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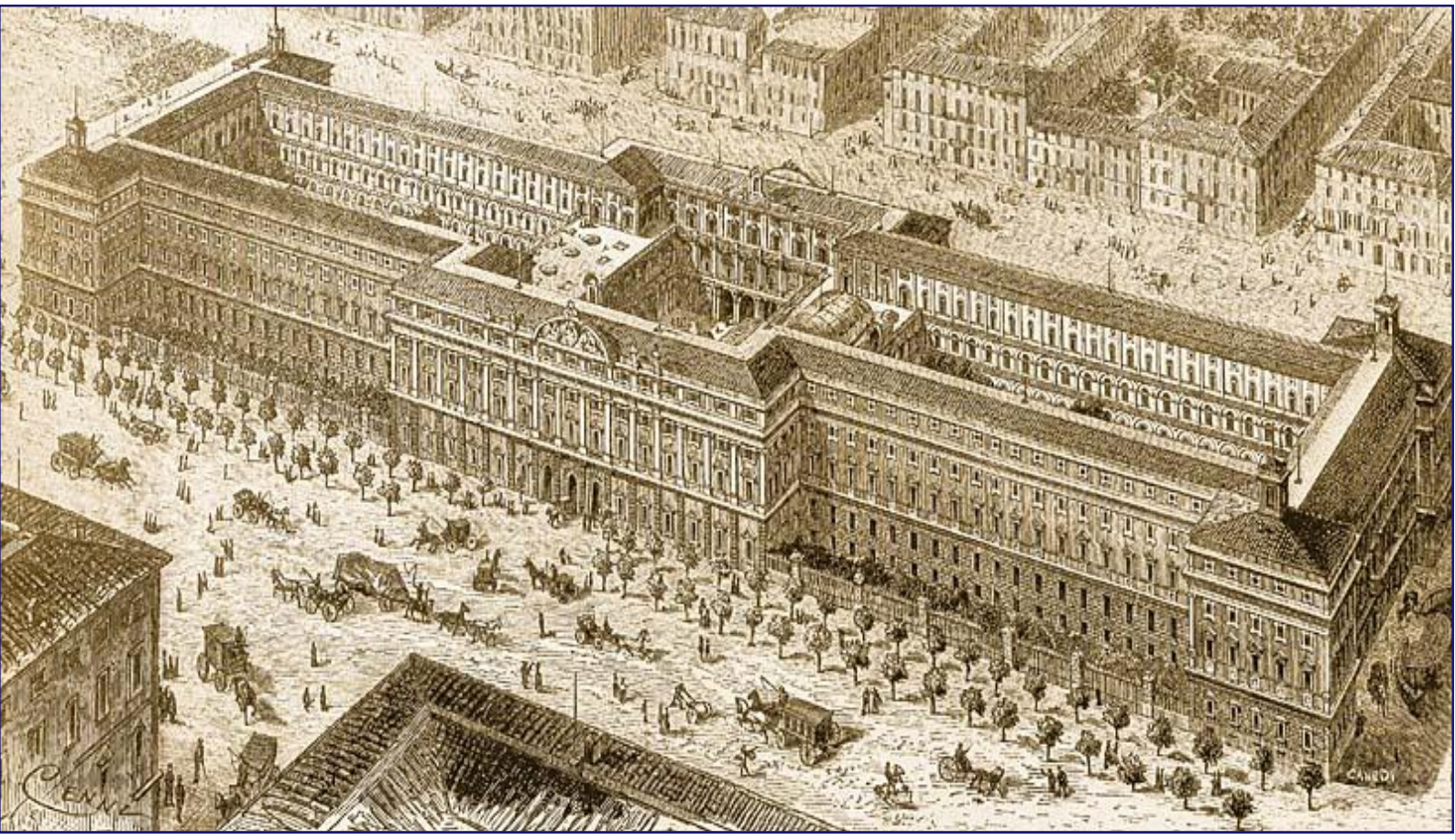

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Fiscal Extension to ORANI-IT: a Computable General Equilibrium Model for Italy

Francesco Felici[1], Maria Gesualdo[2]

Abstract

In this paper we expand the national multi-sectoral computable general equilibrium (CGE) model ORANI-IT, allowing for a number of fiscal tools. The outcome is a computable general equilibrium tax model of Italy, developed at the Department of Treasury of the Italian Ministry of the Economy and Finance, in collaboration with the Centre of Policy Studies (CoPS), and currently managed at Sogei S.p.A. (IT Economia - Modelli di Previsione ed Analisi Statistiche). The paper demonstrates in considerable detail the methodology to incorporate a fiscal extension, that mainly consists in including a detailed tax information into existing commodity and production tax matrices, to the existing national model. In particular, the procedure to accommodate national data on tax revenues within the model's database and explicitly model the full range of indirect taxes within the theoretical structure is reported. Within the fiscal extension, the model includes a comprehensive model of Value-Added-Tax (VAT), which accounts for all the typical features of a complex VAT system - such as multi-production, multiple tax rates, different degrees of exemptions and refundability factors - as well as of EU-specific matters relating to taxation of intra-EU exports, and to the scope of VAT and exemptions of public interest. Interestingly, the framework developed in this paper for Italy may be extendible to other European countries, which fall within the EU VAT legislation. The model also features a special emphasis on sectors national accounts, with a detailed system of equations describing government and households budget revenues and expenditures and transactions with the rest of the world. The output is a powerful tool for acquiring new insights on the current fiscal system, through the assessment of tailored fiscal reforms, which can consist of either changes in tax rates and tax bases. Future research may be pursued in the application of the model for evaluating alternative policies.

JEL Classification: C68, H20, H25
Keywords: Computable general equilibrium (CGE) tax models, Indirect Taxes, Value-Added-Tax, Sector accounts, Italy

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Contents

1 Introduction

This paper describes the main features of the Italian CGE model, ORANI-IT, with some fiscal extensions. The model, designed at the Department of Treasury of the Italian Ministry of the Economy and Finance, in collaboration with the Centre of Policy Studies (CoPS), and currently managed at Sogei S.p.A. (IT Economia - Modelli di Previsione ed Analisi Statistiche), is intended for policy analysis. A detailed specification of a full range of direct and indirect taxes is incorporated into the existing national CGE model[3]. The inclusion of an extremely detailed indirect commodity taxes matrix by commodity, user, source and tax type and production taxes matrix by industry and tax type makes the model a suitable tool for fiscal policy analysis. In dealing with the fiscal extension, this paper aims to provide a roadmap into the complex data-job required to add new features into an existing database, as it can result challenging by limited data availability and by model dimensions.

The model also features a comprehensive Value-Added-Tax (VAT) model. The framework for economy-wide modelling of VAT systems, developed by Giesecke and Tran (2010, 2012) has been further extended in order to accommodate country-specific features. If issues arising from multiple tax rates, exemptions and industry-specific refundability factors are shared by many VAT systems, two EU-specific issues stand out from the EU VAT legislation: the treatment of the VAT for public bodies and activities in the public interests, and the VAT regime applicable to cross-border transactions.

CGE modelling represents a suitable tool for the assessment of the allocative efficiency effects of tax policies, thanks to its capability of capturing the distortion of relative prices. On the other side, the solid theoretical background combined with national accounts data enable estimates of the welfare and revenue effects of alternative reforms. Focusing on the VAT, the development of a general framework with a detailed description of institutional features of tax systems combined with an input-output linkages with commodity, industry and input factors details allow for the computation of the share of tax burden bear by producers, which represents an essential ingredient when dealing with VAT analysis[5].

As part of large-scale models, CGE models rely on a well-structured database, which fits into a theoretical model. For constructing the database, the first piece of information is represented by Input-Output tables and national accounts. Then, depending on the nature of the model and on the desired level of detail, additional data sources can be required. However, when dealing with detailed models extensions, data availability and/or format can come to represent a shortcoming.

In recent years, several studies[6] have been commissioned by the European Commission (EC) for an assessment of the current EU VAT system, with the aim of identifying weaknesses and problems and setting out a simpler, more robust and efficient system (European Commission, 2010). Of particular interest to this paper are those studies dealing with the aforementioned EU-specific rules. The Institute for Fiscal Studies (2011) identifies these rules as being problematic, as exemptions of public services and limitations to the scope of VAT seem likely to be extremely damaging in terms of neutrality and competition, and some of the transactions between member states can incentive non-compliance and can result in an high burden cost. The IMF (Keen et *al.* 2012) in the assessment of the delega fiscale[7] of the Italian government has called for a rethinking of the exemptions system, as the resulting unrecovered input VAT is imputed to cause: distortion

[3] The model is fully documented in Felici and Gesualdo (2014).
[5] See Fullerton, Henderson, and Shoven (1984), McLure (1990, p.38), Fehr, Rosenberg, and Wiegard (1995, pp. 39-40).
[6] Refer to http://ec.europa.eu/taxation_customs/common/publications/studies/index_en.htm, for a full list of studies made for the Commission.
[7] Law 11 March 2014, n.23, Delega al Governo recante disposizioni per un sistema fiscale più equo, trasparente e orientato alla crescita.

of real decisions, competitive disadvantage within the EU, and loss of transparency. The European Commission (2013) has launched a public consultation regarding the lack of neutrality resulting from the current legislative framework ruling the scope of the VAT. In the CGE literature, two earlier studies build multi-country CGE models for EU aimed at studying a VAT reform. Fehr et al. (1995) develop a framework particularly suitable for investigating the welfare and revenue effects of alternative setting for the taxation of intra-EU trades (destination versus origin-based VAT). Copenhagen Economics (2013) addresses the controversial rules applicable to the public sector, by means of a multi-regional CGE model of EU27 specifically designed to analyse the economic effects of the admixture of public production and VAT policies. In this model the non-taxable or tax-exempt sectors are captured by setting zero output VAT rates, but positive input VAT rates. If this model captures deviations from a "pure" VAT system via the tax rate, on the contrary, in our framework we carefully reproduce the multiple tax rates, exemption and refundability factors, the non-taxable public sector, and the differential treatment of exports, via a tailored system of equations. In such a way, we allow for the assessment of a whole range of potential reforms of the VAT system dealing with all its features, including potential base-broadening reforms. To the best of the author's knowledge there is no national model that accounts for all of the EU VAT features at the same time.

