jt}$ is the base for the period $t$ and rate $j$ and $\tau_j$ is the rate $j$.

The result given by C-efficiency may depend on different reasons: a high value could be due to policies which make the theoretical VAT close to the benchmark VAT, e.g. reducing the number of rates or levying VAT only on consumption; but could be due also to a good implementation, e.g. low evasion which leads to VAT revenues closer to the theoretical ones.

Following those considerations, a common decomposition of the information given by C-efficiency can be obtained rewriting it as:

$$E_t^c = \frac{V_t^e}{V_t}\frac{V_t}{V_t^\beta} = \left(1 - \frac{V_t - V_t^e}{V_t}\right)\left(1 - \frac{V_t^\beta - V_t}{V_t^\beta}\right) \tag{1.4}$$

$$E_t^c = (1 - G_t^c)(1 - G_t^p) \tag{1.5}$$

The first term $G_t^c$ is a compliance gap while the second one is a policy gap.

The compliance gap – also known as VAT gap – is zero when there is no evasion, giving a measure of the goodness of the implementation of the VAT.

$$G_t^c = \frac{V_t - V_t^e}{V_t} = 1 - \frac{V_t^e}{V_t} = 1 - R_t^c \tag{1.6}$$

With $R_t^c$ being the compliance ratio: it is the revenues actually raised from VAT relative to what would be obtained with no evasion (theoretical VAT). Given the compliance ratio and the theoretical VAT, one can compute the actual revenues by simply multiplying these quantities. Moreover, since $V_t$ is the sum of all the products between tax bases $B_{jt}$ and rates $\tau_j$, one could also express the actual revenue raised by VAT in terms of net base $B_t$, effective rate $\tau$ and compliance ratio $R_t^c$:

$$V_t^e = \tau B_t R_t^c \tag{1.7}$$

where $B_t$ is the net base (sum of the final consumption and investment by households, non-profit institutions and government) and $\tau$ is the ratio of the theoretical VAT to the net base.

The policy gap is zero if the VAT is levied at a single rate to all and only consumption i.e. with theoretical VAT equating benchmark VAT.

$$G_t^p = \frac{V_t^\beta - V_t}{V_t^\beta} = 1 - \frac{V_t}{V_t^\beta} \tag{1.8}$$

The policy gap is calculated under the assumption of full compliance and can be further decomposed into gaps reflecting distinct aspects of VAT design. Indeed, actual VAT and benchmark VAT have two key design differences: the differentiation between statutory rates across commodities and the presence of exemptions.

$$1 - G_t^p = (1 - rate\ differentiation)(1 - exemptions) \tag{1.9}$$

The impact of exemptions is thus measured by the loss of revenue deriving from taxing at effective rather than statutory rates, while the rate differentiation effect reflects the extent to which the weighted average VAT rate is lower than the standard rate (Keen – IMF – anatomy of the VAT).

# 1. Derivation of Theoretical VAT for Italy

Following the approach described in section 1.1.2. the theoretical VAT will be calculated as the sum of the VAT collected from different sectors of the economy, namely:

- Household consumption
- Intermediate consumption
- Investments
- Non-market sector
- Below-threshold

## 1.1 Household Consumption

Household consumption analysis starts with the final consumption expenditure (social welfare provisions included) in National Accounts gross of VAT on consumption, provided by Istat. To obtain the taxable base, we subtract illegal and informal economy, self-consumption and purchases made by households from below-threshold firms (which do not contribute to the formation of VAT taxable base). Thereafter, we apply tax rates (under current legislation or the ones set out in the proposed reform) to each consumption subclass averaged by using NIC weights (consumer price index for the whole nation) or, where missing, by using data from households consumption survey provided by Istat. The theoretical tax base and tax revenue by rate and product subclass are finally obtained by subtracting the tax rate distribution from National Accounts data for each product subclass.

