The Government in SNA-compliant DSGE models*

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Abstract

The government size in developed economies expanded remarkably after the Second World War. This growth shaped the role of the government as a key player in the economic activity and the aggregate dynamics of a country. However, the way in which the government is represented in DSGE models is often reductive, containing homogeneous public spending and a few distortionary taxes without clear counterparts in fiscal data. This paper shows how dynamic general equilibrium models can incorporate a detailed government sector as defined in the System of National Accounts (SNA). This government features six types of public expenditures (i.e., the government's intermediate consumption, public wage bill, debt service, public investment, and transfers to households both in-kind and other-than-in-kind), and five distortionary taxes (i.e., consumption tax, capital and labor income taxes, corporate tax and social contributions).

Keywords: Government; Public sector; DSGE models; Government spending; National Accounts; OECD data.

JEL Classification: J24, J31, O33

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1 Introduction

With the development of modern market economies, government spending has represented a small fraction of the economic activity, with the exception of wartime. However, after the Second World War, public expenditures increased significantly, then stopped and have risen again since the 2000s. For example, government spending in the U.S. comprised less than 5% of GDP at the beginning of the twentieth century, but it increased to approximately 40% by the beginning of the twenty-first century. In European countries, the public sector is even larger and public expenditures can easily reach 50% of GDP (e.g. 57% in France in 2016). Broadly speaking, the increase in government size is due to higher demand for goods provided by the government (either private or public goods), welfare services to ageing households, more public intervention in private markets (due to cases of market failures) and lower competition in industrial sectors that matured during the postwar period.

With the increased size of the public sector, we understand that macro models should be more attentive to the role of government in the aggregate economy. Traditionally, the government plays a minor role in DSGE models, where the aggregate dynamics and the steady state are determined by the private agent's decisions (neoclassical and RBC-like models), or by private agents and the Central Bank (New-Keynesian models). In many cases, the government is reduced to exogenously determined spending on goods that is financed either by lump-sum taxes or by a unique distortionary tax on labor income. This practice seems to have not changed with medium-sized DSGE models [Christiano et al. (2005), Smets and Wouters (2007)].

While the previous approach seems a valid representation of actual economies when government spending comprised 5% or 10% of GDP, it can hardly represent today's economies where the government can control half of the resources involved in all the economic activity of a country. Can such models provide accurate assessments of the economic impact of large and heterogeneous fiscal policies? Would the fiscal policy of such a large player greatly affect economic activity? In this paper, we address these considerations by providing a thorough modelling of the government that is based on the System of National Accounts. This framework can be readily embedded in DSGE models, either neoclassical or New-Keynesian, and it will be useful (i) to evaluate the economy-wide impact of specific components of public expenditure and/or specific taxes, and (ii) to provide better assessments of fiscal consolidation measures.

In the literature, there has been much work to analyze optimal fiscal policy in the context of the aggregate economy (normative approach), but comparatively few papers have endowed actual fiscal practice in DSGE models to analyze the impact of public finance from a macro perspective (positive approach). We believe that the normative approach should not be the only framework to analyze fiscal policy, which is determined by politicians, who undeniably respond to a variety of incentives and pursue a wide range of objectives far beyond economic efficiency. A positive approach, therefore, seems to be a necessary companion to the normative approach. For the sake of comparison, the role of central banks and the implications of monetary policy have been extensively studied (see the New-Keynesian DSGE models), and both the normative approach (optimal monetary policy) and the positive approach (models with Taylor rules) have been used.

After the recent public debt crises and their associated fiscal consolidations, there has been a renewed interest in the role of fiscal policy in the aggregate economy. Most of this literature is empirical and focuses on fiscal multipliers [Alesina, Favero, and Giavazzi (2015), Fatás and Summers (2018), Hagedorny, Manovskii, and Mitman (2019), Ilzetzki, Mendoza and Végh (2013), Leeper, Traum and Walker (2017), Philippopoulos, Varthalitis and Vassilatos (2017a,b), Zubairy (2014)]. However, from a theoretical point of view, most DSGE models still rely on the traditional theory of the government, where government spending is accommodated as a lump-sum transfer of a homogeneous good or money to households.[1]

The main drawback of previous modelling is to neglect the role of the government as a producer. Production-related government expenditures can affect both the demand and supply side of the economy; and, therefore, they should be separately identified in general equilibrium models. For example, public investment absorbs a small fraction of the aggregate demand, but the provision of public capital can have important effects on aggregate productivity. A few macroeconomic models have analyzed the role of public capital from a macro perspective. For example, Aschauer (1985) and Glomm and Ravikumar (1994) considered the role of public investment and public capital as additional inputs in aggregate production, whereas Lansing (1998) studied optimal fiscal policy in a business cycle model with public capital. Leeper, Walker and Yang (2010) included government investment as part of firms' production function.