This paper is organized as follows. Section 2 describes the construction of the commodity and production tax matrices. In section 3, features of the European VAT system are accommodated into an all-embracing VAT model. Section 4 is devoted to the modelling of the institutional sectors accounts. Section 5 concludes.

2 Extensions of the core database

2.1 Balancing conditions on the tax matrices and on the database as a whole

Since CGE models are built on national accounts data, balancing conditions bound the setting up of the database. In fact, several constraints have been observed when assembling the tax matrices and the database as a whole.

In particular, the tax matrices satisfy the following conditions: for each commodity, the total value of net commodity taxes, summed over sources, users and tax types, equals the values reported in column "Taxes less subsidies on products" of the supply table; for each industry, the total value of net production taxes, summed over tax types, equals the values reported in row "Other taxes on production" in the USE table; revenues of each tax types equal that reported in government revenue statistics (Table 1 and Table 2).

The extended model satisfies the following conditions: industry costs equal industry sales, reflecting the model's zero pure profit assumption; the value of the total output of a given commodity equals the value of the total usage of that commodity, in order to meet the model's commodity market clearing assumption; flow matrices do not contain negative numbers, because of the condition that flows of goods, services and factors cannot be negative. However, this condition does not apply to matrices related to taxes and inventories (VTAX6 and V6BAS), as by definition these flows can show negative values.

Note that the database for ORANI-IT is calibrated on the Supply and Use tables (SUT) for 2008, released by ISTAT[8]. Hence all data discussed in this paper are for the year 2008. In particular, the fiscal addition is based on tax revenues government data and on national accounts.

[8]Downloaded at http://www.istat.it/it/archivio/60913.

Table 1. Revenues of commodity taxes and tariffs in 2008 (in Euro million)

	Tax type	Revenue	% of total commodity tax revenue
	a) Commodity taxes		
1	Value added tax (VAT)	93,698	55.1
2	Excise duty on mineral oils	23,452	13.8
3	Excise on tobacco	10,722	6.3
4	Excise on spirits	605	0.4
5	Excise on beer	549	0.3
6	Tax on gambling	7,714	4.5
7	Provincial tax on motor vehicle insurances	2,071	1.2
8	Local surcharge on electricity duty	1,627	1.0
9	Public motor vehicle register tax (PRA)	1,249	0.7
10	Regional special tax on landfill dumping	192	0.1
11	Excise duty on electricity	1,424	0.8
12	Excise duty on methane	2,837	1.7
13	Excise duty on liquefied petroleum gases	469	0.3
14	Municipal taxes on advertising and billboards	403	0.2
15	State mark sales	13	0.0
16	Excise tax on imported sugar	11	0.0
17	Special taxes on products	1	0.0
18	Registration fee	5,920	3.5
19	Stamp duty	4,954	2.9
20	Mortgage duty	2,341	1.4
21	Tax on land and property use right transfer	1,076	0.6
22	Stamp and registration duty	3,094	1.8
23	Contribution to building concessions	3,280	1.9
24	State duties on public shows	66	0.0
25	Special rights on mineral water	36	0.0
26	Slaughter house rights	30	0.0
27	Rights of the National Rice authority	6	0.0
28	Profits of fiscal monopolies	5	0.0
29	Tourist tax	0	0.0
	B. Taxes acting as tariffs		
30	In-bond surcharge on mineral oils	18	0.0
31	In-bond surcharge on liquefied petroleum gases	22	0.0
32	Duties on EU imports	2,200	1.3
	Total	**170,085**	**100.0**

Source: Tavola 15- Conti ed aggregati economici delle Amministrazioni pubbliche, ISTAT
http://www.istat.it/it/archivio/63156

Table 2. Revenues of production taxes in 2008 (in Euro million)

	Tax type	Revenue (EUR m)	% of total production taxes
1	Regional tax on productive activities (IRAP)	36,141	71.0
2	Municipal property tax (ICI)	9,105	17.9
3	Franchise tax	1,519	3.0
4	Rights of chambers of commerce	1,413	2.8
5	Other taxes on production	619	1.2
6	Italian television tax	398	0.8
7	Regulatory authority for Electricity and Gas	39	0.1
8	Fees on notarial records	25	0.0
9	Other special revenues from tax on products	17	0.0
10	Provincial tax for environmental protection	269	0.5
11	Motor vehicle duty paid by enterprises	1,339	2.6
12	Taxes on exports	-34	-0.1
13	SO2 and NOx pollution tax	25	0.0
14	Rights on provincial tourism	0	0.0
	Total	50,875	100

Source: Tavola 15- Conti ed aggregati economici delle Amministrazioni pubbliche, ISTAT
http://www.istat.it/it/archivio/63156

2.2 The core model's database

A full description of the core model's database is provided in Felici and Gesualdo (2014). However, for the reader's convenience, we replicate the basic structure of the model here via a schematic representation of the model's input-output database, as reported in Figure 1.

The column headings in the absorption matrix identify the following demanders: domestic producers divided into I industries; investors divided into I industries[9]; a single representative household; an aggregate foreign purchaser of exports; government demands; and changes in inventories.

The first row in the absorption matrix (the "BAS matrices": V1BAS,…,V6BAS) shows flows in year *t* of commodities to each user. Each of these matrices has CxS rows, one for each of C commodities from S sources. In ORANI-IT, C is 63 and S is 2 (domestic and imported). The flows are valued at basic prices. The basic price of a domestically produced good is the price received by the producer (that is, the price paid by users excluding sales taxes, transport costs and other margin costs). The basic price of an imported good is the landed-duty-paid price, i.e. the price at the port of entry just after the commodity has cleared customs.

The second row (the "MAR matrices": V1MAR,…,V5MAR) shows the values of margin services used to facilitate the flows of commodities identified in the BAS matrices. The commodities used as margins are domestically produced trade, road transport, rail transport, water transport and air transport services. Imports are not used as margin services. Each of the margin matrices has CxSxM rows. These correspond to the use

[9] According to the ORANI's theoretical framework, in the production of final goods and services industries combine inputs to current production and inputs to capital formation. In modelling the minimizing cost problem faced by industries, we distinguish between the demands for the aforementioned inputs and use the term "investors" when dealing with the demand for inputs for capital creation. In terms of database, in accordance with the Italian SUT, which feature a structure by 63 commodities and 63 industries, ORANI-IT presents an investment matrix by 63 commodities and 63 investors.

of M margin commodities in facilitating flows of C commodities from S sources. Inventories (column 6) are assumed to comprise mainly of unsold products, and therefore do not bear margins. As with the BAS matrices, all the flows in the MAR matrices are valued at basic prices. Consistent with the UN convention (UN 1999:33), we assume that there are no margins on services.

The third row (the "TAX matrices": V1TAX,…,"V5TAX) shows sales taxes on flows to different users. The tax rates can differ between users and between sources. For example, tax rates on a commodity used as an intermediate input to producers can be lower than that on household consumption of the same commodity.

Figure 1. The ORANI-IT Flows Database

			Absorption Matrix					
			1	2	3	4	5	6
			Producers	Investors	Household	Export	Government	Change in Inventories
		Size	← I →	← I →	← 1 →	← 1 →	← 1 →	← 1 →
1	Basic Flows	↑ C×S ↓	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
2	Margins	↑ C×S×M ↓	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
3	Taxes	↑ C×S ↓	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
4	Labour	↑ O ↓	V1LAB					
5	Capital	↑ 1 ↓	V1AP					
6	Land	↑ 1 ↓	V1LND					
7	Production Taxes	↑ 1 ↓	V1PTX					
8	Other Costs	↑ 1 ↓	V1OCT					

C = Number of commodities
I = Number of industries
S = Sources (domestic, imported)
O = Number of occupation types
M = Number of commodities used as margins

	Production Matrix
Size	← I →
↑ C ↓	MAKE

	Tariff
Size	← 1 →
↑ C ↓	V0TAR

Besides intermediate inputs, current production requires inputs of three types of primary factor: labour, fixed capital, and agricultural land. These are shown in rows 4,5 and 6. Industries also have to pay production taxes and other cost tickets (rows 7-8). The "other costs" category covers various miscellaneous costs for firms, such as municipal taxes or charges, or the costs of holding inventories.

The final two data items in Figure 1 are the MAKE and Tariff matrices. MAKE is a CxI matrix showing the value of commodity $c \in COM$ produced by industry $i \in IND$. In principle, an industry can produce more than one commodity, and a commodity can be produced by more than one industry. Indeed, that is a feature of the MAKE matrix for Italy. The tariff matrix represents tariffs on imports. They are used to calculate the tariff rates in the base year as the ratios between the tariff revenues and the c.i.f. value of imports. The Tariff matrix is kept separate from the absorption matrix because the values of tariff revenues are already included in the basic price of imports in the absorption matrix (row 1).

2.3 Creating indirect taxes matrices

Following the System of National Accounts (SNA), ORANI-IT presents two tax types, namely: commodity taxes, which are represented as a matrix of net total tax by commodity and user (matrices V1TAX to V5TAX) and production taxes, which are represented as a vector of net production tax by industry (matrix V1PTAX).

If the computation of the latter is straight forward, as it mirrors the vector "Other tax on production" in the USE table at basic price; the computation of the former is bounded by data availability, as the SUT contains data on net taxes on products only by commodity. To incorporate the user dimension, we follow a procedure that computes the commodity taxes matrix in conjunction with the margins matrix (V1MAR to V5MAR), as it decomposes the difference between the USE table at purchasers price and the USE table at basic prices - difference that is composed by net taxes plus margins[10]. The procedure relies on the assumptions that all intermediate and final usages of a commodity are taxed at the same rate, and that no taxes are levied on stocks. However, Italian data on tax revenues by user (as deducted by computing the difference by users between USE at basic prices and USE at purchasers' prices) show positive values on stocks. Therefore, in order to reflect the theory and at the same time to meet the total tax revenues as indicated in the SUT, we reallocate tax revenues on stocks to other users, in proportion to their shares on total tax revenues.

Taking the inherited database from the national CGE model as our starting point, the commodity matrices V1TAX to V5TAX and the production tax matrix V1PTAX are subject of additional splitting into specific tax-types. The schematic representation of the extended ORANI-IT is represented in Figure 2.

