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Assessing the effects of VAT policies with an integrated CGE-microsimulation approach: evidence on Italy*

by

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ABSTRACT

Reforming the structure of the Value Added Tax (VAT) is an open issue in different countries, mostly for raising revenues and improving the efficiency of the tax system. However, most of the existing analyses do not combine micro- and macro-modelling tools for assessing the welfare and redistributive effects of VAT reforms. Aspects like tax evasion and erosion, moreover, are usually of secondary importance when studying VAT changes. The objective of this paper is twofold. First, we propose an integrated approach, based on the new dynamic multi-sector, multi-household tax computable general equilibrium (CGE) model (ITAXCGE) recently developed at the Italian Ministry of Economy and Finance, to study a uniform VAT rate reform in Italy. Our empirical approach has the merit of including new information when evaluating VAT reforms: tax evasion and erosion, irregular labour, different household groups, and a detailed structure of taxation. Second, we simulate the effects of a uniform VAT rate reform on welfare and redistribution, by taking into consideration the consequences of such reform on VAT gap changes. Our results suggest that the equity-efficiency trade-off deriving from the reform under investigation is reduced when including information on tax evasion in the analysis. The policy implications of our study are finally discussed.

JEL classification: H31, D58, J22

Keywords: Microsimulation, CGE-Modelling, integrated approach, VAT, tax gap.

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1. Introduction

Reforming the tax system is one of the priorities in the agenda of many governments worldwide, particularly where there is need of raising tax revenues for financing the post Covid-19 recovery and promoting a fairer and growth-friendly taxation. In the past few years, there has been international consensus on the role of indirect taxes (i.e. VAT and excises) for improving tax collection and promoting the efficiency of the tax system in advanced economies (Cammeraat and Crivelli, 2020). In particular, consumption taxes show high performance in raising revenues in comparison to other taxes (Keen and Lockwood, 2006; 2010), they have small distortionary effects in the long-run (Ormaechea and Morozumi, 2019), and they can be used to finance tax cuts on labour and promote competitiveness (De Mooij and Keen, 2013; Engler et al., 2017). In the OECD countries, consumption taxes count for more than 10% of Gross Domestic Product (GDP) on average, and almost one-third of total tax revenues (OECD, 2020). When designing indirect tax reforms, however, it is necessary to take into consideration two main factors that can influence revenue performance: tax erosion including the rules for defining the tax base and tax rates; and, the presence and the extent of tax evasion (Agha and Haughton, 1996; Ebrill et al., 2001).

The evaluation of the effects of indirect tax policies has been usually based on both micro and macro approaches, separately. The former includes microsimulation (MS) studies that are mostly used to assess the distributive consequences of tax changes, and rely on disaggregate microdata on firms and individuals/households (Figari et al., 2015). Micro analyses, however, have the major limit of uncovering the aggregate, efficiency consequences of indirect tax reforms, which need to be assessed with macro models (Peichl, 2016). Computable General Equilibrium (CGE) models are macro tools widely used to conduct tax policy analysis and, in particular, to assess the effects of tax reforms on static (i.e. a given allocation of resources) and dynamic (i.e. growth effects) efficiency (Peichl, 2016). CGE models are based on the general equilibrium theoretical foundations and they exploit the informative content of input-output tables and social accounting matrices (SAM), by allowing for the consideration of sector and agent feedbacks (Adam and Bozio, 2009). Most of macro approaches, however, are unable to provide a deep understanding of the redistributive effects of tax policies since they are based on a single representative household (Cockburn et al., 2014) and lack industry and product heterogeneity. Despite the application of linked macro micro models can contribute to understand the overall effects of indirect tax policies, there are only few works that employ integrated approaches to study tax reforms in advanced economies (Warren, 2008; Nygård and Revesz, 2016).[1]

This paper has two main objectives. First, we present an integrated CGE-microsimulation approach to study VAT reforms in a developed country, such as Italy. Our analysis is based on the new multi-sector, multi-household dynamic tax computable general equilibrium model (ITAXCGE), recently developed at the Department of Finance (DF) of the Italian Ministry of Economy and Finance (MEF). The model is specifically designed for tax policy analysis and incorporates many relevant features of the Italian economy; the social accounting matrix (SAM) is based on the most recent input-output tables available for Italy referring to the year 2016. From the theoretical point of view, the model builds on the concept of general equilibrium but features significant deviations from the neoclassical framework and includes labour market and price rigidities with the presence of involuntary unemployment, non-perfect mobility of the capital factor, and presence of adjustment costs for investment. The model makes the following key advancements with respect to the existing literature. It incorporates detailed information on tax erosion and tax evasion for different taxes (i.e. PIT, CIT, VAT, excises) which are relevant when assessing the effects of tax policy reforms (Giesecke and Tran, 2018). It is based on the disaggregation of households in ten income groups: this is useful to conduct distributional analyses within a CGE framework (Savard, 2004). The ITAXCGE model, moreover, is integrated with the MS models available at the DF - tax-benefit PIT model, VAT-revenue model, VAT MS model (VATSIM), and, CIT model – that combine survey data with administrative micro data, and cover the different characteristics of the Italian tax system (Di Nicola et al., 2015; Manzo and Miola, 2021; Cirillo et al., 2021).[2]

Second, we provide a novel empirical quantification of the effects of a uniform VAT rate reform in Italy in terms of efficiency and income distribution. As in other developed countries, the shift from the existing different VAT rates to a single VAT rate has been suggested on efficiency grounds in order to reduce market distortions and improve the C-efficiency ratio (Thomas, 2020). The removal of reduced VAT rates has been also justified given the low redistributive power of differential VAT rates (Liberati, 2001; Boeters et al., 2010). Moreover, the presence of VAT rate differentiation is one of the key sources of VAT evasion: taxpayers omitted to declare a higher VAT rate for sales and a lower VAT rate for intermediate purchases in order to reduce the tax burden. In

[1] There are some recent works that apply dynamic scoring (Mankiw and Weinzierl, 2006) in developed countries, by integrating MS models with macroeconometric/DSGE models. For a recent discussion, see Barrios et al. (2018).
[2] The description of the MS models of MEF can be found at https://www.finanze.gov.it/it/il-dipartimento/Modelli-economici-e-strumenti-di-analisi/.

Italy, VAT evasion from different rates counts for about 10,4 billion euro and one third of total VAT evasion (NENS, 2021). In our analysis, we explicitly model the effects of a uniform VAT rate reform on both the policy and compliance gap. Specifically, our VATSIM model allows for the estimation of changes in total VAT gap following the adoption of a uniform VAT rate reform.[3] As a result, we are able to introduce two different shocks in the CGE framework: a shock that captures the reduction of VAT erosion from the removal of reduced VAT rates (i.e. policy gap shock), and a shock that describes the decrease of VAT evasion (i.e. compliance gap shock).

The interest for the Italian case is motivated by different factors. First, in this country, the VAT is a relevant part of total tax revenues counting for about 10% of GDP and one-fourth of total tax revenues (OECD, 2020). Italy is a developed country characterized by a complex VAT system, where the tax gap is higher in comparison to other advanced economies counting for about 22% of total tax liabilities (Tyson, 2014). This mostly depends on the presence of four different tax rates and a large number of special regimes and tax exemptions (MEF, 2020a). The Italian VAT compliance gap is among the highest in the European Union (EU) - in 2018, the VAT gap was equal to 35,4 billion euro (EU Commission, 2020; MEF, 2020b). VAT evasion, moreover, shows relevant sectoral differences (Di Caro and Sacchi, 2020). The Italian government has planned to reform the tax system in line with the agreement reached with the EU for the implementation of the Resilience and Recovery Plan (EU Commission, 2021). Finally yet importantly, there are only few studies that link micro and macro approaches to analyse tax policy reforms in Italy, but they do not explicitly focus on indirect taxation (D’Andria et al., 2018). Our results can be of interest also for other countries where the VAT system shows complexity, and they register high policy and compliance gap.