Another example is public employment. The public wage bill absorbs a significant fraction of total government spending, and is used to hire a non-negligible fraction of total

[1]See Barro (1990), Baxter and King (1993), Ljungqvist and Sargent (2004). More references and a discussion on the traditional modeling of government spending in DSGE models can be found in Fève, Matheron and Sahuc (2013).

employment in almost all countries [Fontaine (2020)]. Labor from public servants affects GDP through several channels. It also provides administrative services, public education, healthcare and other caring services that are provided to households under-priced, thus raising welfare (demand side). In addition, public labor is employed in infrastructure, defense, legal systems, research and R&D programs, thus enhancing the productivity of private firms (supply side).

In the last few years, some DSGE models have accounted for government spending on public employment and wages, and they have analyzed the interaction between public and private production inputs. Bermperoglou, Pappa and Vella (2017) studied the macroeconomic effects of public wage expenditures in the U.S. using a model with public production and associated government spending on public investment and public wage bill. Using a New-Keynesian model, Chang et al. (2020) argued that a variation of the same magnitude in either public wages or government purchases of goods and services can affect private production very differently, even though they have almost the same effect on GDP. Their work rationalizes earlier empirical evidence from Linnemann (2009), who showed that increases in government employment generate temporarily positive responses of private employment and output in aggregate U.S. time series. Bandeira et al. (2018) studied the effects of fiscal consolidation achieved, either through cuts in public wages or through hiring in a model of monetary unions. Quadrini and Trigari (2007) added public employment to the basic search and matching model to study the impact of changes in public wages and public employment on the business cycle. Finally, De-Córdoba, Pujolas and Torres (2017) argued that a four-factors aggregate production function (private labor and capital plus *public* labor and capital) provides a more accurate description of the existing production activity in developed economies.

More generally, a few papers have analyzed the effect of heterogeneous government expenditures from an aggregate perspective. Dellas et al. (2018) separate government spending into four chapters of expenditures: consumption of final goods, government investment, government transfers and public wage bill. They differ from our setup because they do not divide government consumption between intermediate and final goods, plus they do not include debt service. Regarding taxation, their model is mostly similar to ours, with the only exception that they do not account for social security contributions. In addition, they do not account for services from public employment as possibly enhancing private productivity, as we do in this paper. Stähler and Thomas (2012) included two types of public spending (transfers in kind and lump-sum) and they considered public capital as an additional factor in the private production function. However, they did not consider public labor as possibly enhancing private productivity. Gemmell, Kneller and Sanz (2016) analyzed the effect of different categories of government expenditure on long-run GDP. They differ from this paper because: (i) they used a *functional* decomposition of public spending (i.e., public expenditure was broken down in terms of its function, such as health, defence, etc.) instead of an *economic* decomposition, as we do in this paper; and (ii) they rely on a reduced-form empirical approach instead of a structural approach. Economides et al. (2020) considered public spending with a level of disaggregation comparable to the one used in this paper. They differ from us in three dimensions; first, they used an overlapping generation model instead of a DSGE framework; second, they used a *functional* decomposition of government expenditure; and third, they considered public capital but not public labor as enhancing private production.

Macro models are less stylized when it comes to taxes [Dellas et al. (2018), Forni et al. (2009), Stähler et al. (2012)]. Usually, they assume distortionary taxation on labor and/or capital income, and sometimes on consumption. Marginal tax rates are typically set to balance the government's budget. In this paper, we improve upon the existing literature by accommodating a larger array of taxes in the model, including labor and capital income taxes, consumption tax, corporate tax, and social security contributions. Corporate taxes are not generally used in DSGE models because of the constant return to scale and perfect competition assumptions, which together imply zero profits in equilibrium. There are positive profits in our framework, even in the presence of these two assumptions, because we model positive externalities from public capital and labor to private production. In addition, social security contributions are usually neglected in DSGE models, even though in pay-as-you-go systems social contributions must be considered as pseudo-taxes given that pensions are included among public transfers to households. This implies that we should consider social security contributions as an additional revenue in fiscal income.

Finally, we have included public debt in our model, and consequently public debt service as a government expenditure. From a quantitative point of view, spending on debt interests is not a minor chapter of public expenditure. The current level of public debt exceeds 100% of GDP in the U.S., Belgium, Japan, Italy, and Spain, just to cite the OECD countries. This implies that a non-negligible fraction of public spending is devoted to paying interest on debt. Neglecting this spending would imply a bold approximation in replicating actual total government expenditure.