In the sections below we describe the process by which we create the extended tax matrices using information from the SUT, as well as additional tax revenues data for detailed commodity and production taxes and subsidies from government statistics. First of all, data on indirect tax revenues by tax-type and subsidies by industry, as released by ISTAT in the "Accounts for general government"[11], represent the new piece of information the fiscal extension is built on. To be consistent with the original tax structure, we label each of the item as commodity or production tax, by recalling the ISTAT grouping system[12], and by meeting sub-totals for the two tax types[13]. As a result, the model considers: 32 commodity taxes and a commodity subsidies; and 15 production taxes and a production subsidies. Tables 1 and 2 present revenues of commodity and production taxes respectively.

Each item has been explicitly modelled, referring to the relevant tax base in the model and to several tax rates, enabling the model to capture important details of the tax system. For each tax type, an initial estimate of the expected tax revenue is computed by applying the legislated tax rate to the relevant part of the input-output table, which forms the tax base[14]. The estimated revenue is likely to differ from the actual tax revenue as reported in government finance statistics for several reasons, such as: various tax reduction and exemptions, that may not have been captured in the calculation; less than full compliance tax rate; and possible shortcomings in the input-output representation of the size of the tax base. Hence, the initial tax matrix by tax type is scaled in order to meet the target, as reported in the aforementioned tables.

[10] For a full description of the procedure to derive the tax matrix in the standard ORANI structure refer to Appendix E in Felici and Gesualdo (2014).

[11] Conti ed aggregati economici delle Amministrazioni pubbliche: Tavola 15 and Tavola 19. Downloaded http://www.istat.it/it/archivio/63156.

[12] Tavola 3.29 - Imposte sulla produzione e le importazioni per tipologia di unità istituzionali che effettuano il prelievo - Anno 2004 (milioni di euro), pag 245, in Metodologia ISTAT. http://www3.istat.it/dati/catalogo/20120207_00

[13] Institutional accounts - Conti istituzionali 2008, ISTAT.

[14] The allocation of each tax type to the relative commodity was based on a guideline provided by ISTAT: Ripartizione delle imposte indirette per rami e classi di attività economica. Anni 1951-1965, Supplemento straordinario al bollettino mensile di statistica n.11- novembre 1996.

The following sections describe the procedure in creating the commodity and production tax matrices. In particular, we discuss in detail our procedure to work out the effective tax rates and calculate tax revenues. This procedure holds for all commodity taxes but the Value-Added-Tax (VAT), whose dedicated model is presented in section 3.

Figure 2. The Extended ORANI-IT-F Flows Database

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	Investors	Household	Export	Government	Change in Inventories
	Size	← I →	← I →	← 1 →	← 1 →	← 1 →	← 1 →
Basic Flows	↑ C×S ↓	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Margins	↑ C×S×M ↓	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
Taxes	↑ C×S× CT ↓	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
Labour	↑ O ↓	V1LAB					
Capital	↑ 1 ↓	V1CAP					
Land	↑ 1 ↓	V1LND					
Production Tax	↑ PT ↓	V1PTX					
Other Costs	↑ 1 ↓	V1OCT					

C = Number of Commodities
I = Number of Industries

S = 2: Domestic,Imported,
O = Number of Occupation Types

M = Number of Commodities used as Margins
CT= Number of commodity tax types
PT = Number of production tax types

	Joint Production Matrix
Size	← I →
↑ C ↓	MAKE

	Import Duty
Size	← 1 →
↑ C ↓	V0TAR

2.4 The commodity taxes matrix

In the Italian fiscal system, commodity taxes can be grouped into four broad areas: taxes on production, taxes on business, taxes pro-environment, and miscellaneous of government-related taxes.

For each of them, the tax burden is allocated to relevant flows of goods and services by first estimating the initial relevant tax revenues, based on the values of the tax base and the tax rate. Then, the estimated initial tax revenues are proportionately scaled to the actual total revenue of the tax, as reported in the government statistics (Table 1 and 2). Specifically, we use the following formula for calculating the tax revenues from flows of good c from source s to user u, $CTAX^{t}_{c,s,u}$:

$$CTAX^{t}_{c,s,u} = \frac{REV^{t} * TBASE^{t}_{c,s,u} * LR^{t}_{c,s,u}}{\sum_{c \in COM} \sum_{s \in SRC} \sum_{u \in USER} TBASE^{t}_{c,s,u} * LR^{t}_{c,s,u}} \quad (1)$$

Where:

- REV^{t} is the total revenue of tax t reported in government statistics (Table 1);
- $TBASE^{t}_{c,s,u}$ is the relevant tax base for tax t;
- $LR^{t}_{c,s,u}$ is the legal tax rates for t on flow (c,s,u).

For many tax types, there is no clear cut legal rate. In these cases, we assume that the rate is the same for all (c,s,u), and hence the total tax revenues are allocated to (c,s,u) in proportion to the values of these flows in total tax base for the relevant tax type. Table 3 reports the tax bases and tax rates for the allocation of non-VAT commodity taxes.

Table 3. The allocation of non-VAT commodity taxes

Tax type	Allocated to		
	ORANI-IT-F Commodity	Source[16]	Tax payers[17] and tax rates
Excise duty on mineral oils and derivatives	Refined petroleum and coke	All	All users. Assumed higher rate for households and Hightax users.
Tobacco tax	Foods, beverages and cigarettes	All	Households
Tax on spirits	Foods, beverages and cigarettes	All	Households
Tax on beer	Foods, beverages and cigarettes	All	Households
Tax on gambling	Art, library and betting	All	Households
Provincial tax on motor vehicle insurance	Insurance	All	All users, uniform rate on the assumed proportion of insurance services used for insuring motor vehicles.
Provincial surcharge on electricity tax	Electricity and Gas	All	All users, assuming higher rate for households and Postal services.
Public vehicle register (PRA)	Motor vehicles, Legal and accounting services	All	All users, uniform rate.
Special tribute on landfill	Waste treatment	All	All users, uniform rate.
Electricity tax	Refined petroleum and coke Electricity and Gas	All	All users, assumed higher rate for households.
Tax on natural gas	Refined petroleum and coke, Mining, Electricity and Gas	All	All users, assuming higher rate for households.
Tax on non-condensable gases	Refined petroleum and coke	All	Uniform rates on Mining, Refined petroleum and coke, and Electricity and Gas industries.
Municipal taxes on advertising and billboards	Publishing, Media and Film, Advertising	All	All users, except Agriculture, Fishing and Forestry. Uniform rate on the assumed shares of the use of publicity that are taxed
State mark sales	Foods, beverages and cigarettes	All	All users, uniform rate.
Excise tax on imported sugar	Agriculture and Foods, beverages and cigarettes	Imp	Households.

[16] In this column, "All" stands for all sources: domestic or imported. "Imp" stands for "Imported".
[17] In this table, "All users" and "Industries" exclude the "Domestic services and own-production" sector, because the tax data show that there are no tax collection from this sector.

Tax type	Allocated to		
	ORANI-IT-F Commodity	Source[16]	Tax payers[17] and tax rates
Special taxes on products	Furniture and Other Manufactures, Health, Other Personal Services	Imp	All users, except households, uniform rate.
Registration fee	Legal and Accounting, Real Estate,	All	All users, assuming higher rates for the Hightax industries.
Stamp duty	Legal and Accounting, Electricity and Gas	All	All users, assuming higher rates for some Hightax industries.
Mortgage duty	Real estate, Legal and accounting, Insurance services	All	All users, uniform rate.
Tax on land and property use right transfer	Real estate, Legal and accounting, Mining, Agriculture and Forestry	All	All users, uniform rate.
Stamp and registration duty	Legal and accounting, Insurance, Financial services,	All	All users, uniform rate.
Contribution to building concessions	Construction	All	All users, uniform rate.
State duties on public shows	Art, library and betting, Sports and Recreation, Furniture and Other Manufacturing	All	Households, Hotel and Restaurants, Publishing, Telecommunication, Financial services, Insurance, Advertising, Other Professional Services, Travel Services, Art Library and Bets, Active Membership Organization.
Special rights on mineral water	Foods, beverages and cigarettes	All	All users, uniform rate.
Slaughter house rights	Foods, beverages and cigarettes	All	All users, uniform rate.
Rights of the National Rice authority	Agriculture	All	Households.
Miscellaneous income of the state monopoly	Foods, beverages and cigarettes; Paper products, Chemicals, Electric Equipment	All	All users
Tourist tax	Hotels and restaurants; Travel services	All	Households
Tarrifs:			
Border surcharge on mineral oils	Refined petroleum and coke	Imported	All users. Assumed higher rate for households
Surtax border (excluding mineral oils)	Foods, beverages and cigarettes	Imported	Households
Duties on EU imports	All commodities with positive net tax in the Supply table	Imported	All users, uniform rate.

These tax bases and rates rely on our current understanding of Italian tax legislations and on the tax values given in the SUT. For example, we initially assume a uniform rate of the Excise duty on mineral oil and derivatives on the consumption of refined petroleum products by all industries. However, the Supply table shows zero tax revenues for the industry "Domestic services and own-production". Hence we exclude this industry from the base of the tax. For the same reason, this industry is excluded in the calculation of all taxes. Higher rates for some industries are assumed for which the tax data from the USE tables at basic and purchasers prices show higher average tax rate across all tax types. These include Post, Education, Financial services, and Health. In Table 3 we call these industries Hightax users.

The resulting four-dimensional net commodity taxes matrix must satisfy the following conditions: total net tax revenue for each commodity, summed over sources, users and tax types, must equal the value of the column "Net taxes less subsidies on products" in the Supply table; total net tax revenue for each user, summed over commodity, sources and tax types, must equal the difference between total commodity consumption by user in the Use table purchasers' prices and those in the Use table at basic prices; the total value of each tax type or subsidy, summed over commodity, sources and users, must equal government statistics for the tax type or subsidy.

Keeping the commodity subsidy unchanged, we RAS the initial commodity tax matrix so as to satisfy the three conditions listed above. We then combine it with the subsidy matrix to arrive at the matrix required for the extended ORANI-IT database.

2.5 The subsidies matrix

As taxes in the SUT are net of subsidies, data on commodity and production subsidies are required. Available data on subsidies consist in: revenues for total subsidies by 37 aggregate sectors in the economy[18]; and sub-totals of subsidies on commodity and on production, that correspond respectively to 12,444 euros millions and 8,584 euros millions. These data come to represent our targets.