In order to estimate the tax bases due to household consumption, we first classify the twelve COICOP consumption functions into 5 digits level product subclasses through the consumer price index for the whole nation (NIC) weights provided by Istat. The NIC weights are used to get the consumption in the period of each product code $C_k$, multiplying the weight $v_{k,t}$ related to the subclass $k$ being part of the same division with the total consumption for each division given by the consumption function $C_{i,(t-1)}$ and dividing by the sum of the NIC weights of the same division.

$$C_k = \frac{\nu_{k,t} \cdot C_{i,(t-1)}}{\sum_{k \in i} \nu_{k,t}} \tag{2.1}$$

Household consumption for each subclass of product $k$ is then used to compute the taxable base $B_{ij}$ at current legislation for each division $i$ of product and tax rate $j$. The taxable base for each rate can be obtained by multiplying each product's consumption $C_k$ with the weight of any rate over total $\rho_{jk}$ and dividing by the current legislation weighted average rate $\bar{\tau}_k$ multiplied by 100. The taxable base for each product division $i$ and rate $j$ is obtained as the sum of each subclass being part of the same division:

$$B_{ij} = \sum_k \frac{(C_k - T_k^S) \cdot \rho_{jk}}{100 \cdot \bar{\tau}_k} \tag{2.2}$$

where the weighted average rate $\bar{\tau}_k$ is the weighted product between the rates with the weight being $\rho_{jk}$:

$$\bar{\tau}_k = 1 + \frac{\sum_j \rho_{jk} \cdot \tau_j}{100} \tag{2.3}$$

In the same way the simulated taxable base is obtained using the corresponding proposed rate weight $\hat{\rho}_{jk}$ and weighted average rate $\hat{\bar{\tau}}_k$:

$$\hat{B}_{ij} = \sum_k \frac{(C_k - T_k^S) \cdot \hat{\rho}_{jk}}{100 \cdot \hat{\bar{\tau}}_k} \tag{2.4}$$

Where $T_k^S$ are the products sold by below-threshold small businesses and individuals, which will be further described in section 2.5.

Each base is then used to get the theoretical VAT for each product division and rate, referable to household consumption, by multiplying each base to the related rate.

$$\hat{V}_t^{HC} = \sum_j \sum_i \hat{B}_{ij}^{HC} \cdot \tau_j \tag{2.5}$$

## 1.2 Intermediate Consumption

Non-deductible or partially deductible intermediate costs are included in the VAT base: non-deductibility is generated by purchases of goods and services used to produce exempt sales; furthermore, the VAT on the purchases of some kind of goods (fuel, cars, tolls, parking and transport of persons) is only partially deductible under Italian legislation. Regarding non-deductible purchases, the theoretical VAT analysis is based on National Accounts data by sector and CPA, provided by Istat. Intermediate costs are obtained as the difference between production and value added, net of intermediate costs of non-market sector (separately analysed), financial intermediation services indistinctly measured, illegal economy and self-production, which do not contribute to VAT taxable base. National Accounts data on intermediate costs are then integrated with tax returns data by sector, to get the VAT rate distribution and non-deductibility percentage (obtained as the ratio between exempt sales and turnover). Moreover, purchases made by below-threshold, which are totally non-deductible, are added to VAT tax base. Therefore, we apply the use table at purchase prices to distribute VAT tax base by CPA product. Thus, the VAT tax base is allocated in the three-way dimension CPA, sector and rate, both under current legislation and policy reform scenario.

According to the invoice-credit form of the VAT, businesses offset the VAT they have been charged on their purchases against the liability on their sales, so that they settle only the net amount[6], with the result that no revenue is collected from the taxation of intermediate goods sales. However, in some cases this chain of output tax and input credit may not remain unbroken due to:

- exemptions on selling that lead to lower offsetting,
- only partial offsetting of purchases for some classes of goods.

### 2.2.1. Current legislation

The VAT revenues collected from intermediate consumption are calculated by combining two different datasets: VAT returns and input-output tables. From VAT returns it is possible to get the rate distribution of total intermediate consumption by sector, while input-output tables allow to

[6] Crawford, Keen and Smith (2010), "Value Added Tax and Excises"

link sectors with used CPA products, thus allowing to classify VAT tax base detailed in three dimensions: sector, product and VAT rate.