The rest of this paper is structured as follows. Section 2 [System of National Accounts] presents the empirical analysis. In particular, Section 2.1 analyzes some key National Accounts identities that are typically used in DSGE models. Sections 2.2 and 2.3 focus on public expenditure data and fiscal revenues data, respectively. Then, Section 3 describes how to introduce detailed public spending and a tax menu in a DSGE model. Meanwhile, Section 3.6 provides a first validation of the model by showing that our setup is consistent with both the general equilibrium and SNA rules. Finally, Section 4 characterizes the effect of heterogenous government expenditures on the aggregate economy. Section 5 concludes this paper.

2 Government in the SNA

National Accounts and fiscal data are collected from the OECD database. We rely on this source because it is the largest, publicly available, and continuously updated source of cross-country homogeneous data on public accounts for developed countries. Within the OECD database, we use two data sections:

- In *Public Sector, Taxation and Market Regulation*, we used the subsections *Government at a Glance* and *Taxation*.
- In *National Accounts at annual frequency*, we used the subsection *General Government Accounts*. Here, public accounts data fall under six main headings:
  - Taxes and social contribution receipts;
  - Government expenditure by function (COFOG);
  - Government deficit/surplus, revenue, expenditure and main aggregates;
  - General Government Debt - Maastricht;
  - Public Finance and Employment: Expenditures according to COFOG Special;
  - Public Finance and Employment: Kinds of Revenue.

General Government Accounts computes public accounts directly from OECD data, whereas *Public Sector, Taxation and Market Regulation* collects data from national governments. Both databases report statistics computed according to the latest System of National Accounts (2008) [henceforth, SNA], but they differ in the fiscal aggregates reported. Regarding public expenditures, the basic intuition is that *General Government Accounts* measures the contribution of the public sector to economic activity (economic accounts), and expenditures are reported in domestic currency. *Government at a Glance* tracks financial inflows and outflows to/from the public sector (financial accounts), and expenditures are expressed in constant-PPP U.S. dollars, possibly to facilitate cross-country comparisons. Regarding taxes, *Taxation* is computed on a cash basis and it provides a detailed classification indicating the subjects on which taxes are levied, whereas *Taxes and social contributions receipts* are computed on an accrual basis and report broader categories of tax revenues divided by the economic function taxed (e.g. production, income etc.).

2.1 National Accounts Identities

In this section, we revise some of the National Accounts identities that are typically used in DSGE models. The most traditional and common definition of GDP used as feasibility or resource constraint is taken from National Accounts and, in closed-economy models, reads as

$$Y_t = C_t + I_t + G_t \tag{1}$$

where Y_t is GDP, C_t is private consumption of goods and services, I_t is private investment, and G_t is government spending. In many models, G_t is the only form of government spending, thus accounting for total government spending. In fact, the same variable G_t appears in government budget constraint

$$G_t - T_t = \Delta B_t \tag{2}$$

where G_t denotes total expenditures including debt service, T_t is fiscal income comprising tax and non-tax revenues, and last term refers to *net lending/borrowing* in which B_t is the public debt.

Although this modeling is widely used in DSGE models, it is not consistent with the fiscal data. According to SNA, G_t in equation (1) refers to government expenditure on consumption goods and services, which is only a fraction of *total* government expenditure appearing in equation (2). For example, in our sample country, final consumption expenditure ($P3$) represented 23.8% of GDP (see Table 1), which amounted to less than half of the total public expenditure in that year (see Table 3). In other words, the French government spent approximately 20% of GDP on consumption goods and services, over a total spending of more than 50% of GDP.

A DSGE model including only a fraction of government spending features an unrealistically small public sector. This is not troublesome for many research questions, in which that the public sector is not a key concern. However, when analysis hinges on fiscal issues such as fiscal multipliers, public debt sustainability, and so on, then we do expect a

Table 1: GDP calculations based on Expenditure and Income approaches. France, 2016

Gross Domestic Product (GDP)	mln €	% GDP
B1_GE: GDP (expenditure approach)	**2,228,568**	**100.0**
P3: Final consumption expenditure	1,741,229	78.1
P31S14_S15: Households [...]	*1,211,784*	*54.4*
P3S13: [...] General Government	*529,445*	*23.8*
P5: Gross capital formation	505,568	22.7
B11: External balance of goods and services	-18,229	-0.8
B1_GI GDP (income approach)	**2,228,568**	**100.0**
D1: Compensation of employees	1,160,083	52.0
D11: Wages and salaries	*848,340*	*38.0*
D12: Employers' social contributions	*311,743*	*14.0*
B26_B36: Gross operating surplus mixed income	773,225	34.7
D2_D3: Taxes less subsidies on production and imports	295,460	13.3