The creation of the subsidy matrices on products and on production involves two tasks: splitting total subsidies by 37 sector into subsidies on 37 commodity, and subsidies on 37 production industries; and then allocating the resulting subsidies to 63 commodities and 63 industries in ORANI-IT. More in details, we create initial matrices for subsidies on products and on production for 37 sectors, by using the reported subsidy data and some assumed shares[19] of subsidies by subsidy-type in each sector, as presented in Table 4. We then use a RAS procedure[20] to adjust the initial matrices, so as to ensure they meet the targets described above.

Finally, we allocate subsidies by 37 sectors to 63 commodity and 63 industry, by multiplying the subsidies for 37 sectors by the shares of 63 commodities and 63 industries in the corresponding 37 sectors.

[18] ISTAT, Conti ed aggregati economici delle Amministrazioni pubbliche: Tavola 19 - Contributi alla produzione erogati dalle amministrazioni pubbliche e dall'Unione Europea per branca di attività economica, anno 2008.
Downloaded at http://www.istat.it/it/archivio/63156).

[19] We base an initial disaggregation of the total value of each of the 37 subsidies by subsidy-type on initial guesses, made up on the basis of gathered information on the categories of subsidies granted in Italy, as well as on ISTAT data on subsidies by 9 aggregated industries for 2000, found at: Metodologia di stima degli aggregati dei conti nazionali a prezzi correnti. Anno base 2000", Prospetto 3.25 and 3.25 bis, ISTAT.
Downloaded at http://www3.istat.it/dati/catalogo/20120207_00.

[20] In preparing data for a CGE model, the need often arises to adjust a matrix so that it sums to given row and column totals. The RAS method, first developed by Stone (1961) on an economic ground, among others, such as the residuals sink and Stone-Champernowne-Meade (SCM) methods, meets this need. The RAS procedure sequentially adjusts rows and columns in a proportional way, by means of a multiplicative scale factors, until both of them add up to given targets. In doing so, the RAS method features two properties bear noting: signs and zero flows are preserved. Generally the procedure converges after a reasonable number of iteration, however in the literature there are examples of non-convergence when the matrix is too sparse.

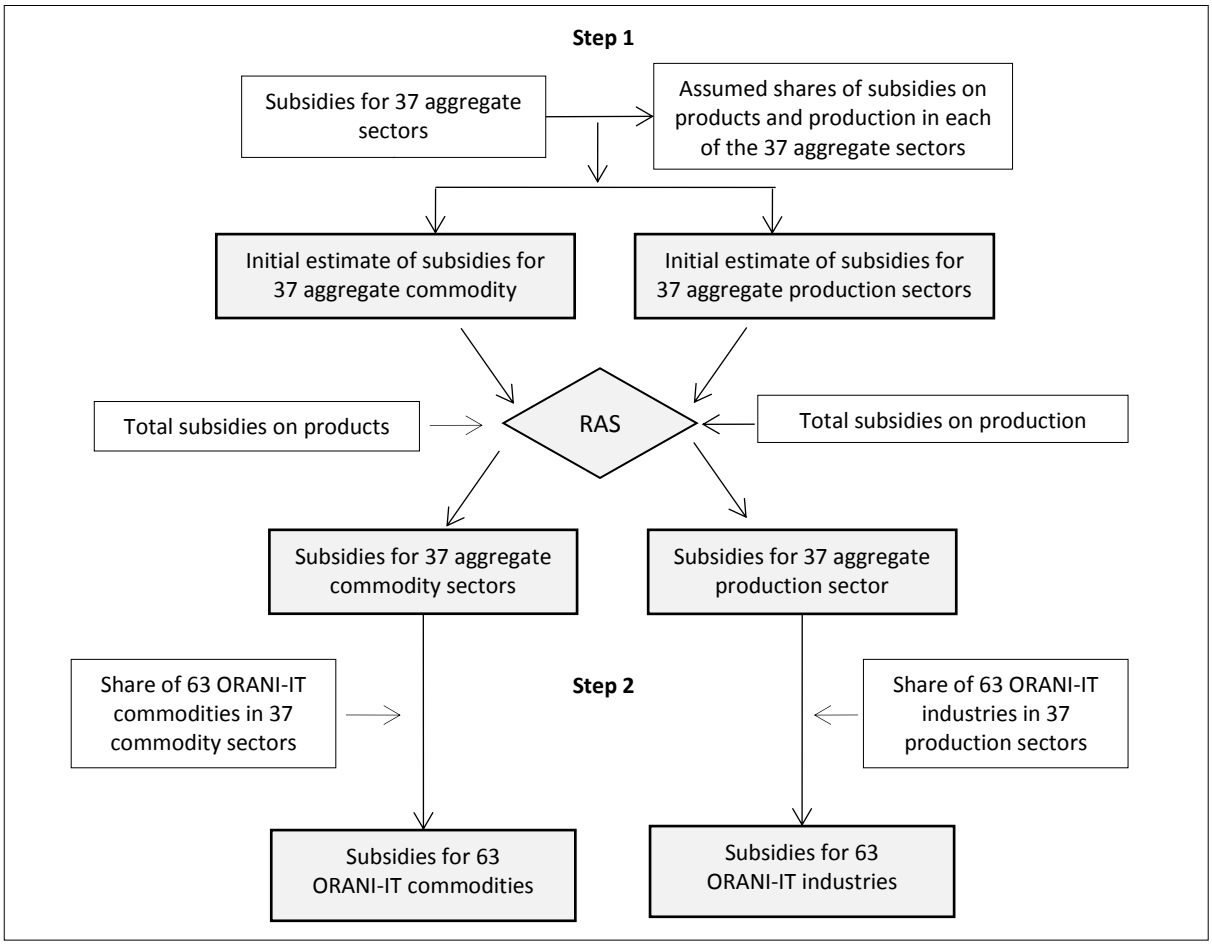
Table 4. Subsidy by 37 aggregate sector (EUR million)

Sector	1.Total subsidy	Assumed proportion allocated to	
		2.Products	3.Production
Agriculture, forestry and fishing	4,310	0.2	0.8
Mining and quarrying	8	0	1
Manufacture of food products, beverages and tobacco products	984	0.5	0.5
Manufacture of textiles, wearing apparel and leather products	107	0.87	0.13
Manufacture of wood, paper and publishing	88	0.5	0.5
Manufacture of coke and refined petroleum products	7	0.9	0.1
Chemicals	57	0.8	0.2
Pharmaceuticals	17	0.5	0.5
Rubber and Plastic and other non-metallic mineral products	71	0.8	0.2
Manufacture of basic metals, manufacture of fabricated metal products, except machinery and equipment	178	0.8	0.2
Manufacture of computer, electronic and optical products	40	0.8	0.2
Manufacture of electrical equipment	34	0.8	0.2
Manufacture of machinery and equipment n.e.c	133	0.4	0.6
Manufacture of transports	162	0.3	0.7
Manufacture of furniture; equipment repair and instalation; other manufacturing	58	0.8	0.2
Electricity, gas, steam and air conditioning	29	0.85	0.15
Water and waste management	51	0.2	0.8
Construction	11	0.6	0.4
Wholesale and retail trade; repair of motor vehicles and motorcycles	978	0	1
Transportation and storage	10,828	0.9	0.1
Accommodation and food service activities	71	0.6	0.4
Publishing activities and media film	408	1	0
Telecommunications	69	1	0
Computer programming, consultancy and related activities; information service activities	0	0	1
Financial and insurance activities	0	0	1
Real estate activities	173	1	0
Legal and accounting activities; activities of head offices; management consultancy activities. Architectural and engineering activities; technical testing and analysis	1	1	0
Scientific research and development	9	1	0
Advertising and market research	12	1	0
Administrative and support service activities	532	0.5	0.5
Public administration and defence; compulsory social security	0	0.3	0.7
Education	1,525	1	0
Health services	9	1	0
Social work activities	6	1	0
Arts, entertainment and recreation	57	1	0
Other services	1	1	0
Activities of households as employers; household own-production	0	0	1
Total	21,024	0.592	0.408

(Source: ISTAT, Conti ed aggregati economici delle Amministrazioni pubbliche: Tavola 19 - Contributi alla produzione erogati dalle amministrazioni pubbliche e dall'Unione Europea per branca di attività economica, anno 2008, http://www.istat.it/it/archivio/63156)

The entire procedure is illustrated in Figure 3. In the figure, highlighted rectangular boxes indicate outputs, other rectangular boxes indicate inputs, and diamonds indicate calculation procedure.

Figure 3. Steps in the creation of subsidy matrices



2.6 The production taxes matrix

Production taxes are allocated to different industries based on tax legislation, as reported in Table 5. First, initial estimates are made for industry-specific production taxes by multiplying the tax rates with the tax base, which in most cases, are industry value added. The revenue from production tax type levied on industry I, $PTAX_t^{pt}$, is calculated as:

$$PTAX_t^{pt} = \frac{REV^{pt} * TBASE_i^{pt} * LR_i^{pt}}{\sum_{i \in IND} TBASE_i^{pt} * LR_i^{pt}} \quad (2)$$

Where:

- REV^{pt} is total revenue from production tax type as reported in government statistics (Table 2);
- $TBASE_i^{pt}$ is the tax base on which the tax pt is levied. Typically, it is the total industry pre-production tax production costs. For some taxes, such as the Regional tax on productive activities, the tax base is industry factor costs (hereafter value added).
- LR_i^{pt} is the legal rate of the tax pt on industry i.

As can be seen from Table 5, for many taxes, the rate is assumed to be uniform across industries.