Our results suggest that a uniform, revenue-neutral VAT rate reform has positive consequences on welfare, by producing a positive variation of about 0.15% in terms of GDP, in line with the results obtained for Italy in recent studies (Gesualdo et al., 2019). We find that the reduction of the VAT rates to a single rate can produce adverse effects in terms of income distribution, with a raise of VAT incidence on poorer households. Interestingly, and differently from previous studies, we find that the regressive consequences of the uniform VAT rate reform can be smoothed once the reduction of VAT gap is included in policy simulations. In particular, the rise of revenues following the reduction of VAT gap can be used to reduce the unique VAT rate and, therefore, the VAT incidence on poor households. Although our results need to be interpreted with caution, mostly because we do not consider aspects related to the administration of the proposed

[3] In this paper, we use the concept of VAT gap for describing VAT evasion; for details, see HMRC (2021).

reform (Keen and Slemrod, 2017), our approach can be useful to assess alternative VAT reforms currently under discussion in Italy and other countries.

The remainder of the work is organised as follows. In Section 2, we discuss the related literature. In Section 3, we present the methodology: the ITAXCGE model, the MS models, and the linked macro-micro approach. In the Section 4, we present the results of our policy simulations. The final section concludes with some policy implications.

2. Related Literature

Our work builds on, and makes some contributions to, different strands of the empirical public finance literature: macro CGE tax policy works; macro-micro tax evaluation studies; and, VAT-focused analyses.[4] Although CGE models are well established tools for evaluating the welfare effects of tax policies (Perali et al., 2018), most applied CGE research does not include details on tax erosion and tax evasion when modelling the tax system (Giesecke and Tran, 2012).[5] Most of the CGE models are based on a single representative household and, therefore, they are not ideal for conducting distributional analyses (Santoro, 2007; Bouet et al., 2013). In this paper, we present a novel CGE model with detailed information on tax erosion and tax evasion, which disaggregates households in ten income groups. As for the Italian case, Ahmed et al. (2019) quantify the impact of tax-cut policies on GDP and income distribution, by calibrating a CGE model with a SAM where households are disaggregated into five classes according to the income level. In that contribution, however, the tax system does not contain the details on the tax erosion and tax evasion that we present in this paper.[6] Gesualdo et al. (2019) apply a CGE framework with details on the tax system and a single representative household to study the efficiency effects of VAT policies in Italy, by finding that a revenue-neutral VAT base broadening reform is welfare improving. We innovate with respect to Gesualdo et al. (2019) by using an integrated CGE-microsimulation approach with household heterogeneity to study the equity effects of VAT policies. Recently, Socci et al. (2021) analyse the redistributive effects of personal income tax reforms in Italy by using the MACGEM-IT

[4] There are also studies that employ econometric techniques to investigate the effects of consumption tax policies on pricing behaviour (i.e. 'pass-through' effects), and production-consumption relations (Benzarti and Carloni, 2017). For a recent survey, see Bellon et al. (2021).
[5] For a review of CGE models for tax policy evaluation, see Mitra-Kahn (2008).
[6] There are several applied CGE models developed for the Italian case for studying tax reforms (Ciaschini et al., 2012; Severini et al., 2019; Felici et al., 2020). These models, however, do not include information on the tax erosion and tax evasion that we consider here; moreover, they do not adopt an integrated macro-micro approach as in our paper.

model developed in collaboration with the Department of Treasury of the MEF. This model, however, does not include household heterogeneity and information on tax evasion.

The integration of macro and micro models for studying the effects of tax policies is a growing area of research, though with limited applications for developed countries (Auerbach, 2005; Peichl, 2016); for a survey on the different, possible linkages, see Cockburn et al. (2014). Åvitsland and Aasness (2004) and Bye et al. (2009) propose an integrated approach based on a CGE model linked to a MS model to study indirect tax reforms in Norway, by finding that a general and uniform VAT system is welfare superior to non-uniform systems. Benczúr et al. (2018) present a general-equilibrium behavioural microsimulation model to study tax-benefit reforms in Hungary. Capeau et al. (2018) adopt a micro-macro linkage to analyse a tax shift from direct to indirect taxation in Belgium. Cazcarro et al. (2020) propose a bridge method to combine information on consumption from national account data and micro studies in the European Union. In such contributions, however, the tax details that we propose here, including information on tax erosion and evasion and household heterogeneity, are not present in the macro approach.

We also contribute to VAT distributional analyses, which are mostly based on MS applications (Thomas, 2020). The existing MS analyses provide different results on the redistributive effects of indirect taxation, depending on the measurement of tax incidence with respect to income and/or consumption (Decoster et al., 2010), the national tax system and the inclusion of behavioural aspects (Pestel and Sommer, 2017). Such contributions, however, do not usually consider income and consumption evasion that are crucial elements when simulating the economic effects of VAT policies (Ricther and Boadway, 2005; Economides et al., 2020). As for Italy, Gastaldi et al. (2017) apply a microsimulation model to assess the distributive effects of VAT reforms, by finding that the reduction of VAT rates is not necessarily associated with negative equity effects. Our integrated macro-micro approach allows for the consideration of the efficiency effects of VAT reforms and, most importantly, for the inclusion of tax evasion in the MS framework.

3. The Italian VAT system

The value added tax is one of the major taxes in Italy, with more than 100 billion euro per year. It represents the second source of revenue among different types of taxes just after personal income tax. It mainly applies on final consumption but also on part of the intermediate consumption that cannot be deducted as it applies on goods and services exported.

The VAT is made of four different rates, two minimum rates of 4% and 5% to be applied mainly on food, drugs and main residence, a reduced rate of 10% applied mainly on residual foods, on restaurant sector, on transportation, on recreational and culture sector and on the utilities and finally a standard rate of 22% which is applied residually. The weighted average VAT rate computed in 2016 is 15.7%.

4. Data and Methodology

4.1 SAM construction

The model is calibrated on the 2016 Social Accounting Matrix (SAM) . We update the benchmark data to 2020 by using macroeconomic variations resulting from the latest public economic and financial documents (i.e. Italian annual budget law, etc.)

The information contained in the SAM is obtained by combining national account data, such as national account matrix for 2014, supply-use tables for 2016 and Eurostat data. In addition, as explained in the next Sections, we integrate missing information with data from tax returns available at the DF.

National Accounts data provide detailed information on the final and intermediate consumption at activity and commodity levels, though they do not contain detailed information on taxation. Hence, we use the tax return data to distribute taxes and subsidies per commodity. In Figure 1, we provide a description of the structure of the SAM used in the analysis based on twenty activities, twenty commodities, ten household groups, two trading partners, and seventeen tax categories.

Figure 1. The SAM structure of the ITAXCGE model

	Sectors - Export EU-	Sectors - Export Non EU-	Commodities	Sectors	Factors of Production	Institutional Sectors	Taxes and SSCs	Subsidies	Inventories	Gross Capital Formation	Rest of World - EU-	Rest of World - Non EU-	Savings
Sectors - Export EU-											Export		
Sectors - Export Non EU-												Export	
Commodities			Margins	Intermediate Consumption		Consumption			Inventories	Gross Capital Formation			
Sectors	Export	Export	Production										
Factors of Production				Income									
Institutional Sectors					Net Income		Tax Revenue	Government Transfers					
Taxes and SSCs			Indirect taxes and Tariffs	CIT, Taxes on production, SSC^{er}	SSC^{ee}, SSC^{me}	Tax Revenue							
Subsidies						Government Transfers							
Inventories													Inventories
Gross Capital Formation													Gross Capital Formation
Rest of World - Non EU-			Import										
Rest of World - EU-			Import										
Savings						Savings					Savings	Savings	

4.2 The ITAXCGE model

4.2.1 Model overview

The ITAXCGE model is a multi-sector, multi-product dynamic model describing the behaviour of four agents: households, firms, government, and the rest of the world. The general structure is built in the tradition of Dervis et al. (1982) and Bayar et al. (2004). The model, however, incorporates additional features that are relevant to the Italian economy deviating from a pure neoclassical approach. The model considers regular and irregular labour and introduces frictions in the regular labour market allowing for involuntary unemployment.[7] The irregular labour is mainly used to model evasion, rather than introducing a dualistic labour market. It is a factor used to produce tradable goods but its compensation is completely untaxed. Substitution between regular and

[7] This follows the idea of the natural rate or equilibrium rate of unemployment, which was initially introduced by Phelps (1968): in a situation of very low unemployment finding a job is easy and firms are keen to pay a higher wage to keep their employees.

irregular labour plays an important role and it is governed by standard CES elasticity of substitution parameter.