The non-deductible component of intermediate costs $N_{jn}$ is estimated by multiplying, for each rate $j$, the taxable purchases $P_{jn}$ with a non-deductibility rate $\chi_n$, defined for each sector as the ratio between exempt transactions $X_n$ and total turnover $R_n$.

$$N_{jn} = \chi_n \cdot P_{jn} \tag{2.6}$$

$$\chi_n = X_n / R_n \tag{2.7}$$

The rate distribution can be obtained by multiplying, for each statutory rate, the share of that component $N_{jn}$ over the sector's total intermediate costs $\boldsymbol{I}_n$ with the national accounts data on intermediate consumption $\boldsymbol{C}_n$ by sector (where intermediate consumption is calculated as the difference between production and value added, net of consumption from non-market sector, financial intermediation services, illegal activities and self-production).

$$I_{jn} = \frac{N_{jn}}{\boldsymbol{I}_n} \cdot \boldsymbol{C}_n \tag{2.8}$$

Non-deductible intermediate costs $I_{jn}$ by sector $n$ are then classified by 20 CPA through the use table expressed at purchase prices. Noting with $U_{mn}$ the use of the product $m$ by the ATECO sector $n$, the relative weight is:

$$\upsilon_{mn} = \frac{U_{mn}}{\sum_m U_{mn}} \tag{2.9}$$

Distribution of these weights by tax rate is obtained using the same rate distribution of household consumption, leading to a weight $\pi_{jmn}$ by rate, product and sector:

$$\pi_{jmn} = \upsilon_{mn} \cdot \frac{B_{mj}^{HC}}{B_m^{HC}} \tag{2.10}$$

The current legislation taxable base for non-deductible intermediate costs is thus allocated to CPA and tax rates using those weights:

$$B_{jmn}^{IC} = I_{jn} \cdot \frac{\pi_{jmn}}{\sum_n \pi_{jmn}} \tag{2.11}$$

Finally, the taxable base by rate and CPA product can be obtained as a sum of $B_{jmn}^{IC}$ by sector and VAT revenues is given as the product of each rate with the taxable base referable to each rate:

$$B_{jm}^{IC} = \sum_n B_{jmn}^{IC} \tag{2.12}$$

$$V_t^{IC} = \sum_m \sum_j B_{jm}^{IC} \cdot \tau_j \tag{2.13}$$

### 2.2.2. Simulation

The measure of the change on intermediate consumption rate distribution due to a legislation change has to be related to the change occurred to household consumption distribution by rate and product, given that, as said in section 2.2.1, the latter is used as an approximation to the former. Noting the weight of the household consumption base at a rate $j$ on the total by CPA as:

$$\gamma_{mj}^{HC} = \frac{B_{mj}^{HC}}{\sum_j B_{mj}^{HC}} \tag{2.14}$$

The difference between the weight at current legislation and during simulation will be:

$$\delta_{mj} = \hat{\gamma}_{mj}^{HC} - \gamma_{mj}^{HC}\,, \qquad \begin{cases} \delta_{mj}^{+} \; if \; \hat{\gamma}_{mj}^{HC} - \gamma_{mj}^{HC} > 0 \\ \delta_{mj}^{-} \; if \; \hat{\gamma}_{mj}^{HC} - \gamma_{mj}^{HC} < 0 \end{cases} \tag{2.15}$$

The estimation of simulated intermediate costs weights $\hat{\gamma}_{mj}^{IC}$ works in two steps:

- application of the negative differences $\delta_{mj}^{-}$ in the same measure as households,
- application of the positive differences $\delta_{mj}^{+}$ in the same proportion as households.

$$\hat{\gamma}_{mj}^{IC} = \gamma_{mj}^{IC} \cdot \left(1 + \delta_{mj}^{-}\right) + d_m \cdot \frac{\delta_{mj}^{+}}{\sum_j \delta_{mj}^{+}} \tag{2.16}$$

where $d_m$ is the ones' complement of the first term:

$$d_m = 1 - \sum_j \gamma_{mj}^{IC} \cdot \left(1 + \delta_{mj}^{-}\right) \tag{2.17}$$

Thus, the simulated taxable base by CPA and rate can be obtained as:

$$\hat{B}_{mj}^{IC} = \hat{\gamma}_{mj}^{IC} \cdot \sum_j B_{mj}^{IC} \tag{2.18}$$

Each base is then used to get the theoretical VAT referable to intermediate consumption by product and rate, by multiplying each base to the related rate.

$$\hat{V}_t^{IC} = \sum_j \sum_m \hat{B}_{mj}^{IC} \cdot \tau_j \tag{2.19}$$

## 1.3 Investments

Three different components are taken into account for adjusting the VAT base for capital formation, namely:

- Household investments
- Investments in the market sector
- Investments in the non-market sector

The first two components are discussed in this section, while the third will be considered in the next section, devoted to all transactions within the non-market sector of the economy.