Table 5. Allocation of production taxes

Tax type	Industries, tax rates and tax base[21]
Regional tax on productive activities (IRAP)	Most industries: 3.9%; Agriculture, Forestry and Fishing: 3.75%; Public administration: 8.5%; Insurance: 5%; Financial services: 4.75%; other financial services: 5.3%. Base: industry factor costs.
Municipal property tax (ICI)	All industries, uniform rate. Base: industry capital and land rentals.
Franchise tax	All industries, uniform rate. Base: industry costs.
Rights of chambers of commerce	Agriculture, Fishing, Foods beverages and cigarettes, TCF, Wood products, Paper products, Printing, Refined petroleum and coke, Chemicals, Pharmaceuticals, Rubber and plastic, Other non-metal products, Basic metals, Fabricated metal products, Electronics, Electrical equipment, Other machinery, Motor Vehicles, Other transport equipment, Furniture and manufacturing n.e.c., Equipment repair, Car trade, Wholesale trade, Retail trade. Uniform rate. Base: Industry costs.
Other taxes on production	All industries. Uniform rate. Base: Industry costs.
Italian television tax	Media and films.
Regulatory authority for Electricity and Gas	Electricity and gas
Notarial fee	Legal accounting services. Base: Industry costs.
Other special revenues from tax on products	All industries. Uniform rate. Base: Industry costs.
Environment tributes	All industries. Uniform rate. Base: Industry costs.
Motor vehicle duty paid by enterprises	All industries. Uniform rate. Base: Industry costs.
Refund on the duties paid on the import of ferrous material for the production of goods for export	Fabricated metal products, Other machinery, Motor vehicles, Other transport equipment, Refined petroleum and coke, TCF. Uniform rate. Base: Industry costs.
Carbon tax	Mining, Refined petroleum and coke. Uniform rate. Base: Industry costs.
Rights on provincial tourism	Hotels and Restaurants; Travel services. Uniform rate. Base: industry costs.

After allocating the production taxes across industries as described above, we then use the RAS procedure to ensure the final net production tax matrix meets the following constraints: the gross value of production taxes by industry must equal the "Other taxes on production" vector in the Use table summed with subsidies on production, as calculated in Section 2.5; and the revenue of each tax, summed over industries, must equal government statistics, reported in Table 2.

The result of the RAS procedure is the matrix of gross production matrix, which is then combined with subsidies to obtain the V1PTAX matrix by industry and extended tax type.

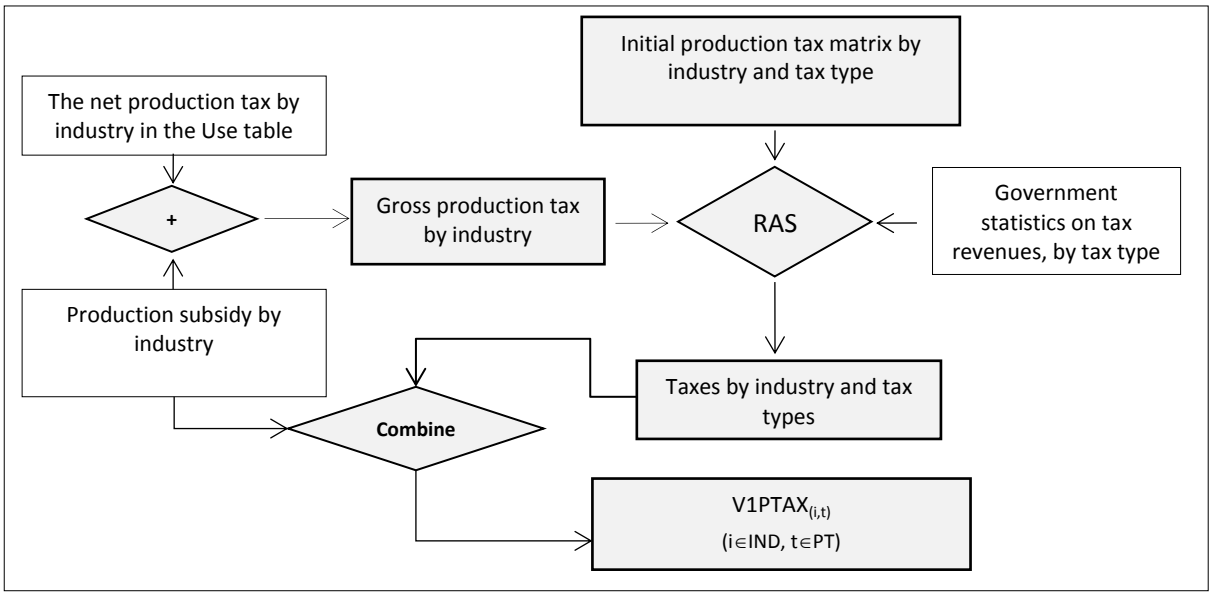
After the creation of new tax matrices, the database is slightly unbalanced. We rebalance it using the Adjuster procedure, which is described in the item TPMH0058, available at http://www.copsmodels.com/archivep.htm[22].

[21] Industries are 63 ORANI-IT industries, except the "Domestic services and own-production" sector.

[22] The adjuster procedure aims at adjusting a newly-constructed CGE data base so that it satisfies some required balance conditions and accommodates the particular data structure of ORANI-IT. Defined as a proportional scaling approach, the adjust procedure has a number of attractions which suit the CGE structure: changes to flows are proportional to their original value, zero flows remain at zero, it is rare for flows to change sign, and cost and sales shares, which underlie CGE simulation results, are changed as little as possible. For each constraint we wish to hit and

The procedure to create the final production taxes matrix is reported in Figure 4.

Figure 4. Creating final production tax matrix



3 The value-added-tax (VAT) matrix

As shown in table 1, the Value-Added-Tax (VAT) accounts for over half of all revenues from commodity taxes, and for over forty per cent of all indirect taxes. Given the current and potential weight of VAT in the government revenues collection, we put a special effort into its modelling, in order to correctly reproduce its complex structure - made of multiple tax rates, exemptions, refundability factors and compliance rates - that makes the VAT incidence greatly differ between users and commodities.

3.1 The EU VAT legislative framework

The Italian VAT legislative framework[23] incorporates principles stated in the European common VAT System Directive (2006/112/EC). To picture the legislative framework, we briefly recall key articles of the EU VAT legislation. Reporting Art. 2(2): "*The principle of the common system of VAT entails the application to goods and services of a general tax on consumption exactly proportional to the price of the goods and services...*". The tax is designed to be borne ultimately by final consumers. Article 168, in fact, recognizes "*...[the right of deduction] of the amount of VAT directly borne out of the various cost components of the production and distribution process before final consumption*. However, art. 168 applies only to taxed transactions of taxable subjects. Hence, exemption of certain sectors and of certain goods and services may prevent firms from deducting the entire amount of VAT paid on inputs. These input taxes cause the so called "tax cascading effect", with positive tax rates borne by all producers using exempt goods.

for each balance condition that must be enforced, we include an endogenous or slack variable which adjusts so that the constraint is satisfied. Associate scale factors with each matrix define the transformation to be applied. In terms of comparison, the approach suggested here overcomes a key disadvantage of other RAS and other iterative scaling approaches, by handling a range of different targets. Contrarily to the RAS method, where each scale factor is adjusted so as to meet one constraint only, the Adjuster procedure simultaneously applies all the constraints and determines all the multipliers, taking full account of all interactions. In that sense it is more efficient, although it does require solution of a linear system, of rank similar to the number of constraints.

[23] Istituzione e disciplina dell'imposta sul valore aggiunto, DPR 633/72.

If the refundability issue is spread in other VAT systems, a special framework has been set up for public bodies within the EU legislation. Article 13(1) of the VAT Directive sets a dispensation to the general principle that every supply is taxable for VAT: "*...[government authorities and bodies] shall not be regarded as taxable persons in respect of the activities or transactions in which they engage as public authorities..".* Closely related is Article 132, which lists exemptions for certain activities in the public interest. Examples are medical care, education, public broadcasting, etc. It follows that, when an activity carried out by public bodies falls within the scope of VAT but it is exempt, or when is outside the scope of tax, public producers cannot claim input VAT, with the result of paying a positive rates on public goods bought from a taxable or non-exempt seller. This means that in those sectors, which are not state monopolies, but are open to private service offering (which is taxable), the missing input VAT deduction causes distortions on the input-side, such as self-supply bias over outsourcing, disincentive to invest, tax cascading. Moreover, on the output-side, when the public sector sells a public good on the market, unlike the private supplier, it doesn't charge VAT on the final price, which results in a distortion of a level-playing field.

From the aforementioned articles, it follows that despite VAT is designed as a consumption tax, its burden is effectively also borne by non-taxable and tax-exempt agents, as well-recognised by the relevant literature[24].

The current VAT arrangements for cross border supplies of goods stand out as being a weakness of the EU legislation. Under the current EU VAT system, the taxation of trade features a differentiate discipline for intra-Community and extra-Community trade, with a direct implication in term of VAT currently remitted on exports at the borders. Exports of goods from the Community to third Countries are zero-rated. The zero-rated supply results in no residual VAT in the final price, but still allowing firms to deduct the full amount of VAT paid on inputs. For intra-EU trades, the tax regime for business-to-business trade in goods is regulated by the destination principle, according to which the VAT payment is due by the taxable person in the member State where the good arrives. However, with no borders, firms are left responsible for remitting net VAT on the full value of their output sales, creating issues for compliance. By contrast, intra-EU supplies to final consumers make the implementation of the destination principle difficult, so that the relative discipline falls into two broad categories. For cross-border shopping and some sales taxed according to the origin principle, the regulation equates intra-Community supplies to national supplies, so that exporters ends up charging the national tax rate on their sells[25]. For distance selling, the seller is required to register for VAT in all member States to which it sells and to account for the destination country rate. However, this requirement applies only above a certain threshold. Below the threshold the seller can choose whether to register or whether to account for VAT according to the origin principle. We did not explicitly account for the rules governing the trade in services. However, at the present the trade of services has increased rapidly, so some rules has been set up to account for services. In particular, business-to-business trade follows the place of supply rule, which means the customer's place of establishment. On the contrary, the default place of supply for business-to-consumers services is the supplier's place of establishment.

The legislative overview has shed light on several weaknesses of the current VAT system, noting that if the problem related to exemptions is common to many other VAT systems, the non-taxable public sector and the differentiate taxation of exports are specific of the current European VAT framework.

[24] The issue arising from tax-exempt agents was first explored analytically in Gottfried and Wiegard (1991), who found that the VAT was paid by all users, not just by households,. The authors found that in Germany in 1984, 63% of total VAT revenues fell on consumption expenditure, 21% on intermediate products and 16% on inputs to capital formation. Giesecke and Tran (2010) found a similar pattern for Vietnam, where the VAT collections from households, production and investment in 2005 were 63%, 28% and 8% respectively.

[25] See VAT on traders, http://ec.europa.eu/taxation_customs/taxation/vat/traders/intra_community_supplies.

3.2 The Value-Added-Tax model

In this section an explicit and all-embracing VAT model for Italy is developed. We expand on the comprehensive and general VAT framework by Giesecke and Tran (2010, 2012), which models multi-production, multiple VAT rates, multiple VAT exemptions, differential VAT registration rates, undeclared imports, unclaimed VAT on tourist's purchases and general and transaction-specific compliance rates. Departing from the original work, we accommodate features of the Italian VAT system, namely: the no-taxable public sector, and the differentiate taxation of intra-Community and extra-Community exports.