Unit: Current Euro (millions). Source: OECD database: *Annual National Accounts >> 1. Gross Domestic Product*

model to truthfully reproduce the public sector, including all public expenditures besides spending on consumption goods and services. In this case, it is crucial to disentangle final consumption expenditure appearing in the resource constraint of the economy from total government expenditure appearing in government budget constraint; that is,

$$\begin{aligned} Y_t &= C_t + I_t + C_{g,t} \\ G_t &= T_t + \Delta B_t \end{aligned}$$

where $C_{g,t} \subset G_t$ denotes final consumption expenditure and G_t is total expenditure including debt service. One of the objectives of this paper is to show how to put things in the right place for calibration/estimation purposes. In the next section, we start by identifying final consumption expenditure among total government expenditure, which was found to be non-straightforward when using OECD data.

2.2 Expenditures of the General Government

The SNA defines *Total expenditure of the General Government* as all transactions recorded under positive uses and subsidies payable, as well as transactions in the capital account. As indicated by the OECD, "*the concept that best captures this overall expenditure is referred to as General Government expenditure. It reflects the total amount of expenditure by the government that needs to be financed via revenues, such as taxation, and borrowing.*" To

Table 2: Government spending in public sector data. France, 2016.

General government expenditures by economic transaction	mln $	% total
LYCG: Total expenditure of general government	1,551,182	100.00
D1: Compensation of employees paid by government	350,147	22.6
D62+D63: Social benefits	711,361	45.8
P2: Intermediate consumption	137,646	8.9
P5+K2+D9: Capital expenditures	122,804	7.9
D3: Subsidies	70,999	4.6
D4: Property income	52,037	3.4
D7+D29+D5+D8: Other current expenditures	106,189	6.8

Units: Current US Dollars, constant PPP (millions). Source: OECD database. *Public Sector, Taxation and Market regulation >> Government at a Glance >> Part I. Public finance and economics.*

analyze this concept in detail, we focus on the database *Government at a Glance*; and, in particular, on "Government expenditure by economic transaction", which is available in *Part I. Public Finance and Economics.*

In Table 2, total government expenditure is broken down into seven chapters of public expenditure: compensation of [public] employees, social benefits, intermediate consumption, capital expenditures, subsidies, property income, and other current expenditures. In more detail, compensation of employees indicates all workers paid by the government (e.g., civil servants, doctors, teachers, army and police) and it also includes wages and salaries paid in cash, and the employer's social security contributions. Social benefits have two components. The first component is Social benefits entailing monetary transfers (D62), which includes payments in cash to a household by social security, and other social insurance and assistance units (e.g., pensions, maternity allowances, employment benefits, family allowances, death benefits, etc.). The second is Social transfers in kind (D63), which includes goods and services purchased by the government from market producers (private firms or professionals) and delivered to a household (e.g., medical assistance; repayments from the health-care sector of social security, such as medicines, transportation of patients, medical visits, and so on; housing allowances, etc.). Intermediate consumption (P2) indicates all goods and services purchased by the government from market producers and employed as inputs in public productions. Subsidies (D3) includes payments to public corporations and private enterprises. Property income (P4) reflects all costs that are borne by the government to borrow physical capital (e.g. renting buildings), intangible capital (e.g. exploiting patents), and financial capital (e.g. issuing public debt to gather liquidity) from third-parties. In DSGE models, it can be used as a proxy for interest payment on public debt. The capital expenditures category includes Capital transfers (D9) to private enterprises and non-profit institutions serving households for acquiring non-financial assets, debt cancellation, and so on; and Gross capital formation (P5) including inventories and Acquisitions less disposals of non-financial non-produced assets (K2). Apart from increases in the stock of public capital, it also accounts for transactions in land, sales of emission permits and radio spectra licenses. Finally, other current expenditures is the aggregation of Other current transfers ($K7$), Other taxes on production ($D29$), Current taxes on income ($D5$), and Pensions adjustment ($D8$). The first category (D7) indicates all transfers in cash to non-profits institution serving households, transfers in kind (clothes, food, medicines, etc.) to charities, non-life insurance claims, and international cooperation aid. The other categories are basically production-related expenses that the government bears to run public firms.