The rationale of including investments in the I-O approach of the VAT modelling is that some categories of investments made by households and firms are subject to indirect taxation.

### 2.3.1. Household investments

Household investments in buildings and lands (net of transactions subject to registration fee) are included in the VAT tax base, detailed in: investments in new buildings, net of investments done by subjects operating in the non-market sector (source: National Accounts and cadastral data); lands and investments in existing buildings (source: Real Estate Register database). The distribution by VAT rate is calculated under current legislation and policy reform scenario, using cadastral data.

Household investments include all the investments in buildings and land whose transactions are subject to VAT. To compute the VAT revenues streaming from household investments we use different datasets: national accounting data provided by Istat, cadastral data and real estate tax databases. Specifically, household investments which contribute to VAT revenues are:

- Investments in new housing (net of non-market investments)
- Land value
- Requalification of the building heritage
- Investments in existing buildings

The first step to determine the VAT base is to subtract rental and management costs of owned or leased properties incurred by the PA (non-market sector) from gross fixed investments as they result from the real estate tax database. Then, from the resulting quantity, we subtract the estimates of extraordinary maintenance costs. In the following we will denote with $GFI_t$ the gross fixed investments at time *t* net of the two cost components above.

Therefore the $GFI_t$ amount is split according to which rate is applied (4, 10 or 22 percent under current legislation). The splitting is made by following these steps:

1. Estimate of the weights for each different tax rate level and computing the weighted average rate
2. Divide the $GFI_t$ by the weighted average rate
3. Determine the VAT bases subject to each different tax rate by multiplying the quantities obtained in the previous point for the respective weight.

In more detail, for point 1. under current legislation, we have to estimate three different weights that we generally denote by $\rho_j$ for the rate $j$ and use them to compute the weighted average rate, denoted by $\bar{\tau}$.

For the weights relative to the lowest tax rate, the aggregate declared values relating to the first house and other properties are obtained from the real estate tax database. Therefore, the weight estimate $\rho_1$ is obtained by dividing the aggregate declared value regarding the first house over the total (first house *plus* other properties).

Unlike the first house – which is subject to the minimum rate – stately homes, houses in villas, castles and palaces of eminent artistic merits are subject to the standard VAT rate. The estimated weight for this tax rate $\rho_3$ is the ratio between the sum of those types of house values (as they result from the real estate market observatory) and the total aggregate value for any type of house.

Therefore, we obtain the estimate for the last weight by taking the complement to one

$$\rho_2 = 1 - \rho_1 - \rho_3 \tag{2.20}$$

and use all the weights to compute the weighted average rate:

$$\bar{\tau} = \sum_j \tau_j \, \rho_j \tag{2.21}$$

For point 2. we divide the gross fixed investment $GFI_t$ by the weighted average rate $\bar{\tau}$ to get the total tax base for the household investment sector.

Finally (point 3.) the ratio $GFI_t/\bar{\tau}$ is distributed according to the different tax rates to obtain the different tax bases $B_j^{HI}$, where *HI* stands for *household investments*. This is achieved by simply multiplying the ratio for the respective weight:

$$B_j^{HI} = \rho_j \, \frac{GFI_t}{\bar{\tau}} \tag{2.22}$$

To conclude, theoretical VAT due to household investments $V_t^{HI}$ is calculated by multiplying taxable bases for the respective rate $\tau_j$ under current legislation and policy scenario.

### 2.3.2. Investments in the market sector

VAT base consists also of investments done by private firms, provided by Istat in the National Accounts, net of investments of firms operating in the non-market sector, self-production and investments done by below-threshold (both out of VAT field), residential buildings (included in households investments) and investments by non-profit organizations (NPO). Given that NPO investments are provided by Istat as a total and not by sector, that allocation has been made with the 2014 National Accounting Matrix. The resulting market sector investments are integrated with tax returns data relatively to VAT rate distribution and non-deductibility percentage, using the same method as for intermediate costs. To get the comprehensive taxable base, the partially deductible investments are then added.