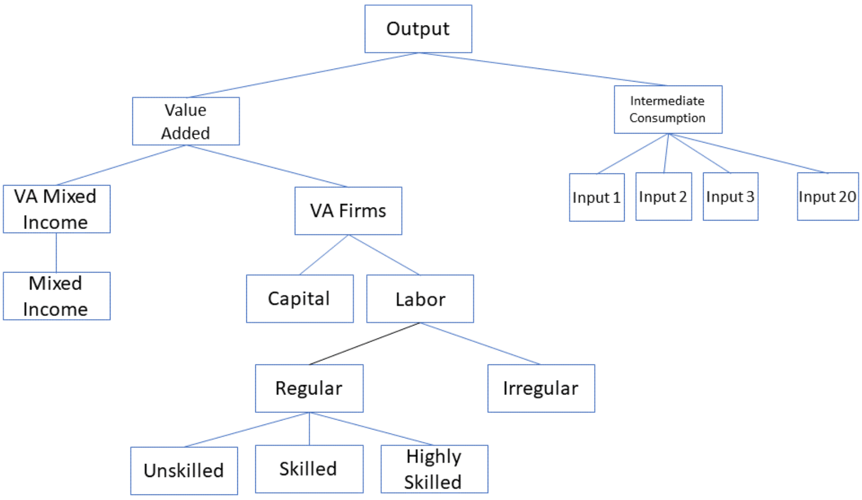
The model considers twenty sectors, twenty commodities, ten household groups, two trading partners, and eighteen tax categories. Households are divided into ten income groups to analyse the distributional effects of the policy measures. They operate as consumers, workers and savers; firms are producers, consumers of intermediate goods, and investors. The government acts as a consumer and transfer agent; the rest of the world is composed of foreign consumers and producers that interact with the domestic markets in terms of imports and exports.

The production structure is organised as described in Figure 2. Producers decide the optimal level of capital, labour and intermediate goods to maximise their profits. Labour input can be regular and/or irregular; regular workers have different skill levels. It is assumed perfect competition in the activities, though we introduce frictions in the labour markets, that is, there is unemployment and a percentage of fixed capital that is not employed in the economy due to endogenous rate of capital use.

The model has recursive dynamics where agents are myopic and base their future decisions on static expectations on prices and quantities. The dynamic part of the model is driven by capital accumulation obtained through savings and/or by exogenous changes such as those in the labour supply. The capital stock in each period is determined as capital stock in the previous period plus investment carried out.

In the reference scenario it is assumed that the economy is on a steady state growth path (or balanced growth path) where all level variables of the model are assumed to grow at a constant growth rate and all relative prices remain unchanged. This constitutes the counterfactual scenario against which all policy scenarios are evaluated. A policy shock is introduced into the economy which then deviates from the initial equilibrium until it converges to the new steady-state growth path.

Figure 2. ITAXCGE, production function



4.2.2 Production structure

The first level of the production structure is based on a Leontief production function: the value of output of industry a (XD_a) is obtained by combining value added and intermediate consumption in fixed shares. The value added is made up of two parts: one provided by firms and another one provided by the self-employed, which we define as the mixed income value added. We assume that the value added deriving from self-employed does not depend on capital and/or labour, that is, is considered a third factor of production. Therefore, firms create value added by choosing the optimal level of capital and labour.

We model the part of the value added dependent upon firms' choices with a constant elasticity of substitution (CES) production function where labour and capital can be substituted with constant elasticity. An important element of our model is that we include some capital stock that can be unused: this is particularly relevant in crisis periods, like the current pandemic shock, where part of the capital owners stickily resist to the changes in price of capital and choose to not provide their capital at equilibrium price.

As a result, producers decide the optimal level of capital and labour in a given sector a as follows:

$$K_{utilisationrate,a}K_a = \left(\frac{p_{VA,a}\gamma_{K,a}}{p_{KTAX,a}}\right)^{\sigma_{VA,a}} VA_a \ , \tag{1}$$

$$L_a = \left(\frac{p_{VA,a}\gamma_{L,a}}{p_{L,a}}\right)^{\sigma_{VA,a}} VA_a, \tag{2}$$

where K_a and L_a are optimal levels of capital and labour in sector a, $p_{VA,a}$ is the associated price for each unit of VA. $\gamma_{L,a}$ and $\gamma_{K,a}$ are the shares of labour and capital in the production, and p_{KTAX_a} is the cost of capital increased of corporate income tax and decreased by the part of erosion of corporate income tax base in sector a. Capital and labour are substitutes according to a sector-specific constant elasticity of substitution $\sigma_{VA,a}$. Since capital is not completely used in the economy as a part of capital stock, we have $(1 - K_{utilisationrate_a})$ the share of capital that is left unused.

Once having reached the optimal level of labour and capital, the producer optimise the use of regular ($Lreg$) and irregular labour ($Lirreg$). The consideration of irregular labour as additional factor of production is important in a country like Italy, where the irregular workers are more than three millions and they are usually employed in regular activities, with implications on tax revenues and collection (Di Caro and Sacchi, 2020).[8]

This is the second novelty of our model, as by considering irregular labour we include personal income tax evasion in the model. At the best of our knowledge, this is the first attempt to model the irregular labour market within a CGE focused on taxation. We assume regular and irregular workers to be substitutable with a constant elasticity of substitution as in equation (3).

$$L_a = \left(\gamma_{Lreg,a} Lreg_a^{-\rho_{L,a}} + \gamma_{Lirreg,a} Lirreg^{-\rho_{L,a}}\right)^{-\frac{1}{\rho_{L,a}}}, \qquad (3)$$

where $\gamma_{Lreg,a}$ and $\gamma_{Lirreg,a}$ are, respectively, the intensity of regular and irregular employees in the production, and $\rho_{L,a}$ is the substitution parameter between the two types of employees.

We further characterise regular workers according to their skill levels, by assuming that each worker can be low skilled, medium skilled or high skilled. We assume that workers with different skills are substitutable within the sector according to a sector specific constant elasticity of substitution. Therefore, the producers set the optimal level of skilled workers by optimising the following CES production function:

$$Lreg_a = \left(\sum_{sk} \gamma_{sk,a} Lskill_{sk,a}^{-\rho_{Lreg,a}}\right)^{-\frac{1}{\rho_{Lreg,a}}}, \qquad (4)$$

[8] In general equilibrium analyses conducted for developing countries (Alm and Sennoga, 2010), CGE includes a two-sector (regular and irregular) economy, where the two sectors show relevant differences. Given our focus on a developed country, we are interested here in modelling irregular consumption and production explicitly, given the low relative importance for Italy (Di Caro and Sacchi, 2020).

where $\gamma_{sk,a}$ is the share of workers with skill sk in sector a, and $\rho_{Lreg_a}$is the substitution parameter among workers with different skills.