From the perspective of our research, the previous definition is only partially satisfactory because it does not include final consumption expenditure of the general government. We still have information on government spending on consumption goods from GDP calculations (see Table 1) but we do not show how to relate it to total government spending (Table 2). To determine the relationship between $C_{g,t}$ and G_t, we switch to *General Government Accounts* and, in particular, to database 11: *Government expenditure by function (COFOG)*. This source reports data on final consumption expenditure, together with total government expenditures, compensation of employees, social benefits, subsidies, property income, intermediate consumption, other production costs, current and capital transfers, and gross capital formation, which are reported in Table 3.

Some categories coincide with those in *Government at a Glance*, as follows: Compensation of employees ($D1$), Intermediate consumption ($P2$), Subsidies ($D3$) and Property income ($D4$). By comparing the two databases, we learn that social benefits in Table 2 is the summation of ($D62$) and ($D63$) that now are separately quantified, and capital expenditures in Table 2 is the aggregation of gross capital formation ($P5$), plus acquisitions less disposals of non-financial non-produced assets ($K2$) and capital transfers ($D9$). From Table 3 we also learn that final consumption expenditures is the sum of two components: Individual consumption expenditure (P31), which represents public expenditure attributed to households (mainly spending in health-care and education); and Collective consumption expenditure (P32), which is used when it is not clear who the final consumer is (households or enterprises). This last category includes all general administration expenses, defense, police, fire-fighters, and so on.

Although *Government expenditure by function* comprises Final consumption expen-

Table 3: Government spending in National Accounts. France, 2016.

Government expenditures by function (COFOG)	mln €	% total
LYCG: Total government expenditure	1,256,458	100.00
P3: Final consumption expenditure	526,742	41.9
P31: Individual consumption expenditure	*343,649*	*27.4*
P32: Collective consumption expenditure	*183,093*	*14.6*
D1: Total compensation of employees paid by the gov.	283,619	22.6
D3: Subsidies	57,509	4.6
D4: Property income (consolidated S13)	42,150	3.4
D62+D63: Social benefits & transfers in kind	576,202	45.8
D62: Social benefits other than social transfers in kind	*442,767*	*35.1*
*D63: Social transfers in kind - purchased market prod.**	*133,435*	*10.7*
P2/D29/D5/D8: Intermediate cons. +Other taxes on prod. +Current taxes on income + pensions adj.	122,230	9.7
P2: Intermediate consumption	*111,493*	*8.9*
D29/D5/D8: Other taxes on production + pension adj. + Current taxes on income	*10,737*	*0.8*
D7: Other current transfers (consolidated S13)	75,276	6.0
D9: Capital transfers (consolidated S13)	22,253	1.8
D92: investment grants	*18,425*	*1.5*
P5/K2: Gross capital formation and Acquisitions less disposals of non-fin. non-prod. assets	77,219	6.2
P5: Gross capital formation	*75,294*	*6.0*
K2: Acquisitions less disposals of non-financial non-produced assets	*1,925*	*0.2*

Unit: Current Euro (millions). (*) Payable. Source: OECD database >> *Annual National Accounts >> General Government Accounts >> 11. Government expenditures by function (COFOG).*

diture, it reports categories that do not sum up to 100%, thus leaving the problem of computing $C_{g,t}$ as fraction of G_t unsolved. The reader can readily check that the sum of heading expenses in Table 3 exceeds total government expenditure:

$$\begin{aligned} P3 + D1 + D3 + D4 + D62 + D63 + P2 + D29 &\quad + \\ +D5 + D8 + D7 + D9 + P5 + K2 &\quad > \quad LYCG \end{aligned} \tag{3}$$

By analyzing the SNA section on Public Accounts, we learn that the imbalance is due to a double accounting issue generated by Final consumption expenditure ($P3$). As pointed out by the OECD, the aggregate *P3S13S* describes final consumption of good and services of the general government, which includes goods and services provided by the government and transferred to households. The aggregate comprises both privately-produced goods bought by the government from market producers and publicly-produced goods. The accounting issue arises with the last quantity. In SNA, public goods are evaluated at factor cost, and production-related expenses are included among the government's expenses because the public sector is consolidated (code $S13$). Thus, production-related expenses in summation (3) are accounted twice: within final consumption expenditure and by themselves alone. Using the definition of $P3$ in SNA, we learn that the costs included in the evaluation of public goods are: expenses for intermediate consumption ($P2$), compensation to employees ($D1$), other production costs ($P2 + D29 + D5 + D8$), and consumption of fixed capital ($K1$).[2] Hence, we can overcome the double accounting issue by breaking down total government expenditures as follows

$$\begin{aligned} \text{Total government expenditure (LYCG)} &= \text{Final government consumption (P3)} \\ &+ \text{Subsidies (D3)} \\ &+ \text{Property income (D4)} \\ &+ \text{Social benefits other than in kind (D62)} \\ &+ \text{Other current transfers (D7)} \\ &+ \text{Capital transfers (D9)} \\ &+ \text{Gross capital formation (P5)} \\ &- \text{Consumption of fixed capital (K1)} \end{aligned} \tag{4}$$