3.2.1 Legislative rates

The fiscal legislation represents the starting point for the allocation of tax revenues, with information about tax rates, tax payers and tax bases. Differences in legislated VAT rates across commodities and users are represented via $LR_{c,u}$, a matrix of legislated VAT rates on sales of commodity c to user u. The modelled economy assumes 130 users, comprised of 63 industries, 63 investors and four final users, namely: households, export, government and stocks[26]. Therefore, we evaluate a 63 commodity x 130 users $LR_{c,u}$ matrix, through careful inspection of information on Italian VAT legislation (Istituzione e disciplina dell'imposta sul valore aggiunto, DPR 633/72), which sets values for $LR_{c,u}$ at 0, 0.04, 0.1, and 0.2.

Legislated tax rates are specified for commodities at a more disaggregated level than that in our model. For example, ORANI-IT has one Agriculture commodity, which contains different agricultural products, which in turn bear different VAT rates. Where the legislated tax rates are more disaggregated than the disaggregated commodity level in the model, a weighted average tax rate is computed, based on a guessed share of each commodity component. The resulting average legal VAT rates differ across users, reflecting differences in the commodity composition of their purchases.

Lastly, published data, even with very high levels of commodity and user detail, aggregate transactions with different tax and exemption statuses under the legislated VAT code, altering the effective tax rate indicated by law.

3.2.2 Legal and de-facto exemptions and the scope of VAT

As discussed in section 3.1, Italy allows VAT exemptions for certain services[27]. We model the legal exemptions via $LEX_{c,s,u}$, a coefficient measuring the share of sales of commodity c from source s to user u that are VAT exempt by law. For most flows the coefficient is zero. It has a non-zero value where the tax code exempts from VAT some or all of the sales of commodity c to user u. In particular, partial exemption, $0<LEX_{c,s,u}<1$ derives from data aggregation.

Apart from legal exemptions, commodities can be exempt in practice if: the domestic producers of the goods do not register for VAT; the producer is out of the scope of VAT; and/or the imported goods enter the country informally, i.e. they are not declared for tax purposes. De facto VAT exemptions for commodities c from source s (imported or domestic) is denoted as $DEX_{c,s}$. These de factor exemptions involve several features of the real economy. We discuss them in some detail below.

The de facto exemptions of informal imports, $DEX_{c,import}$, is simply the proportion of imports not declared for tax purposes, IM_c.

$$DEX_{c,import} = IM_t \qquad (3)$$

[26] The modelled users derive from the model's database, whose structure is briefly described in section 2.2. Please note that here "stock" is a different label for inventories.

[27] Financial and insurance services, transactions related to the collection of taxes, lotteries, betting and gaming, certain transaction relating to civil dwellings and properties, postal services, cultural services, and certain real estate transaction.

The de-facto exemption of domestically produced goods, $DEX_{c,dom,}$ depends on the degree by which industries producing the good register for VAT.

$$DEX_{c,dom} = 1 - \sum_{i \in IND} SJ_{c,i} REG_i \quad (4)$$

Where:

- $SJ_{c,i}$ is industry i's share of total output of commodity c;
- REG_i is the proportion of industry i's production represented by firms registered for VAT or within the scope of VAT. The coefficient is further described in the next section.

Taking the maximum value between the legal exemption rate $LEX_{c,s,u}$ and the de facto exemption rate $DEX_{c,s}$, the model captures the differential effective exemptions for commodity c from source s to user u, denoted by the exemption factor $EX_{c,s,u}$.

$$EX_{c,s,u} = MAX[LEX_{c,s,u}, DEX_{c,s}] \quad (5)$$

For example, Italy's VAT law stipulates that lotteries are exempt, i.e. $LEX_{Lotteries,s,u} = 1$, and via (5) $EX_{Lotteries,s,u} = 1$ regardless of how many producers of financial services register for VAT (that is, regardless of the value for $DEX_{Lotteries,dom} = 1$).

3.2.3 Registration rate

The registration rate is a key coefficient, as it allows for the modelling of the de-facto exemptions and, in the present framework, also of the scope of the VAT. This latter represents a big concern in the EU legislation and its modelling represents a main contribution to the original model by Giesecke and Tran (2010, 2012).

$$REG_i = (1 - NRI_i)(1 - NTPS_i) \quad (6)$$

As equation (6) shows, the registration rate depends on:

- NRI_i, the proportion of industry i's output produced by businesses which do not register for VAT, either because operating informally or because of the minimum regime; and
- $NTPS_i$, the proportion of industry i's output produced by public bodies, which are non-taxable.

According to official data on tax revenues "Activities of households as employers; undifferentiated goods and services producing activities of households for own use" industry records zero payments. The plausible assumption that this industry does not register for VAT, i.e. operates informally, is made. In model terms this translates in setting the coefficient NRI_i for that industry equal to 1. The same coefficient captures the VAT registration threshold, that in the Italian case applies to individuals that generate a turnover below 7.000 euro per year. We set NRI_i = 0.1 for that sectors, which tend to have small enterprises, such as agriculture, forestry and fishing.

Via the inclusion of the new coefficient $NTPS_i$, we allow for the distinction between public and private producers in the supply of public goods. In such a way, we account for the complex VAT treatment of public bodies, set up by Article 13 of the European VAT Directive[28].

[28] We identify the following public goods: education, waste disposal, water, health, social works, post (for the share of USO services, represented by basic letter post and basic parcel post), broadcasting. We also include cultural services, which are taxable but tax-exempt. We assume $NTPS_i$ to be 1 for the public administration industry; $NTPS_i$ 0.6 for education, health, social works, post and art, library, betting industries; $NTPS_i$ 0.4 for waste treatment and water; and

3.2.4 The VAT treatment of public bodies and exemptions in the public interest

We recall that according to Articles 132 and 13 of the VAT Directive activities carried out by public bodies can be: taxed, within the scope of VAT but exempt, and outside the scope of the tax.

If exemptions in the public interest are captured by the coefficient modelling legal exemptions, LEX; the treatment of activities carried out outside the scope of the VAT, is captured via the inclusion of the coefficient $NPSI_i$ into the existing formula for the registration rate.

The aim is to accommodate into the existing VAT framework those activities within the scope of VAT but exempt and services performed outside the scope of the tax. As a result, we provide a comprehensive VAT model for the EU, enabling the assessment of the taxation of the public sector.

3.2.5 The VAT refundability factor

When producer i buys input c from source s, it pays a VAT rate equivalent to the legislated rate less the exemption proportion applicable to (c,s) and i. Industry i then reclaims this tax, but only to the extent input (c,s) is used to produce non-exempt goods, and even then, only to the extent that firms in industry i are registered for VAT. Industry i's capacity to reclaim VAT paid on inputs is modelled via the refund factor, $REFIND_i$, defined as the proportion of industry i's VAT payments on inputs to production that is refunded by the tax authority:

$$REFIND_i = REG_i \sum_c SO_{c,i} \sum_u SS_{c,u} [1 - LEX_{c,s,u}] \quad (8)$$

On the right-hand side of this formula, first it appears the VAT registration rate, in recognition that only registered firms can reclaim VAT paid on their inputs, then three dimensions of industry i's sales, as described below. First, what the industry produces, captured by $SO_{c,u}$, which computes the share of total output of industry i represented by output of commodity c. Second, to whom the industry sells, through $SS_{c,u}$, which computes the share of total sales of commodity c sold to user u. Third, the extent of non-exempt sale, via $[1 - LEX_{c,s,u}]$.

The Italian VAT system allows for the refund of VAT paid on inputs into creation of fixed assets. The following equation defines $REFINV_{c,s,k}$, as the effective VAT refund rate on inputs of commodity c from source s into capital formation by industry k:

$$REFINV_{c,s,k} = REG_k * \psi_{c,s,k} \quad (9)$$

Where:

$\psi_{c,s,k}$ is the legal refund rate for VAT paid on inputs of (c,s) to capital formation by industry k.

Equation (9) recognizes that the effective refund rate for industry k depends not only on the legal refund rate allowed by the tax authority $\psi_{c,s,k}$, but also on industry k's registration rate. This is assumed not to be the case for the real estate sector, because final consumers cannot claim VAT on their investment. Therefore, no refund is assumed for this industry.

3.2.6 Effective VAT rates

For producers, the effective VAT rates depend on the legal VAT refundability, and on the exemption rate of their outputs. In addition, the calculation of these rates is complicated by the multi-production nature of the economy. In math, the effective VAT rates paid by industry i on intermediate good c can be calculated as the product of the legal rate and the proportion of good that is not exempt, and by the refundability factor:

$NTPS_i$ =0.3 for broadcasting. In assuming these shares we consider the public and private producers' shares of core functions, as formulated by Copenhagen Economics (2013) on the basis of GTAP and Amadeus databases.

$$ER_{c,i} = LR_{c,i} * \left[1 - EX_{c,i}\right] * [1 - REFIND_i] \quad (10)$$

The effective VAT rate on commodity c from source s used in investment in industry k is:

$$ER_{c,s,k} = LR_{c,s,k} * \left[1 - EX_{c,s,k}\right] * [1 - REFINV_{c,s,k}] \quad (11)$$

3.2.6.1 Effective VAT rate of exports

In modelling the effective rate of exports we deal with the differentiate EU discipline puts in place for the taxation of trade, as described in section 3.1. In particular, the modelling differs depending on whether: the trade is intra-EU or extra-EU, the intra-EU trade is towards another producer or a final user, and the intra-EU trade towards consumer is above or below a certain sales' threshold. In addition, exports can still be subject to VAT in case of purchases of domestic goods by tourists or other non-residents.