Next, we assume a multi-product economy where firms in each acitivity can produce multiple commodities. We assume the commodities to be transformed using a Constant Elasticity of Transformation (CET) function as follows.

$$XD_a = \left(\sum_c \gamma_{a,c} \, XS_{a.c}^{\rho_{XD,a}}\right)^{\frac{1}{\rho_{XD,a}}}, \quad (5)$$

where $XS_{a.c}$ is the commodity c supplied in sector a, $\gamma_{a,c}$ is the share of commodity c in producing goods in sector a, and $\rho_{XD,a}$ denotes the substitution parameter among the different commodities in sector a.

Finally, firms combine intermediate commodities with value added in a Leontief production function to produce the final output (first layer).

Once the producers decide the optimal level of commodities to produce, they also set the share of each commodity in each activity to be produced for the domestic market and for the foreign markets. Moreover, the foreign market is divided into EU and non-EU markets.

Our model includes a stylised foreign market composed of consumers and producers. More specifically, the foreign market, composed of EU and non-EU countries demand commodities according to an exogenous baseline demand calibrated on the national accounts data. The proportion of each commodity demanded by the foreign markets depends on the relative prices of the commodities, while the overall demand depends on the income level. The income level, in turn, is dependent upon the income obtained by exporting to the domestic market, i.e. imports from the Italian perspective. The difference between foreign income and spending defines the foreign savings that are assumed to be equal, in absolute value, to the current account balance with each partner. Further, we assume two exchange rates, one for the EU another for the non-EU countries, which are left flexible.

We assume that commodities can be transformed into domestic supply commodity ($DS_{a,c}$), EU-exported commodities ($ES_{EU_{a.c}}$), and Non-EU exported commodities ($ES_{NOEU_{a.c}}$) according to a Constant Transformation Function as follows:

$$XS_{a,c} = \left(\gamma_{a,c}^{DS}\, DS_{a.c}^{\rho_{XS,a,c}} + \gamma_{a,c}^{ES_{EU}}\, ES_{EU}{}_{a.c}^{\rho_{XS,a,c}} + \gamma_{a,c}^{ES_{NOEU}}\, ES_{NOEU}{}_{a.c}^{\rho_{XS,a,c}}\right)^{\frac{1}{\rho_{XS,a,c}}} \tag{6}$$

4.2.3 The demand system

Households, non-profit organisations (NPOs), government and firms demand commodities from domestic suppliers and foreign producers, as well. We have the following composite demand of produced goods X_c:

$$X_c = \left(\gamma_{EU_c}^{M} M_{EU_c}^{-\rho_{X,c}} + \gamma_{NOEU_c}^{M} M_{NOEU_c}^{-\rho_{X,c}} + \gamma^{DD} DD_c^{-\rho_{X,c}}\right)^{-\frac{1}{\rho_{X,c}}} \tag{7}$$

Each institution demands the optimal level of Imports, from EU and non-EU countries, and the optimal level of domestically produced commodities.

One of the innovations of our model is that we disaggregate the households into ten deciles according to their income. We classify households according to their equivalent level of income by using the tax benefit model available at DF (TAXBEN-DF). The model combines, the survey on income and living conditions carried out by the Italian National Institute of Statistics (IT-SILC); the tax returns of individuals; the information on the real estate and on the shares owned by the individuals extracted from the cadastral archives; the information in the contribution statement, the pensions and welfare benefits derived from the Italian National Institute for Social Security (INPS) archives and the registry of financial reports (Di Nicola et al., 2017).

For every household group, we calibrate the level of labour income, the level of self-employed income, the capital income, the transfers from government and firms, and the interest payment on the government debt. Therefore, we have:

$$YH_h = YHL_h + shareY_{mixed,h} \textstyle\sum_a p_{mixed} Mixed_a + shareY_{K_h} \textstyle\sum_a (p_{K,a} K_{utilisationrate,a} K_a) + Transfer_{GtoH_h} + Transfer_{FtoH_h} + Interest_h \tag{8}$$

The labour market is made up of regular and irregular employees: labour income earned by each household is the combination of the remunerations of regular and irregular employment. Note that, the share of labour activities' income over total labour income is decile-dependent, that is, varies depending on the household group. While remuneration from regular employment is subject to personal income tax and social security contributions (SSCs), irregular employment is not subject to taxes and SSCs. Further details on the tax structure are provided below.

Disposable income is allocated to savings according to a fixed share calibrated at household decile level, while the residual part of the disposable income is used for consumption purposes. Moreover, we assume that household utility can be approximated by a Stone-Geary Utility function, which enable us to accommodate partial non-homothetic preferences. Therefore, we assume a minimum level of consumption of each commodity depending upon the household's decile, and a constant elasticity between different commodities. More formally, we have:

$$UH_h = \prod_c \left(CH_{c,h} - CH_{c,h}^{MIN}\right)^{\alpha_{\mathrm{c,h}}^{\mathrm{LES}}}$$

$$with \ \sum_c \alpha_{\mathrm{c,h}}^{\mathrm{LES}} = 1 \qquad (9)$$

Government and NPOs demand for consumption goods emanate from maximisation of Cobb-Douglas utility functions under their respective budget constraints. Every institutional sector also demands goods and services for investment purposes. We assume that the overall level of investment is determined according to the difference between the total savings and the value of the inventories We assume that the loanable funds available for investment are allocated between the institutional sectors based on exogenous shares. These shares are calibrated using the national accounts data. fixed capital formation. These allocations stem from maximising Cobb-Douglas utility functions under budget constraints imposed by the share of each institutional sector in the investment funds.

4.2.4 Market clearingand disequilibrium in the factor markets

Although the model has a neoclassical structure with perfect competition in all markets, we introduce disequilibrium in the labour markets by considering unemployment. We allow for an endogenous working force supply (for each skill level) to be dependent upon the disposable income changes with respect to the initial, steady-state, equilibrium and changing according to the elasticity of labour supply with respect to income (ε) as follows.

$$\frac{\sum_a LSkill_{sk}}{\sum_a LSkill_{sk_0}} = \left[\frac{\left(\frac{p_{LSkill_{sk}} - \sum_h \left(p_{Lskill_{sk}}\left(rate_{PIT_{IRPEF_h}} + rate_{PIT_{SUPP_h}}\right) - citizen_h - child_h\right) share_{YLskill_{h,sk}}}{PINDEX_{CPI}}\right)}{\left(\frac{p_{LSkill_{sk,0}} - \sum_h \left(p_{Lskill_{sk,0}}\left(rate_{PIT_{IRPEF_{h,0}}} + rate_{PIT_{SUPP_{h,0}}}\right) - citizen_{h,0} - child_{h,0}\right) share_{YLskill_{h,sk}}}{PINDEX_{CPI,0}}\right)}\right]^{\varepsilon}$$

(10)

In addition, we assume that the total supply of labour is exogenous and it is made up of the supply of workforce, and a part being made of unemployed individuals.

$$LabSupplySkill_{sk} = LSkill_{sk} + UNEMP_{sk} \qquad (11)$$

The markets for irregular labour and for self-employed are assumed to be in equilibrium. The supply of these factors are exogenous.

All the commodity markets are also assumed to be in equilibrium.

Finally, we allow the model to close in different ways, either by fixing the government gross savings, or government expenditures or even by fixing government savings net of government investment.

4.2.5 Modelling the tax dimension

The model includes seventeen taxes, of which seven are direct taxes, seven are indirect taxes and three are different social security contributions, as reported in table below.

Table 1. Detail of taxes included in the ITAXCGE model

Direct Taxes on Households	PIT - IRPEF
	PIT - Regional and Municipal surtax
	Forfeit Regime
	Tax on rents
	Capital income tax
Direct taxes on Corporations	CIT - IRES
	Regional Business tax - IRAP
Social Security contributions	Paid by employee
	Paid by employer
	Paid by self-employed
Indirect taxes on product	VAT
	Excise duties
	Tariffs on imports from non-EU countries
	Other taxes on products
Indirect taxes and subsidies on production	Real Estate tax - IMU
	Other taxes on productions
	Negative taxes and subsidies on production

Every tax is modelled using the data from the MS models available at the DF. Taxes and SSCs are the main source of income for the government, while subsidies and transfers are part of the expenses.