To compute investments in the market sector, we use tax returns data (as described in section 2.2 - *intermediate consumption*) merged with data provided by Istat on gross fixed investments. By combining the two data sources, we quantify non-deductible and partially deductible investments made in the market sector by:

- Non-financial corporations
- Financial corporations
- Households producing goods and services

The starting point for quantifying market sector investments that contribute to the formation of the VAT base are total gross fixed investments *(GFI)* provided by Istat, classified according to the type of asset *i* and ATECO sector *n*. For each pair of type of asset *i* and sector *n,* we subtract from total economy investments $GFI_{i,n}$, self-production (not included in VAT tax base) and investments made by Public Administration $GFI_{i,n}^{PA}$ and by non-profit organizations $GFI_{i}^{NPO}$ (separately analysed). Data computed so far are then combined with tax returns, with the same methodology described in section 2.2 for intermediate consumption, in order to obtain market investments VAT tax base by sector, capital good and VAT rate. Theoretical VAT is then calculated by multiplying taxable bases for the respective VAT rate under current legislation and policy scenario.

## 1.4 Non-market

The non-market component includes both the taxable base generated by non-deductible intermediate costs and the one consisting of taxable investments made by public firms or non-profit organizations (NPO). Concerning the intermediate costs, the theoretical VAT analysis is based on Istat National Accounting data relative to Public Administration and NPOs (institutional sectors S13 and S15), net of indistinctly measured financial intermediation services (SIFIM). Distribution by VAT rate under current legislation is estimated using data from electronic invoicing system and allocation by CPA is made by applying the use table. The taxable base so obtained is distributed in the triple dimension CPA, sector and VAT rate, both under current legislation and VAT policy reform. Regarding non-market investments, the analysis of theoretical VAT is based on Istat National Accounting and electronic invoicing system data, with the same methodology used for intermediate costs.

The non-market sector includes all taxable transactions made by Public Administration and NPOs, which can be grouped in two main components: intermediate non-market consumption and non-market investments.

### 2.4.1. Intermediate non-market consumption

To compute the taxable VAT base for intermediate consumption made in the non-market sector, we use both electronic invoicing data and Istat National Accounts data on intermediate consumption of Public Administration and NPOs.

From electronic invoicing data we get the total non-market costs by sector *n* and rate *j* and subtract the share of investments as it results from the use table, to obtain intermediate consumption only $C_{n,j}^{int}$.

From Istat National Accounts data, we get intermediate consumption of Public Administration and NPOs, net of financial intermediation services indistinctly measured (which are not included in VAT tax base).

We then obtain a distribution by supplier sector *n* and rate *j* by merging National Accounts and invoicing data. Therefore, we classify non-market intermediate consumption in 20 CPA throughout the supply table corrected for margins, thus obtaining VAT tax base $B_{jmn}^{IC}$ by sector *n*, CPA *m* and rate *j*.

We aggregate by sector in order to obtain VAT base $B_{jm}^{IC}$ by product *m* and rate *j* and, finally, VAT revenues is given as the sum of the product of each rate with the taxable base referable to each rate:

$$V_t^{IC} = \sum_m \sum_j B_{jm}^{IC} \cdot \tau_j \tag{2.23}$$

### 2.4.2. Non-market investments

This sub-section regards specific investments items *n* made in the non-market sector, mainly buildings and other civil engineering works, ICT systems, research and development, software, and others. Starting from Istat data on gross non-market investments $GI_{n,j}^{NM}$ in item *n* subject to rate *j*, we compute the weight of VAT rate *j* for item *n*, denoted by $\gamma_{n,j}$, by taking the ratio between taxable non-market investments in item *n* subject to rate *j* and the sum of all taxable non-market investments in item *n*:

$$\gamma_{n,j} = \frac{GI_{n,j}^{NM}}{\sum_j GI_{n,j}^{NM}} \tag{2.24}$$

For each investment item *n,* we compute the weighted average tax rate $\bar{\tau}_n$:

$$\bar{\tau}_n = \sum_j \tau_j \, \gamma_{n,j} \tag{2.25}$$

Taxable non-market investments in item *n* are then equal to the product between gross investments and weight of VAT rate *j* in item *n*, divided by the weighted average tax rate for the same item:

$$B_{n,j}^{NM} = GI_{n,j}^{NM} \frac{\gamma_{n,j}}{\bar{\tau}_n} \tag{2.26}$$

Lastly, we can compute the theoretical VAT revenues due to non-market investments by summing taxable non-market investments subject to the same rate *j* over *n* and by applying to them the respective tax rate:

$$V_t{}^{NM} = \sum_j \sum_n B_{n,j}^{NM} \, \tau_j \tag{2.27}$$

## 1.5 Below-threshold

The provision of simplified tax scheme results in the invoicing without charging of VAT and, as a consequence, in the impossibility of offsetting the VAT paid on purchases. Some adjustments in the estimation of VAT base are required: concerning household consumption, the adjustment consists on subtracting purchases from below-threshold from consumption by tax rate and adding them to purchases not subject to VAT; concerning intermediate costs, the adjustment consists on subtracting purchases done by below-thresholds before the estimation of the non-deductibility percentage by sector and including them in the computation of totally non-deductible intermediate costs. The purchases done by final consumers from below-threshold are estimated applying to the B2C (Business to Consumers) share of turnover (source: tax returns data) the VAT rate distribution resulting from the last VAT return submitted before joining the simplified tax scheme. Purchases done by below-threshold are calculated by applying to total purchases the VAT rate distribution resulting in the last VAT return submitted before joining the simplified tax scheme.

It is generally agreed[7] that the costs of complying with the VAT legislation are likely to include a significant fixed component and so may bear most heavily on smaller traders, who may easily translate the burden on consumers through higher prices. This circumstance encourages many countries to fix a threshold to exclude smaller businesses from VAT application. Simplified fiscal schemes for those businesses mean invoicing with no VAT debt and consequently allowing no deduction for VAT paid on purchases. It's thus necessary to adjust VAT tax base and rate distribution by subtracting, from household consumption, purchases from below-threshold businesses and by including, in market intermediate consumption, purchases done by below-threshold as 100% non-deductible.

### 1.5.1 Household consumption

Households' purchases from below-thresholds $T_k^S$ are subtracted in (2.2) from the tax base of household consumption. That component is estimated by using data in the section of VAT returns filled in by businesses below-threshold during period $(t-1)$, and specifically the starting point is represented by taxable operations toward final consumers $B_n^{B2C}$ and total positive components $T_n^+$ with $n$ being the ATECO sector and $B2C$ stands for business to consumer.

[7] Ebrill et alii (2001), "The modern VAT", IMF.

Applying to the total positive components the weight of each sector obtained as the ratio between taxable operation $B2C$ of the sector $n$ over total, it's possible to obtain a distribution by sector of the households purchases from below-threshold $T_n^s$:

$$T_n^s = \frac{B_n^{B2C}}{\sum_n B_n^{B2C}} \cdot (T^+ - B^{B2G} - B^{B2B}), \;\; T^+ = \sum_n T_n^+ \tag{2.28}$$

The product distribution is obtainable using the weights obtained from supply table elements $S_{in}$ where $i$ is the COICOP product division.

$$T_i^s = T_n^s \cdot \frac{S_{in}}{\sum_i S_{in}} \tag{2.29}$$

### 1.5.2 Intermediate consumption

As intermediate goods purchased by below threshold $T_{jn}^p$ are totally non-deductible, they should be included in the market intermediate consumption VAT tax base, described in section 2.2.

It is possible to compute that component by applying to the total negative components declared $T_n^-$ the rate distribution of purchases in the last ordinary VAT returns filled in by these firms before applying for the special regime.

$$T_{jn}^p = \frac{T_n^- \cdot \zeta_n \cdot \eta_{jn}}{1 + j} \tag{2.30}$$

where $\zeta_n$ is the weight of intermediate consumption, $\eta_{jn}$ are the weights of purchases subject to rate $j$.

# 2. Derivation of Effective VAT

In order to estimate tax evasion rates, we use shares of unobserved economy by sector, provided by Istat. These shares are then allocated to CPA products by using the supply table and to COICOP goods with a conversion matrix developed by the Department of Finance. Effective tax bases and VAT revenues are estimated by applying these gaps to theoretical tax bases. The loss of revenue due to VAT frauds and omitted payments is calculated on aggregate VAT (not by class of product) using the official data reported in the latest financial statement of the Public Administration. Both theoretical and effective taxable base and VAT revenues are then revaluated throughout the growth rates of the main economic variables reported in the macroeconomic framework of the latest public finance document.