[2]Consumption of fixed capital is reported in the database *12. Government deficit/surplus, revenue, expenditure and main aggregates* among production-related expenses of the government.

which includes $P3$ together with a list of categories that sum up to 100%. Note that consumption of fixed capital must be subtracted from the summation because is included in final government consumption, even though it does not entail any monetary expense for the government and, therefore, is not included among Total government expenditure.[3]

2.3 Fiscal Income

In public finance, a revenue transaction is one that increases government's net worth. Total fiscal income is divided in Tax revenues, Social contributions, and non-tax income. This last indicates revenues from Capital transfers, sales of publicly produced goods sold as market output (e.g. state-owned firms operating in competition with private firms), and payments for non-market production (e.g. health services provided in co-payment regime). Tax revenues comprises taxes on production and imports (indirect taxes), current taxes on income and wealth (direct taxes), and capital taxes (some classifications of taxes include capital taxes as a component of direct taxes). Net social contributions comprises social contributions by employers and households actually collected as well as imputed social contributions. Other current revenues contains Property income – i.e., income earned by the government from renting public capital – plus Other current transfers. An example of the tax structure is presented in Table 4, which reports data on tax revenues from the database *Taxes and social contributions receipts* of *General Government Accounts*. This database features a categorization of tax revenues that closely resemble the tax aggregates typically defined in DSGE models.

From a theoretical point of view, the treatment of public expenditure and fiscal revenues in DSGE models is opposite. Government expenditures are exogenous variables set by the government, thus in principle independent from macro aggregates (except for automatic stabilizers). Tax revenues, instead, are determined by the combination of an exogenous tax menu, typically set by the government, and endogenous tax bases that depend on macro aggregates. Hence, tax revenues and marginal taxes cannot be jointly used in DSGE models as calibration targets or estimation data. Eventually, the calibration/estimation choice will hinge on the model at issue. For models featuring realistic measures of fiscal income and/or public debt, the researcher requires a truthful representation of total fiscal income and a calibration based on tax revenues is preferred. For models evaluating the impact of tax changes on macro aggregates, data on effective marginal tax rates should be used in simulating model, given that in micro-founded models agents'

[3]A key principle in SNA is that "*government expenditures are to show strictly monetary expenditure.*"

Table 4: Taxes and social contributions in National Accounts. France, 2016

TREC: Total receipts from taxes and social contributions less various amounts	1,056,589	100.00
D2/D5/D91/D611: Total tax receipts and actual social contributions	1,021,060	96.6
D2D5D91: Total tax receipts	645,592	61.1
D2: Taxes on production and imports	345,646	32.7
D21: Taxes on products	254,674	24.1
D29: Other taxes on production	100,972	9.6
D5: Current taxes on income, wealth, etc.	277,584	26.3
D51: Taxes on income	253,019	24.0
D59: Other current taxes	24,565	2.3
D91: Capital Taxes	12,362	1.2
D611: Actual social contributions	375,468	35.5
TAXB: Tax burden: total receipts from taxes and compulsory SC - various amounts	1,012,869	95.9
D612: Imputed social contributions	42,873	4.1
D995: Capital transf. from govt, taxes and social.contributions unlikely to be collected	7,344	0.7

Unit: Current Euro (millions). Source: OECD database >> *Annual National Accounts* >> *General Government Accounts* >> *10. Taxes and social contributions receipts.*

decisions occurs at the margin. It is worth noting that estimating marginal tax rates is impractical at international level given data limitations (both availability and comparability), and the complexity of comparing tax systems across countries. Mendoza, Razin and Tesar (1994) proposed a method to estimate effective average taxes, showing that they are within the range of marginal rates estimated in other empirical works and display very similar trends. They also argued that their definition of effective average tax rates can be interpreted as an estimation of specific tax rates that a representative agent, in a general equilibrium context, takes into account. In general, average effective tax rates involves the use of conservative values (smaller implied behavioral responses) relative to marginal taxes.