Commodity taxes may vary according to the type of commodity, to the institution buying it, and according to the type of use of the good bought. One of the richness of our model consists of including in the CGE model granular tax rates estimated by using the microsimulation models internal to the Department of Finance as described in the next section.

We consider separately, and thus we estimate specific VAT rates, the VAT revenue from the final consumption of commodities by each type of institution, the VAT revenue from the intermediate consumption, the VAT revenue from the investments carried out by each institution and the VAT revenue from the inventories. We develop a 20x13 matrix made of VAT rates estimated for the 20 commodities related to the acquisition of consumption goods by the 10 deciles of households, by the NPOs, by the government and by the firms. We additionally estimate a vector of VAT rates for the 20 commodities used as intermediate goods and a vector of rates for the commodities used as inventory.

We can therefore compute the total value of VAT revenue as follows:

$$VATRev = \left(\sum_c \sum_h rate_{VATCH_{c,h}} p_{X,c} CH_{c,h} + \sum_c rate_{VATCNPO_c}\, p_{X,c}\, C_{NPO_c} + \sum_c rate_{VATCG}\, p_{X,c}\, CG_c\right) + \left(\sum_c \sum_h rate_{VATIH_{c,h}} p_{X,c} IH_{c,h} + \sum_c rate_{VATINPO_c}\, p_{X,c}\, I_{NPO_c} + \sum_c rate_{VATIFIRM_c}\, p_{X,c}\, I_{FIRM_c} + \sum_c rate_{VATIG_c}\, p_{X,c}\, I_{G_c}\right) + \sum_c rate_{VATCA_c}\left(1 + rate_{EXCISE,c}\right) p_{X,c}\, DIT_c + \sum_c rate_{VATInventory}\, p_{X,c}\, Inventory_c \quad (12)$$

For the excise taxes, we estimate the rate for each commodity used as an intermediate input in the production process. We also include the revenue from by tariffs imposed on the imports from the non-EU countries, and we group together the residual part of the taxes on products that cannot be considered as VAT, excise or tariffs.

Direct taxation is captured in the model by the personal income taxes and the corporate income taxes.

Personal income tax in Italy is composed of two taxes: IRPEF at the national level and a local supplement to IRPEF. We estimate the two rates separately using our microsimulation model and we include them in the CGE model by applying them to the tax base for the PIT. We estimate each of these rates for each of the 10 household deciles.

$$PITRev = \sum_h \left(rate_{PITIRPEF_h} Base_{PITIRPEF_h} + rate_{PITSUPPLEMENT_h} Base_{PITIRPEF_h}\right) \quad (13)$$

The PIT tax base is heterogeneous across households' deciles and is dependent on the household income and according to the PIT erosion and evasion rates estimated for each decile. The tax erosion and evasion are described in the next section.

CIT revenue is defined as the sum of the revenues from the national CIT tax, IRES, and the local CIT tax, IRAP. Similarly as before, we apply the estimated CIT rates, differentiated by sector, on the CIT tax base. CIT base is defined as the income generated by the capital employed in the production function decreased by an eroded part, which is sector dependent.

$$CITRev = \sum_a rate_{CITIRES_a} Base_{CITIRES_a} + \sum_a rate_{CITIRAP_a} Base_{CITIRAP_a} \quad (14)$$

The social security contributions are also included in the model and are computed by distinguishing between the SSCs paid by the employer in each activity and the SSCs paid by the employee that are dependent upon the skill level of the worker. As self-employed pay a different rate of SSC contribution than employees, we include in the model a separate SSC rate for mixed income being dependent on the household' decile.

$$SSCRev = \sum_a \sum_{sk} rate_{SSC_{ER_a}} p_{Lskill_{sk}} Lskill_{sk,a} + \sum_a \sum_{sk} rate_{SSC_{EE_{sk}}} p_{Lskill_{sk}} Lskill_{sk,a} + \sum_a \sum_h rate_{MIXED_h} shareY_{mixed,h} p_{mixed} Mixed_a \quad (15)$$

We also model, at the household decile level, the forfeit regime, which is a flat tax rate regime applied to the low-income self-employed, and the taxation on income derived from transfers and interest income from the government debt. We additionally include taxation on immovable assets and on rents distinguishing the two for each activity and household levels, we consider subsidies to the production at the activity level and we include all the residual taxes on production in a separate variable.

4.2.6 Modelling tax evasion and erosion

The model includes much detail on the tax erosion and the evasion on VAT, PIT, CIT, the forfeit regime, and excises.

As for the VAT gap, we incorporate information from the VATSIM model, where the value-added tax received by the government can be decomposed between the theoretical VAT, corresponding to the VAT that government would receive if no erosion and evasion happened and the VAT gap which is itself defined as the difference between the theoretical and the observed VAT. The theoretical VAT revenue is the result obtained by applying the statutory VAT rates to the VAT tax base, the VAT gap is therefore equal to the VAT evasion.

The linkage between the microsimulation model and the CGE model, allows us to distinguish the VAT gap from the theoretical VAT as follows.

$$rate_{VAT} = rate_{VATtheory}(1 - VATgap) \quad (16)$$

From the VATSIM model, we estimate the theoretical VAT and the VAT gap for each commodity by using the national accounts data on the tax evasion, and by comparing them with the national accounts data on the actual VAT revenue. This approach follows the literature that includes information on VAT compliance in the CGE framework by adopting the VAT gap measurement (Giesecke and Tran, 2012). We can therefore include in the CGE model the two different rates for each type of commodity. Interestingly, this enables us to consider possible shocks on the VAT rates, in the form of policy and compliance shocks, for each of the 20 commodities included in the model.

Tax evasion and tax erosion is also included in the model when referring to the personal income tax. More specifically, we define the tax base for PIT as the difference between the household income decreased by an erosion part and the part of self-employed income and of irregular labour income that are evaded.

$$Base_{PITIRPEF,h} = \left(1 - erosion_{PITIRPEF,h}\right)YH_h - evasion_{LIRREG,h}\, shareY_{Lirreg,h} \sum_a p_{Lirreg_a} Lirreg_a - evasion_{MIXED,h} shareY_{mixed,h} \sum_a p_{mixed} Mixed_a \quad (17)$$

By applying our PIT microsimulation model, we are able to estimate the share of the erosion for each of the 10 household deciles. In particular, we model the PIT gap for the ten group of Italian households by using the information derived from the bottom-up approach developed in Bazzoli et al. (2020), where the PIT evasion of self-employed households is calculated by adopting a consumption-based methodology. This allows us introducing any shock which may have a heterogeneous effect among different households' erosion behaviour.

We also include tax erosion and evasion within the CIT tax base. More specifically, we model both the national and the local CIT rates, respectively IRES and IRAP, for each activity by applying the respective rates to the CIT base. As the corporate tax is meant to be levied upon capital being used in the production process, we define the tax base for IRES and IRAP as follows.

$$Base_{CITIRES_a} = \sum_a p_{K_a} K_a K_{utilisationrate,a} (1 - erosion_{CITIRES_a})$$

$$Base_{CITIRAP_a} = \sum_a p_{K_a} K_a K_{utilisationrate,a} (1 - erosion_{CITIRAP_a}) \quad (18)$$

By allowing the CIT tax bases to be dependent on two different erosion variables, our model is capable of introducing heterogeneous shocks on the two taxes.

Finally, the model also includes the tax base for the forfeit regime, for taxes on capital income and for taxes on rents by estimating a tax base for each of these taxes and by applying the effective tax rate to the tax base.