In section 2. the estimate of theoretical taxable base has been obtained, for each sector of the economy, for each rate and product class for consumption, and for each investment good for investments, relative to the period in which input data are collected.

Through the present section the effective and theoretical VAT will be estimated, also for subsequent periods.

## 2.1 Growth rates application

To get an estimate of taxable base and consequently the tax collected in a period subsequent to the one in which input data are collected, it is necessary to re-valuate the estimates of the model in line with the economy growth rates forecasts reflected in the latest official financial document (Document of Economics and Finance or Update of DEF).

The theoretical taxable base for the period of interest is thus given, e.g. for household consumption and for period $t + 2$, by:

$$B^{HC}_{t+2,ij} = B^{HC}_{t,ij} \cdot (1 + r_{t+1}) \cdot (1 + r_{t+2}) \qquad (3.1)$$

## 2.2 Evasion estimate

The starting point for the estimate of VAT gaps are the shares of unobserved economy provided by Istat in the report “Non-observed economy in national accounts”.

As non-observed economy shares are expressed as incidence rate $\epsilon_n$ on added value by sector $n$, in order to obtain VAT gaps by product, they are distributed using the supply table (adjusted for transport and trade margins in order to approximate purchase prices) and scaled using the use table.

In this way we get a distribution of the non-declared taxable base $b_{in}$ by product $i$ and sector $n$, which divided by the theoretical taxable base gives the *gap* useful to estimate the effective tax collected.

As said above the components $S_{mn}$ of the supply table are first of all adjusted for commerce and transport margins $M_{mn}$ obtaining therefore a supply matrix net of margins:

$$\tilde{S}_{mn} = S_{mn} + M_{mn} \tag{3.2}$$

The matrix obtained is then scaled, through the use table, to households consumptions $C_i$ expressed in CPA:

$$b_{mn} = \frac{\tilde{S}_{mn}}{\sum_m \tilde{S}_{mn}} \cdot C_m \cdot \epsilon_n \tag{3.3}$$

The gap $\omega_m$ for each product class $m$ is then given as the ratio between the not-declared VAT base and the theoretical VAT base on households consumption:

$$\omega_m = \frac{\sum_n b_{mn}}{C_m} \tag{3.4}$$

In the same way, it is possible to get the gaps classified by COICOP by using the conversion matrix developed by the Department of finance:

$$b_{in} = \frac{\widetilde{U}_{in}}{\sum_i \widetilde{U}_{in}} \cdot C_i \cdot \epsilon_n, \qquad \omega_i = \frac{\sum_n b_{in}}{C_i} \tag{3.5}$$

To get the effective VAT revenues we then apply the rate $\omega$ to the theoretical VAT collected from consumption (final or intermediate), while for investments the gaps $\omega_a$ can be taken from the corresponding sector incidence rates $\epsilon_n$.

$$V_{it}^{e} = V_{it} \cdot \omega_i \tag{3.6}$$

## 3.Derivation and decomposition of C-Efficiency

Throughout the previous sections have been described the derivation of the theoretical and effective VAT. Recalling the conclusions of section 1. it is now possible to calculate some of the main performance indicators such as C-Efficiency and its components.

The theoretical VAT $V_t$ can be obtained as the sum of the VAT revenues from all the sectors of the economy, in the same way the effective VAT $V_t^e$ can be obtained as the sum of the VAT revenues from all sectors of the economy after deducting the gaps $\omega_i$ seen in the previous section[8]:

$$V_t = \sum_K \sum_j \sum_i B_{ij,t}^K \tag{4.1}$$

$$V_t^e = \sum_K \sum_j \sum_i B_{ij,t}^K \cdot (1 - \omega_i) \tag{4.2}$$

The benchmark VAT $V_t^\beta$ as seen in section 1. is the VAT that would be collected with a uniform rate equal to the standard rate on all the taxable base:

$$V_t^\beta = \tau_s \cdot \sum_K B_t^K \tag{4.3}$$

With $K$ being the sectors of the economy.

C-Efficiency is then easily calculated as:

$$E_t^C = \frac{V_t^e}{V_t^\beta} = \frac{\sum_j \sum_K V_{j,t}^{e,K}}{\tau_s \sum_K B_t^K} \tag{4.4}$$

[8] In this section $i$ does not denote a COICOP class but a generic product class, being it a CPA, COICOP or sector n.