OECD database contains information to pursue each of these calibration/estimation strategies. We shall analyze them in turn. First, if the model must replicate exactly the magnitude of fiscal income, then tax revenues should be set as calibration targets and tax rates implicitly determined through the calibration/estimation process. They will be model consistent even tough can sensibly differ from existing tax rates. In particular, government revenues in the model will match actual tax revenues as reported in Table 4. Tax bases will depend on endogenous variables whose values are determined by the equilibrium algorithm. Implicit tax rates will be additional equilibrium variables jointly determined with endogenous variables (or elasticities, depending on the chosen calibration strategy).

Second, tax rates in the model can be calibrated using average tax rates. Data on tax revenues in Table 4, together with empirical tax bases from National Accounts, can be jointly used to compute average tax rates, which then are used in the model as exogenous parameters. This calibration strategy does not guarantee tax revenues to match observed figures, but tax rates will resemble actual tax rates after removing distorting factors, such as the black economy, tax evasion, etc., which are not considered in the statutory tax menu. In this case, the consistency is achieved in the fiscal instrument and the only requirement is that the definition of each tax taken from data is consistent with the model. Mendoza et al. proposed to calculate tax rates by dividing tax revenues by income (taxes on household income, labor income and capital income) or expenditure (taxes on consumption). They assume that all household income is taxed at the same rate (both labor and capital incomes). Carey and Rabesona (2002) and McDaniel (2007) updated Mendoza *et al.* (2004) calculations, introducing some changes in the method for calculating average tax rates. For the period 1980-2003 and 15 OECD countries, McDaniel (2007) calculated series of tax rates on labor income, capital income, consumption and investment. Consumption and investment taxes are computed from data on production and imports taxes. In any case, tax rates are calculated using information from fiscal revenues and other variables as proxies of the tax bases. In general, 'Taxes on production and imports' can be used as data counterpart of consumption tax revenues in the model (available among National Accounts statistics, database *1. GDP (income approach).*) The implicit consumption tax can thus be calculated by dividing the revenues from the taxes on production and imports over private consumption.[4] An implicit direct household income tax (labor and capital) can be calculated from revenues from 'Taxes on income, wealth, etc.', and 'Capital Taxes', as the percentage over GDP. The implicit labor income tax is computed as revenues from 'Taxes on income, wealth, etc.', over total compensation to employees. Labor income tax can be calculated by dividing labor income tax revenues by labor income. However, household income taxes represent taxes on total income. A standard assumption adopted by the literature is that the tax rate is the same for all

[4]McDaniel (2007) proposes a method to decompose taxes on production and imports between consumption and investment taxes. This is because taxes like imports duties and general taxes fall on investment expenditures as well as on consumption. She divided between these two components depending on the share of consumption and investment.

types of income. Alternatively, the implicit capital income tax is computed as revenues from 'Capital taxes', over GDP less compensation to employees. This is so, assuming that total Income less compensation to employees is equal to capital income. Capital tax income revenues come from household income tax (as indicated above) and tax on corporate income. This tax should also include property taxes paid by entities other than households. Finally, the implicit social security tax is computed as Social contributions over labor income.[5]

Finally, tax rates can be directly calibrated using their counterparts in data. Information about statutory and effective tax rates is available in the OECD Tax database *Public Sector, Taxation and Market Regulation*.[6] This database includes for types of taxes: Taxes on consumption (VAT) and excise duties, Personal income taxes, Corporate and income taxes, and social security contributions. Notice that these categories almost exactly match the definition of taxes typically included in DSGE models. For instance, consumption tax in the model can be obtained as the weighted sum of VAT taxes (or general sales taxes), plus excise duties (taxation of beer, wine, alcoholic beverages, tobacco, gasoline, etc.). Consumption tax as a percentage of GDP and as percentage of total taxation are calculated by the OECD (see *Consumption Tax Trends*).

3 Modelling the Government

3.1 Government Budget Constraint

The financial budget constraint of the government can be defined in real terms as

$$G_{p,t} + r_t^B B_t + \Delta D_t = T_t + r_t^D D_t + CBT_t + \Delta B_t \tag{5}$$

Equation (5) states that all cash outlays (i.e., transfer payments to households, non-interest government expenditures ($G_{p,t}$), public debt service ($r_t^B B_t$), new purchases of financial assets (ΔD_t)) must be funded by some combination of tax receipts (T_t), interest earnings on government assets ($r_t^D D_t$), transfers from the central bank (CBT_t), and new debt issuance (ΔB_t). Aside from an unconventional monetary policy that we do not

[5]In aggregated models, social security contributions paid by employees are not usually distinguished by those paid by employers, specially because the first are only a small fraction of total contributions. If needed, this distinction can be easily incorporated into the model, just by including the corresponding employee social security tax in the households budget constraint and the employer social security tax in the definition of profits of the firm.