4.3 The VATSIM model

We use VATSIM-DF, a model developed at the DF in Italy, to simulate VAT policy reforms.[9] More properly, VATSIM-DF is a set of simulation models aiming at analysing the effects of VAT reforms and evaluating both the tax revenue and the distributional impacts. Therefore, we distinguish the following three models: VATSIM-DF (I) is a mesoeconomic model based on the integration of national accounts data (including supply-use tables) and the tax declaration aimed at quantifying the VAT revenue on all the components of the demand for intermediate and final goods and services[10]; secondly, VATSIM-DF (II) is a non-behavioural microsimulation model focused on final private consumption in order to analyse the tax revenue and the distributional effects on each household; finally, VATSIM-DF (III) is a behavioural model estimating income and price elasticities between goods and services.

For our purpose, the motivation to use VATSIM-DF (I) is twofold: to quantify the overall impact generated by the VAT reform in the theoretical VAT revenue; to estimate the impact of reforms in changing the VAT gap. Hence, on one hand, theoretical VAT revenue changes are microsimulated for the non-deductible intermediate consumption and for the final demand of goods and services. On the other hand, changes in the VAT gap are properly estimated through two main devices: by comparing VAT declarations and national accounts according the methodology known in the literature as the top-down approach; by encompassing the share of non-observed economy provided by National Institute of Statistics.

Accordingly, we are able to disentangle the total amount of VAT gap into different components: VAT gap due to B2B transactions with respect to B2C ones; VAT gap due to failure to invoice compared to the one due to failure to declare; VAT gap stemming from the omitted declaration of VAT base with respect to the false declaration of the VAT rates. The latter manifests itself in practice through the fraud represented by the omitted declaration of lowest VAT rate for the intermediate purchases whereas ordinary VAT rates are not declared for the sales. Our methodology to estimate the total amount of VAT gap due to rate differentiation is similar to the approach

[9] See https://www.finanze.gov.it/it/il-dipartimento/Modelli-economici-e-strumenti-di-analisi/VATSIM-DF/.
[10] For a methodological note, see https://www.finanze.gov.it/export/sites/finanze/.galleries/Documenti/Varie/LINK-1-Nota-metodologica-VATSIM-DF.pdf.

followed by NENS 2021[11], consisting in comparing the implicit VAT rate on sales and purchases for each taxpayer. We find that around ten billion euros of potential VAT revenue are evaded by exploiting the rate differentiation, of which around 5.7 billion is assumed to be recoverable.[12]

Secondly, VATSIM-DF (II), based on the consumption survey provided by ISTAT, the Italian Institute of Statistics, is applied to quantify the impact on the VAT burden for the household deciles (Cirillo et al. 2021[13]). Hence, we are able to introduce shocks in the VAT charged on the final consumption in a multi-household CGE model. Finally, the VATSIM-DF (III) model is also used to calibrate the income and price elasticities in the CGE model.

4.4 An integrated approach

ITAXCGE-DF is closely connected to the microsimulation models (MSMs) available at the DF. In fact, data and information used both to develop the SAM and to calibrate some of the deep parameters derives from the results of the MSMs. Precisely, three different MSMs are integrated into the CGE framework: TAXBEN-DF microsimulation model that is mainly used in order to incorporate in the model data of personal income tax, social transfers to families and labour income disaggregation among skills; VATSIM-DF microsimulation model that is mainly used in order to quantify theoretical VAT revenue and VAT gap; CITSIM-DF microsimulation model that is used to quantify the corporate income tax revenue and tax allowances for incorporated firms.

As far as the micro-macro link is concerned, an important challenge is how to combine the MSMs with the CGE model.[14] Simulations are carried out according to the integrated approach (Savard, 2004). In detail, we firstly analyse the effects of a budget-neutral VAT reform based on abolishing all reduced VAT rates, by using the VAT non-behavioural microsimulation model developed at the DF. The results from this microsimulation allows us to evaluate the first-round or the non-

[11]See https://www.nens.it/sites/default/files/Studio%20sull%27evasione%20IVA-Analisi%20della%20Base%20imponibile%20e%20evasione%20da%20aliquote.pdf.

[12] This amount is prudential in order to take into account VAT's omitted payments and changes in tax frauds.

[13] https://www.finanze.gov.it/export/sites/finanze/.galleries/Documenti/Varie/VATSIM_WP_v3.pdf.

[14] In the literature, there are three main different approaches. The bottom up approach that consists in defining tax policy shocks by using MSMs and, then, analyse the macroeconomic results in the CGE model, without further feedbacks from the CGE model to MSMs (Savard, 2010). The top down approach where changes in good or input prices obtained through the CGE model are then introduced into MSMs (Chen and Ravallion, 2004). The integrated approach that is based on defining tax policy shocks by using MSMs; then, CGE models are used to analyse also the distributional results, by removing the representative household hypothesis and considering ten categories of heterogeneous households that correspond to the micro simulated deciles of equivalent disposable income.

behavioural effects. Then, the microsimulation outputs are used as inputs to the CGE model. Concretely, we introduce the shocks in the CGE models based on the changes we quantify through the microsimulation models in the implicit theoretical VAT rates, as well as in the VAT gap rates. In this way, we can assess the behavioural or second round effects based on the interactions and the feedbacks between the markets and the economic agents in a general equilibrium context. The ultimate scope of the analysis is to compare VAT incidence on the disposable income by decile and, at the same time, to investigate the impact on the GDP.

5. Policy simulation

A budget-neutral uniform VAT rate reform

In this section, we report the results of simulating a VAT reform would eliminate all tax expenditures by imposing a unique nominal VAT rate on all the commodities. We simulate this reform in three different scenarios.

In the *first scenario*, we we simulate a budget-neutral VAT reform where the share of the VAT gap over the overall VAT rate is fixed. In the *second scenario*, we consider a reduction in the VAT gap due to the reaction of firms to the changes in the nominal VAT rates. This scenario implies an increase in the VAT revenue the erosion and the evasion might decline thanks to the unification of the VAT rates. In the *third scenario*, we consider the reduction in the VAT gap and use the generated increase in the VAT revenue to reduce the nominal rate in order to simulate a budget neutral reform.

We analyse the three simulations under the equity and efficiency considerations. More specifically, we assess if - and to what extent - the reform induces a rise in GDP while at the same time assessing if it increases the tax burden on the poorest households.

As the focus of our analysis is on the ten household deciles, Table 2 reports the pre-reform effective tax rates for every commodity and each household decile estimated within the CGE model.