It follows that the effective tax rate on exports is modelled as the weighted average between the effective tax rate paid by non-residents inside the country and the tax rate paid on exports, which in turn is a weighted average of the effective tax rate paid on exports to VAT registered customers and the rate paid on exports to VAT non-registered customers. Equation (12) expresses this in math:

$$ER_{c,s,exp} = SHNRES_{c,s} * \left[1 - EX_{c,s,hou}\right] * [1 - REFEXP_c] * LR_{c,s,hou} +$$

$$\left[1 - SHNRES_{c,s}\right] * \left[1 - EX_{c,s,exp}\right] * [SHXI_{c,s} * LR_{c,s,exp} + SHXF_{c,s} * LR_{c,s,hou}] \quad (12)$$

Where:

- $SHNRES_{c,s}$ is the share of export sales of commodity (c,s) representing domestic sales to non-resident agents (such as tourists). Italian SUT for 2008 provide the total value of domestic purchases by non-residents. We allocate it among goods which are commonly consumed by tourists, such as foods, beverages and tobacco, clothing and footwear, refined petroleum, pharmaceuticals, electronics, motor vehicles, transports, hotel and restaurants. The resulting shares is 14 percent;
- $SHXI_{c,s}$ and $SHXF_{c,s}$ are the shares of exports to outside of Italy to VAT-registered customers and VAT non-registered customers respectively. These shares were calculated by using the international trade data from the GTAP database for 2007[29];
- $EX_{c,s,hous}$ and $EX_{c,s,exp}$ are the exemption rates on commodity sold to households and to exports respectively;
- $REFEXP_c$ is the proportion of VAT paid by non-residents on purchases of commodity c that is reclaimable under the country's VAT refund scheme. We set the value at 0.9 for all commodities; and
- $LR_{c,s,hous}$ and $LR_{c,s,exp}$ are the legal VAT rates on payable by households and exports respectively.

In summary, we model the VAT collections from exports as comprising of the following three components. VAT payments by non-residents on their purchases in the Country, at the domestic households' effective rates. Recognizing that this represents an application of VAT to exports, Italy provides for some refund of this VAT at the time of the non-resident's departure. Such VAT refund schemes typically only cover a part of the purchases made by domestic non-residents, and even then, many non-residents may fail to claim their full VAT refund entitlement. VAT payments on exports to VAT-registered customers within the EU, and to non-EU countries. These exports are zero-rated. VAT payable on exports to customers in other EU states who are not registered for VAT. These customers pay the same rates as domestic consumers.

[29] Global Trade Analysis Project, Narayana and Warmsley 2008.

3.2.7 Expected VAT revenues

Equations 1 to 12 embody the key features of the VAT system. We use them to estimate the expected tax revenues by multiplying the effective tax rates by the relevant tax base, where the relevant VAT base is the basic value plus trade and transport margins for each of the flows of commodity c from source s to user u:

$$EVAT_{c,s,u} = VATBASE_{c,s,u} * ER_{c,s,u} \quad (13)$$

However, the expected VAT revenues can differ from the actual VAT collections, as reported in government financial statistics, because of a less-than-100% compliance rate. The degree of compliance in the collection of VAT payable on sales of commodity c from source s to user u is denoted by the transaction-specific compliance rate $CRT_{c,s,u}$. Due to lack of data, we assumed an uniform full compliance rate across commodity, source and users. Consequently, the total expected VAT collections in the economy is:

$$EVAT_{tot} = \sum_{u,user} \sum_{c,com} VATBASE_{c,s,u} * ER_{c,s,u} * CRT_{c,s,u} \quad (14)$$

At the moment we only have data on the total VAT collection. The gap between expected and actual VAT revenues is attributed to the economy-wide overall compliance rate, denoted by a common coefficient CR_{gen}. We compute it according the following formula:

$$CR_{gen} = \frac{VAT_{tot}}{EVAT_{tot}} \quad (15)$$

The economy-wide compliance rate is then used to adjust all expected VAT flows, so to ensure that the total values of VAT in our database is the same as that provided in government statistics:

$$AVAT_{c,s,u} = CRT_{c,s,u} * EVAT_{c,s,u} \quad (16)$$

The VAT model, designed in terms of equations, translates into a commodity by user matrix of VAT payments, that is consistent with both published input-output data and the tax code. Our calculations show that in 2008 only 0.6 per cent of VAT collections is from consumption (including private and public consumption and export), 0.35 per cent from production and the residual from investment. The economy-wide compliance rate equals 0.58.

Equations are then integrated into the existing core model. By placing the system of equations that computes the effective tax rates into the model, the following variables are endogenously calculate: effective VAT rates applying to flows of commodity c to user u; and current production refund factors, given (a) exogenously specified values for legislated VAT rates; (b) exemption factors ; and (c) capital formation refund factors.

Table 6. National income accounts

Item	Government		Households		Net payment to RoW	Total economy[30]	How they are included in the model
	Resources	Uses	Resources	Uses			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gross operating surplus (GOS)	27,710	0	689,455	0	0	717,166	Allocated across capital and land income by industry (V1CAP + V1LND) based on government and private shares in the industries. Current adopted values for government shares are: 100% in Public administration, 60% in Education, Waste treatment and Water, and 30% in Elasticity and gas, Land and Water transportation, and Transport services.
Compensation of employees (COE)	0	0	658,890	0	-848	658,890	V1LAB in the model
Net indirect taxes	215,842	16,107	0	0	201	199,936	Already in the model (taxes on products and production)
GDP	**227,445**		**1,348,345**		**-648**	**1,575,143**	Calculated as sum of GOS, COE and net indirect taxes.
Investment income	0	74,696	42,041	-13,696	18,959		Include interest payment, dividends and reinvested earnings. Modelled as payment on net domestic and net foreign liabilities. See discussion in Section 4.2. Items in this row correspond to items number 10, 11, 7 and 2 in Table 10).
Insurance Income	0	0	1,126	0	-1,126		Assumed to accrue to households and to move with value added in the insurance industry
Rents and property rights from deposits	3,721	41	0	3,680	0		Linked mainly to the gross operating surplus (GOS) in the mining industry (80%), and also to the gross operating surplus in all other sectors (20%).
GNI	**156,429**		**1,401,529**		**0**	**1,557,957**	For government and households: calculated as GDP plus net investment income, insurance income and rent and property rights from deposits. For the whole economy: calculated as national GDP plus following net payments to the world: COE, net indirect taxes, investment income, insurance income, rents and property rights from deposit.
IRPEF (Personal income tax)	171,147	0	0	171,147	0		Modelled as a tax on the three following components of household income: (1) labour income after social contribution; (2) the mixed income part of GOS; and (3) pensions and net transfers.
ISOS	13,813	0	0	12,492	-1,321		Modelled as a tax on interest and dividends receivable by households. Interest is the interest payment to households from government domestic debt. Dividends are calculated as net operating surplus (NOS) multiplied with a dividends/NOS ratio.
ICI (building component)	580	0	0	580	0		Modelled as a tax on the value of buildings by all industries. The shares of buildings in industry capital stock are currently assumed to range from 10% for primary industries, 30% for manufacturing and 50% for services. These shares can be adjusted if data become available.
IRES (Corporate income tax)	43,586	779	0	42,807	0		Modelled as a tax on GOS. Note that the ratios of this tax to the value of GOS given (the first row of this Table) are different for government and households (at 2.8% and 6.2% respectively). As the laws stipulate the same tax rate for all industries, this may mean that the proportion of net accounting profit in GOS is lower for government enterprises than for private enterprises. Therefore, we first calculate the same tax rate for all

[30] Calculated for key items only.

Item	Government		Households		Net payment to RoW	Total economy[30]	How they are included in the model
	Resources	Uses	Resources	Uses			
							industries as the ratio of total revenue of this tax to economy-wide taxable GOS. We then use two variables to adjust the IRES revenues for government and households. We think these adjustment variables may reflect the profitability of the two sectors.
Other Direct Taxes	10,518	0	0	10,518	0		This item is an aggregate of miscellaneous taxes, such as tax on licences, on cars, on bets, on life insurance and other taxes on income and wealth. Currently linked to capital income. A more detailed modelling of this tax may link some of its components to household income.
Social Contributions	215,809	0	0	215,589	-220		Linked to compensations of employees
Social Benefits	0	277,183	278,844	0	-1,661		There is no theory to determine this item. We assume that it moves with nominal GDP
Insurance transfers	71	883	516	531	827		Includes net premium and compensation from insurance. Assumed to move with value added in the insurance industry.
International aids	0	936	0	0	936		There is no theory to determine this item. We assume that it moves with nominal GDP
Transfers to EU	0	10,701	0	0	10,701		There is no theory to determine this item. We assume that it moves with nominal GDP
Other Current Transfers	18,139	11,070	-12,742	0	5,672		There is no theory to determine this item. We assume that it moves with nominal GDP
Disposable Income	**328,542**	**0**	**1,214,483**	**0**	**0**	**1,543,025**	For government and households: calculated as GNI plus net revenues from direct taxes and transfers. For the whole economy: calculated as national GNI less net transfers to RoW.
Final Consumption	0	315,406	0	932,007	0		Already in the model as aggregate government and households consumption.
Gross Saving	**13,136**	**0**	**282,476**	**0**	**0**	**295,612**	Calculated as the difference between Disposable income and Final consumption.
Depreciation	0	29,149	0	225,454	0		Should have been calculated from the values of capital stock and depreciation rates. However, we do not have these data in our current comparative statics model. Therefore, we model this item as a proportion of capital rental.
Net Saving/Balance on current transaction with RoW	**-16,015**	**0**	**57,021**	**0**	**45,224**	**41,009**	For government and households: this is "Net saving", calculated as the difference between Gross saving and Depreciation. For RoW, this is "Balance on current transaction with RoW", calculated as the sum of net current transaction payable to RoW, less the balance of trade (not shown in this Table).
Capital Taxes	488	0	0	488	0		Assumed to be moved with primary factor income. Payable by households only.
Investment Grants	0	20,420	21,337	0	-917		Treated as a subsidy on investment
Other capital Transfers	0	126	68	0	58		Treated as a negative tax on capital
Change in Net Assets	**-6,9224**	**0**	**303,392**	**0**	**44,366**	**296,471**	Calculated as Gross saving plus net capital taxes, net investment grans and net other capital transfers.

Item	Government		Households		Net payment to RoW	Total economy[30]	How they are included in the model
	Resources	Uses	Resources	Uses			
GCF	0	35,225	0	305,611	0		Already in the model as the sum of investment and changes in inventories. To allocate the aggregate GCF to government and households, we use the share of government in each industry to calculate the initial value of government investment, and then scale the data to meet the NA data. Household GCF is a residual.
Asset Acquisition	0	-46	0	1,089	1,042		There is no theory to determine this item. We assume that it moves with nominal GDP.
Net Lending/borrowing requirement	**-42,101**	**0**	**-3,307**	**0**	**45,408**	**-45,408**	Calculated as the difference between Change in Net Assets and (net GCF + net asset acquisition). For the whole economy, the change in net borrowing requirement with the World in the change in the economy's net foreign liabilities.