Table 2 Pre-reform VAT rates by commodities and household deciles

Commodities \ Household Deciles	H1 (Poorest)	H2	H3	H4	H5	H6	H7	H8	H9	H10 (Richest)
Agriculture and fishing	7.5%	7.4%	7.4%	7.4%	7.4%	7.5%	7.5%	7.4%	7.4%	7.4%
Mining	3.1%	3.2%	3.2%	3.4%	3.5%	3.6%	3.5%	3.4%	3.4%	3.6%
Manufacturing	11.9%	12.2%	11.9%	12.0%	12.0%	12.1%	12.0%	12.1%	12.3%	12.0%
Electricity and gas	2.6%	2.7%	2.7%	2.8%	2.9%	2.9%	2.8%	2.8%	2.7%	2.8%
Water supply, sewerage, waste management	3.0%	3.2%	3.1%	3.4%	3.5%	3.5%	3.4%	3.4%	3.4%	3.5%
Construction	4.1%	4.5%	4.3%	4.4%	4.5%	4.6%	4.5%	4.2%	4.4%	4.4%
Trade	14.6%	14.4%	14.7%	14.7%	14.9%	14.8%	14.8%	14.7%	14.9%	14.4%
Transportation	16.6%	16.5%	16.7%	16.7%	16.9%	16.8%	16.9%	16.8%	17.0%	16.4%
Hotels and restaurants	7.9%	8.0%	8.0%	8.0%	8.0%	8.0%	8.1%	8.0%	8.1%	8.1%
Information and communication	15.2%	15.4%	15.2%	15.4%	15.3%	15.2%	14.9%	15.2%	15.2%	14.5%
Finance	12.2%	11.7%	11.6%	10.9%	11.2%	10.1%	9.9%	10.4%	10.7%	10.9%
Real estate	2.7%	2.9%	2.8%	3.0%	3.1%	3.0%	3.0%	3.0%	2.9%	3.0%
Professional services	12.2%	12.2%	12.0%	11.8%	12.1%	11.4%	11.2%	11.7%	11.9%	11.9%
Support services	10.0%	10.5%	10.3%	10.5%	10.8%	10.9%	10.8%	10.8%	11.1%	10.8%
Public_Administration	12.2%	11.7%	11.6%	10.9%	11.1%	10.2%	9.9%	10.5%	10.8%	10.9%
Education	1.3%	1.4%	1.2%	1.3%	1.5%	1.5%	1.3%	1.2%	1.2%	1.1%
Health	7.8%	7.4%	7.6%	7.3%	6.7%	6.5%	6.5%	6.7%	6.0%	5.8%
Entertainment	8.2%	9.4%	8.9%	10.2%	10.1%	10.6%	9.9%	10.5%	10.5%	10.3%
Other services	12.6%	12.3%	12.2%	11.4%	11.5%	10.8%	10.5%	10.8%	11.1%	10.9%
Household services	16.3%	16.7%	15.8%	14.6%	14.0%	14.8%	14.1%	12.8%	13.4%	10.6%

First scenario: a budget-neutral reform with constant VAT gap

We estimate a single nominal VAT rate which respects a budget-neutral reform of the VAT system using the DF MSM. We find that, by imposing a unique 15.7% VAT rate on all commodities, we can reform the VAT tax system without incurring any VAT revenue losses.

We therefore compute the theoretical VAT and the VAT gap from the MSM for each institutional sector and for each household decile. We use the matrix containing the theoretical VAT and the VAT gap within our CGE model to estimate the effective VAT rate, the theoretical VAT rate and the percentage of the VAT that is lost due to the VAT gap.

Table 3 reports the changes, in percentage points, of the effective VAT rates by commodity and household decile. The results show that applying a unique statutory VAT rate, implies an increase in the effective rate for agricultural products, hotels and restaurants and professional services.

Differently, the unique rate produces a reduction in the VAT rate for household services and support services together with the trade and transportation related products.

Table 3.First scenario post-reform effective VAT rates changes (in pp) by commodity and household decile

Commodities \ Household Deciles	H1 (Poorest)	H2	H3	H4	H5	H6	H7	H8	H9	H10 (Richest)
Agriculture and fishing	7.0%	7.2%	7.3%	7.5%	7.4%	7.5%	7.4%	7.2%	7.6%	7.2%
Mining	0.2%	0.2%	0.2%	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%	0.2%
Manufacturing	-0.4%	-0.3%	-0.4%	-0.4%	-0.5%	-0.7%	-0.9%	-1.1%	-1.0%	-1.2%
Electricity and gas	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Water supply, sewerage, waste management	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%
Construction	-0.3%	-0.2%	-0.3%	-0.3%	-0.3%	-0.4%	-0.4%	-0.3%	-0.3%	-0.3%
Trade	-3.2%	-3.3%	-4.3%	-3.8%	-4.0%	-3.8%	-4.3%	-4.2%	-3.9%	-3.8%
Transportation	-3.8%	-3.8%	-4.9%	-4.3%	-4.7%	-4.4%	-4.9%	-4.9%	-4.5%	-4.4%
Hotels and restaurants	5.3%	4.7%	5.7%	5.1%	5.6%	5.8%	5.7%	6.1%	5.5%	5.6%
Information and communication	-3.9%	-3.8%	-4.0%	-4.0%	-4.1%	-3.9%	-4.0%	-4.2%	-3.8%	-3.4%
Finance	-3.5%	-2.9%	-3.7%	-3.4%	-3.0%	-2.8%	-3.1%	-3.1%	-3.2%	-3.5%
Real estate	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.2%	0.2%	0.1%
Professional services	7.4%	9.8%	8.0%	9.2%	8.6%	9.1%	8.6%	8.8%	10.3%	10.4%
Support services	-8.5%	-9.0%	-8.8%	-9.1%	-9.3%	-9.5%	-9.5%	-9.6%	-9.9%	-9.6%
Public_Administration	-3.5%	-3.0%	-3.6%	-3.5%	-2.9%	-2.9%	-3.0%	-3.1%	-3.3%	-3.5%
Education	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%
Health	0.7%	1.1%	0.8%	1.0%	0.7%	0.8%	1.0%	0.8%	0.7%	0.5%
Entertainment	0.4%	0.8%	0.7%	0.1%	0.4%	0.4%	0.2%	0.0%	0.3%	0.6%
Other services	-4.4%	-4.0%	-4.6%	-4.3%	-3.8%	-3.7%	-3.9%	-3.9%	-4.0%	-4.1%
Household services	-5.6%	-4.4%	-4.8%	-4.8%	-4.2%	-4.6%	-4.6%	-4.5%	-4.2%	-3.2%

Next, we simulate the reform in the CGE model and we obtain the estimated macroeconomic effect connected to it. The reform clearly shows a trade-off between equity and efficiency as it produces an increase in GDP going from 0.15% in the first year to the 0.19% after 15 years, and at the same time, it increases the burden linked to the VAT expenditures related to the poorest households (Table 5).

The results suggest that the poorest families may face a rise in the share of VAT expenditures over their disposable income while the richest families benefit from the reform as the share of the VAT expenditures decreases. While the first and the second decile observe a rise, respectively, by 0.1 and 0.13 percentage points in the share of the VAT expenditure over the disposable income, families in the ninth and tenth deciles observe a decrease in the VAT burden by respectively 0.07 and 0.04 percentage points.

More specifically we find that the share of VAT paid by the households compared in their disposable income corrected by the transfers in kind, the biggest change happens in the second decile, whose ratio increases from 9.56% to 9.69%, and in the eighth decile where the VAT burden decreases from 6.19% to 6.05%.

The regressive effect of the reform is caused by the increase in the VAT rate for the primary goods (see Table 3) that are mostly consumed by the poorest households. On the other hand, as luxury goods,administrative and support services are taxed at lower rates, richest households may benefit from the reform as their burden of VAT payments in their disposable income declines.

Second scenario: a budget-non-neutral reform with reduced VAT gap

The second simulation consists of applying the reduction in the VAT gap due to the introduction of a unique VAT rate and simulating a reform which is not budget-neutral. As the nominal VAT rates converge towards a unique rate, the propensity of firms to evade taxation, by declaring sales of goods at lower VAT rates and purchases of intermediate goods at higher VAT rates, will decrease. By using the tax returns data, we are able to estimate the amount of VAT revenues foregone due to this type of evasion, hence, we add up this amount to the VAT revenue collected to estimate a new VAT gap matrix.

This allows us to compute the effective VAT rates for each commodity bought by each institutional sector and by each household deciles. Finally, we shock the VAT rates imposing them to be equal to the newly estimated ones. As the reduction in the VAT gap affects only the B2B transactions, it does not produce any change in the effective VAT rate for the households that will face the same rate as in the first simulation.

Our results suggest that, while the dynamics of the VAT burden on the households remain the same as in the first scenario where the reform is regressive, GDP has a different reaction to the VAT rate unification.

Due to the reduced VAT gap, the firms pay more VAT as they can no longer exploit the tax rate differentials to decrease their tax liability. The increase in VAT liability produces an increase in GDP smaller than in the first scenario, as it increases by 0.005% in the first year after the shock up to 0.1% in 15 years (Table 5).

This reform produces an increase in the VAT revenue of about 6.2 billion euro, thus, the fiscal VAT multiplier estimated in our model reports values in a range between 0.01 and 0.26.

It is worth noting that, while this reform appears the same as the budget-neutral one with a constant VAT gap under the equity profile, it performs much worse under the efficiency profile as the GDP rises much less than in the previous scenario due to the increase in the firms' VAT liability (Table 5).

Third scenario: a budget-neutral reform with reduced VAT gap

Finally, we simulate the effects of a budget-neutral VAT reform where the VAT gap is reduced due to the introduction of a unique VAT rate.

Similarly as before, once the unique rate is introduced, VAT revenue increases due to the rise in VAT liability paid by the firms. The rise in the VAT revenue allows for an additional decrease of the VAT rate, hence, we simulate a reform in which the nominal VAT rate decreases from 15.7% to 14.9%.

The effective VAT rates paid by the households for every commodity change due to the the reform. Table 4 reports the changes, in percentage points, of the VAT rates with respect to the pre-reform scenario. The introduction of a unique VAT rate still induces a rise in the effective rates for low-end goods, such as agriculture related commodities, while at the same time reduces the rates for the high-end services such as finance and support services. Nevertheless, as the unique rate is lower than in the ones used in the previous two scenarios, the rise in VAT rates for the low-end goods is smaller than what we observe in the first two scenarios.

As the VAT rate decreases, the reform results progressive when considering the burden of VAT by household deciles. More specifically, while all the household deciles observe a reduction in the their VAT burden with respect to their disposable income, the poorest households benefit more than the richest as they experience higher reductions as the VAT burden represents a greater proportion of their income. The ratio of VAT paid over disposable income for households in the first decile decreases by 0.69 percentage points from 15.3% to 14.61%, while it decreases by 0.25 percentage points for households in the tenth decile going from 4.02% to 3.77% (Table 5).

From an efficiency point of view, the reform increases GDP by 0.13% in the first year up to a 0.15% in the last year of our analysis.

Reforming the VAT system by allowing the VAT rate to further decrease - due to the incorporation of the positive effects of reducing tax evasion – appears, according to our model, a Pareto improvement with respect to the second simulation as it performs better both in terms of equity and in terms of efficiency perspective.

However, when comparing the first with the third scenario, we cannot assess a Pareto improvement. In fact, while the former simulation performs better under efficiency perspective, the latter is better for equity reasons. The policymaker will therefore choose the optimal reform according to the importance assigned to each of these two criteria. However, it is worth noting that the third simulation, by producing just slightly lower results on GDP but much better results in terms of the VAT burden redistribution, may be an optimal solution for reforming the VAT system.

Table 4. Third scenario post-reform effective VAT rates changes (in pp) by commodity and household decile

Commodities \ Household Deciles	H1 (Poorest)	H2	H3	H4	H5	H6	H7	H8	H9	H10 (Richest)
Agriculture and fishing	6.1%	6.4%	6.4%	6.6%	6.6%	6.6%	6.5%	6.4%	6.7%	6.4%
Mining	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Manufacturing	-1.0%	-0.9%	-1.0%	-1.0%	-1.2%	-1.3%	-1.6%	-1.8%	-1.6%	-1.8%
Electricity and gas	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%
Water supply, sewerage, waste management	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Construction	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.6%	-0.6%	-0.6%	-0.6%	-0.5%
Trade	-3.8%	-3.8%	-5.0%	-4.4%	-4.6%	-4.4%	-4.9%	-4.9%	-4.5%	-4.4%
Transportation	-4.4%	-4.4%	-5.7%	-5.0%	-5.4%	-5.1%	-5.6%	-5.6%	-5.2%	-5.1%
Hotels and restaurants	4.5%	4.1%	4.9%	4.4%	4.8%	5.0%	4.9%	5.2%	4.7%	4.8%
Information and communication	-4.4%	-4.4%	-4.6%	-4.7%	-4.8%	-4.5%	-4.6%	-4.9%	-4.4%	-4.0%
Finance	-4.0%	-3.4%	-4.1%	-3.8%	-3.4%	-3.2%	-3.5%	-3.5%	-3.7%	-3.9%
Real estate	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Professional services	6.4%	8.7%	6.7%	7.9%	7.4%	7.9%	7.3%	7.5%	9.0%	9.0%
Support services	-8.6%	-9.1%	-8.9%	-9.1%	-9.4%	-9.6%	-9.6%	-9.7%	-10.0%	-9.7%
Public_Administration	-4.0%	-3.4%	-4.1%	-3.9%	-3.3%	-3.2%	-3.4%	-3.5%	-3.7%	-3.9%
Education	-0.2%	-0.2%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.1%
Health	0.2%	0.6%	0.3%	0.6%	0.4%	0.4%	0.6%	0.4%	0.3%	0.2%
Entertainment	-0.1%	0.3%	0.1%	-0.5%	-0.2%	-0.1%	-0.4%	-0.7%	-0.4%	0.0%
Other services	-4.9%	-4.4%	-5.1%	-4.7%	-4.2%	-4.1%	-4.3%	-4.2%	-4.4%	-4.5%
Household services	-6.3%	-5.0%	-5.3%	-5.4%	-4.7%	-5.1%	-5.2%	-5.1%	-4.7%	-3.6%

__Table 5. Changes in GDP and VAT relevance for every simulation__

GDP changes (in %)		Budget-Neutral constant VAT GAP	Not-Budget neutral reduced VAT Gap	Budget-Neutral reduced VAT GAP
		[0.15%-0.19%]	[0%-0.1%]	[0.13%-0.15%]
Changes (in percentage points) in VAT relevance over disposable income by household corrected by transfers in kind	H1 (poorest)	0.07%	0.06%	-0.69%
	H2	0.13%	0.13%	-0.32%
	H3	0.04%	0.03%	-0.36%
	H4	0.05%	0.05%	-0.32%
	H5	0.00%	-0.01%	-0.35%
	H6	-0.01%	-0.01%	-0.36%
	H7	-0.08%	-0.08%	-0.43%
	H8	-0.14%	-0.14%	-0.47%
	H9	-0.07%	-0.07%	-0.37%
	H10 (richest)	-0.04%	-0.04%	-0.25%

6. Concluding remarks

In this paper we describe the ITAXCGE model developed by the Italian DF. It consists of a CGE model of the Italian economy with the highest level of detail on taxation than any other similar model currently available. By providing a multi-sector, multi-commodity and multi-household analysis, the model is capable of delivering highly detailed results. The model is also enriched by the integration, within the CGE, of the outcomes obtained by the MSMs developed by the DF.

The paper uses the ITAXCGE model to simulate the effects of a VAT reform. More specifically we simulate the introduction of a unique VAT rate and assess the equity-efficiency trade-offs under three different scenarios.

Our analysis confirms that the introduction of a single rate with the same level of revenue (first scenario) determines a trade-off between equity and efficiency with an increase in GDP but, at the same time, an increase in the burden of the VAT payments by poorer households. The hypothesis that the firms' evasion in the purchase of intermediate goods is reduced with a relative increase in revenues (second scenario) does not change the results from a distributional point of view and, indeed, reduces the positive impact on GDP. On the other hand, in the third scenario, where the VAT reform is neutral because the revenue deriving from the reduction in evasion is used to further reduce the unique rate, positive effects are obtained on income distribution since poorer households benefit more from the reduction in the VAT burden.

The analysis carried out in this paper is meant to be a first step in analysing different VAT reforms using the new ITAXCGE model. As a follow up, it would be interesting to compare different VAT reforms involving more than one VAT rate to assess how these kind of reforms perform in terms of the equity-efficiency trade-off.

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