4 Modelling national income accounts

The next step consists in deriving the national income accounts for the institutional agents, by referring to the economic sectors accounts, released by ISTAT for 2008[31]. Table 6 reports the national income accounts as implemented in the model, which differ from the published ISTAT data in four main aspects.

First, because the ORANI-IT model recognises only two NA sectors, namely government and households, we group together the data for households, NPHIS, financial and non-financial institutions under the "households" category. Values for this new households account are netted out to account for the internal flows between households and industries.

Second, we disaggregate the item "taxes on income" into more detailed direct taxes. Data on direct tax revenues are provided by ISTAT in "Accounts for general government"[32]. Starting from the published data, direct taxes have been aggregated following a legal schema, according to which households pay IRPEF and ISOS, and industries pay IRPEF or IRES, depending on their legal structure. In particular, the proportion of households in the total IRPEF payment was deducted by recalling data on IRPEF fiscal declaration, released by the Ministry of Economy and Finance[33]. Other taxes were computed as residual, using data on households' total indirect tax payments provided by ISTAT.

Third, we net out the values of RoW resources and RoW uses to get only the value of net payment to RoW. This is because we only want to model Italy's net transactions with the world.

Finally, we model only key items which have non-zero values. For example, we do not model the sub-items "by the government" and "from other sectors", which appear as a sub-item under many items in the NA, but with only zero values.

Following the economic process, transactions, in goods and services and distributive transactions, are shown in a sequence of accounts ranging from production, income generation and income redistribution, through the use of income for consumption and saving, and through the investment, to financial transactions such as borrowing and lending. Sector accounts are reproduced in the model with roughly the same break-down of the official data, leading to the computation of key economic indicators for the institutional agents, such as Gross Domestic Product (GDP), Gross National Income (GNI), disposable income and net lending.

More in details, government outlays have an impact on GDP, as they affect the demand directly through the purchase of intermediate consumption goods, or indirectly via transfers and subsidies. Government incomes encompass final revenues and financial transactions. Final revenues include: capital incomes, interests income, indirect taxes, direct taxes and social contributions; international aids, current transfers, tax on capital, investment grants and other capital transfers from household. Financial transactions capture changes in the governments' net liabilities and represent the difference between government revenue and expenditure. Turning to households, disposable income represents the key indicator, which consists of: primary factors income, social benefit incomes, social security payments, direct taxes and other incomes. Household financial assets consists of saving (net of investment) augmented with capital transfers.

Once all of the relevant national account items have been identified, we reproduce them into the model. Specifically, we compute resources and uses back in terms of a tax base times an implicit tax rate, linking them to the relevant variables in the model, so to reconcile the respective values. In order to impute the

[31] Available at http://www.istat.it/it/archivio/58448.
[32] Conti ed aggregati economici delle Amministrazioni pubbliche: Table 12, http://www.istat.it/it/archivio/63156.
[33] Available at http://www.finanze.gov.it\/stat_dbNew\/index.php.

resulting economic flows from domestic production across domestic agents, we assume shares of government ownership in each of the industry. Receipts and expenses relating to various forms of property income, such as interest, dividends and (land) rent; and incomes imputed to households on their reserves with (life) insurance corporations and pension funds are carefully modelled. In particular, interest payments and dividends are reconciled with net foreign liabilities and domestic debt. The procedure is explained in the remainder of this section.

4.1 Investment income items, net foreign liabilities and government domestic debts

The national income account shows investments income, which is comprehensive of interest payments, dividends and reinvested earnings, for each institutional agent, but no information is given regarding the flows between the agents. For modelling purpose, these flows are reconstructed, relying on data on the stock of debt and the net investment foreign position, and on plausible assumptions. We gather data on total government and private net debt and on total and government net international investment position from the Bank of Italy's database (BIP on-line: financial account by institution and international investment position for 2008). We then compute the private net investment position and the domestic debt as residuals.

Table 7. Data and calculation of stock and interest payments on foreign and domestic liabilities

	Item	Value[34]	Source
A.	*Data and calculation of stock and interest payments on net foreign liabilities*		
(1)	Italy's net foreign liabilities (NFL)	380,738	BIP on-line: financial account by institution and international investment position for 2008
(2)	Total interest payment on NFL	**18,958**	BIP on-line: financial account by institution and international investment position for 2008
(3)	Implied interest rate on NFL	4.98%	=(2)/(1)
(4)	Government net foreign debt	655,802	BIP on-line: financial account by institution and international investment position for 2008
(5)	Private NFL	-275,064	= (1) –(4)
(6)	Interest payment on government NFL	32,655	= (4) * (3)
(7)	Interest payment on private NFL	**-13,696**	= (5) * (3)
B.	*Data and calculation of stock and interest payment on government domestic debt*		
(8)	Government net debt (foreign + domestic)	1,474,298	Financial account – stock at 31/12/2008, by institutional sector
(9)	Government domestic debt	818,497	= (8) – (4)
(10)	Government net investment income payment	**74,696**	National income accounts
(11)	Government interest payment on domestic debt	**42,041**	=(10) – (6)
(12)	Implied interest rate on domestic debt	5.14%	= (10) / (9)

[34] EU m, unless otherwise indicated.

We model investment income items in the national accounts as the product of the relevant stock and interest rate. Specifically: government pays interest on its foreign debts and domestic debt, households pays investment income (which include both interest and dividends) on its net foreign liabilities, and receive interests on its loan to government, RoW receives investment income from both government and households on Italy's net foreign liabilities. These items (denoted by bold) are included in the "Investment income" row of Table 6.

4.2 Direct taxes

Within the national account, direct taxes have been explicitly introduced into the model (Table 6). Using data on tax revenues released by ISTAT[35], we further disaggregate the national account item "Current taxes on income" into several direct taxes, as listed below.

The personal income tax IRPEF, which includes the individual tax charged by the central government together with the regional and local surcharges. The substitute taxes on household capital income ISOS, which includes various financial substitute taxes (with lower rates) on interests, dividends, capital gains and other form of returns. The property tax on buildings ICI. The corporate income tax IRES, which is levied on corporate income, regardless of its nature, of specific forms of corporation. Other taxes, which is computed as a residual, using data on households' total indirect payments provided by ISTAT and includes a miscellaneous of taxes levied on households and industries. Examples are: tax on capital assets, tax on capital gains from enterprise disposal, tax on insurance industry, ILOR, taxes on cars, other taxes on income and wealth, taxes on life insurance and supplement state pension, tax on prizes and winnings, tax on insurance, tax on driving licenses.

Households pay the main income tax IRPEF together with withholding income taxes ISOS, with the aim of differentiating the treatment of specific income types, in particular financial assets income. IRPEF is mostly imposed on labour income at progressive tax rates, but the tax base includes also mixed income and social benefits, after deducting social contributions. However, as the present model specifies a representative household, we consider an implied tax rate. ISOS is modelled considering the domestic government debt and its implied rate of return and the gross operating surplus. Industries pay IRPEF or IRES, depending on their legal structure. In particular, the proportion of households in the total IRPEF payment was deducted by recalling data on IRPEF fiscal declaration, released by the Ministry of Finance[36]. IRES taxable income is represented by the gross operating surplus, for the share of industries that pay proper business taxes, and expenses are allocated between households and government by using government capital shares.

4.3 Modifying the core equations to incorporate new information

Enriching the model with new details requires the modification of the model structure, in order to make the new variables working. As explained in section 2, a tax dimension has been added to the commodity and production tax matrices. Additional shifters with tax dimension are then incorporated in the equations describing the power of tax for commodity taxes, to allow tax-specific shocks. The system of equations composing the core model is presented in the Tablo Appendix.

Next, the full VAT structure explained in the previous sections has been included into the model, empowering the range of applicable simulations, dealing with tax rates, tax base, exemptions, refundability factors, compliance rates. In particular, equations enabling the move from a multiple rate structure to a uniform tax rate have been introduced in order to evaluate the impact of such a reform on the economy.

[35] Conti ed aggregati economici delle Amministrazioni pubbliche: Table 6, ISTAT. http://www.istat.it/it/archivio/63156.
[36] Available at http://www.finanze.gov.it\/stat_dbNew\/index.php.

Thanks to the introductions of the tax dimension, exercises aimed at rebuilding the fiscal system, which can be characterized by an asymmetric structure, can be run. However, when dealing with these simulations directly affected is the government budget. Government account critically depends on collected revenues. Equations for revenue-neutral simulations are then incorporated into the model, to allow simulations where the fiscal burden is switched from one tax to another, with no effect on the government budget.

All equations describing institutional agents' accounts were linearised and added into the model. The incorporation of the national accounts into the model also enables many interesting simulations whereby government and household expenditures can be linked to their revenues or disposable income, which are affected by changes in policies relating to taxes, transfers, and changes to interest rates.

Overall, the model is a powerful tool for policy analysis.

5 Conclusion

This paper extends the national computable general equilibrium model of Italy via the addition of a significant fiscal detail, which consists in the detailed modelling of a full range of direct and indirect taxes. At the methodological level, the paper provides a framework for including a fiscal detail into an existing CGE model. Data on tax revenues are accommodated within the CGE database structure and the full range of indirect taxes are explicitly modelled within the model's theoretical structure, via the inclusion of the tax dimension into the commodity and production tax matrices. The result is an extremely detailed indirect tax matrix by commodity, user, source and tax type, providing a powerful tool for policy analysis.

Within the development of the fiscal detail, the paper enlarges a framework for economy-wide modelling of the value-added tax system specific to the EU. As it incorporates features of the current EU VAT system that are considered significant weaknesses, it provides a comprehensive model of VAT, which enables the assessment of the current EU rules.

The model also features a detailed modelling of national income accounts, where major groups of revenue and expenditure items by government, households, and net transactions with the rest of the world, are linked to relevant economic activities in the core model.

As a result the capacity of analysis of the national model is enriched, allowing for the analysis of a wide range of fiscal policies, tracing their impacts not only on the economy, but also on the government budget, household income and savings, and on the net lending/borrowing position of the nation. Further researches may be pursued in policy simulations.

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