[6]Available at https://www.oecd.org/tax/tax-policy/tax-database.

consider in this paper, transfers from the central bank in developed countries are zero because direct purchases of government's bonds are precluded; that is, $CBT_t = 0$. Thus, by denoting the financial net position of the government as B_t, we can set financial purchases to zero (i.e. $D_t = 0$) assuming complete stock-flow consistency.[7]

Under these conditions, the budget constraint (5) reduces to:

$$G_{p,t} + r_t^B B_t = T_t + \Delta B_t \tag{6}$$

or, using the definition of total government spending: $G_t = G_{p,t} + r_t^B B_t$,

$$G_t - T_t = B_{t+1} - B_t \tag{7}$$

Equation (7) is the typical budget constraint employed in DSGE models. The fiscal aggregates appearing here can be directly matched with their empirical counterparts from National Accounts.

3.2 Government Spending

In Section 2.2, we break down public expenditure using equation (4). To include detailed government spending in a DSGE model, it is advisable to refine that definition because equation (4) mixes expenditure components affecting aggregate demand and aggregate supply, thus providing a blunt relationship for general-equilibrium models. Ideally, in DSGE models all components of government spending affecting the aggregate demand should be separately identified from those affecting the aggregate supply. To fulfill this purpose, we manipulate equation (4) by defining total government expenditure and final

[7]Stock-flow consistency means that changes between opening and closing positions are fully accounted in transactions. The current methodologies for data collection assume that in cases of stock-flow inconsistencies, transactions or other flows may be adjusted to attain stock-flow consistency. See the Handbook of National Accounts (2015). This model does not leave room for such inconsistencies; therefore, there will always be an uncovered gap when projecting the data to a model.

consumption expenditure as follows:

$$\begin{aligned} & \text{Total government expenditures (LYCG)} = \\ + & \text{ Compensation to employees (D1)} \\ + & \text{ Transfers other than in kind (D3+D62+D7+D9)} \\ + & \text{ Transfers in kind (D63)} \\ + & \text{ Intermediate consumption (P2)} \\ + & \text{ Others production expenses (D29+D5+D8)} \\ + & \text{ Gross capital formation (P5+K2)} \\ + & \text{ Property income (D4)} \end{aligned} \tag{8}$$

$$\begin{aligned} & \text{Final gov. consumption (P3)} = \\ + & \text{ Compensation to employees (D1)} \\ + & \text{ Intermediate consumption (P2)} \\ + & \text{ Other production expenses (D29+D5+D8)} \\ + & \text{ Transfers in kind (D63)} \end{aligned} \tag{9}$$

We use equation (8) to define total spending in government budget constraint, and equation (9) to define government spending in the resource constraint. Several of the characteristics of the previous definitions are worth emphasizing here. First, Subsidies (D3) and Capital transfers (D9), which includes Investment grants (D92) and Other capital transfers (D99), have been included in the general concept of Transfers other than in kind. This is intended as a homogeneous transfer (monetary or real depending on the model at issue) that is paid to private agents by the government, and therefore affects the aggregate demand through the agents' budget constraints. Second, Transfers in kind (D63) are accounted separately from transfers. They are defined as *Social transfers in kind related to expenditure on products supplied by households via market producers*, and corresponds to goods and services either purchased by the government on the market, or produced by the government itself (non-market production). They include both social benefits in kind, which fall into the category of social protection, and benefits that beneficiary households buy themselves and later have reimbursed. Hence, they will enter the model as direct demand of the government and not as transfers. Third, all production-

Table 5: The equivalence between National Accounts and the model

National Accounts	**Model**
Intermediate consumption (P2)	$C_{gi,t}$
Compensation to employees (D1)	$(1+\tau_t^s)w_{g,t}L_{g,t}$
Transfers (D3+D62+D7+D9)	Z_t
Transfers in kind (D63)	$C_{pg,t}$
Gross capital formation (P5+K2)	$I_{g,t}$
Property income (D4)	$R_t^B B_t$
Others (D29+D5+D8)	Added to $C_{gi,t}$

related expenses have been aggregated in a single category because they will affect in the model economy in the same way (i.e., through the pricing of public goods). Finally, we withdraw Consumption of fixed capital (K1) from the definition of Final government consumption (P3), which is a minor approximation and avoids employing an additional source of data to calibrate the model (for more detail, see the discussion in Section 2.2).

Following the previous definitions, Table 5 establishes the equivalence between model variables and their counterparts in data. In model notation, τ_t^s are social contributions paid by firms, $w_{g,t}$ is the public wage rate, and $L_{g,t}$ is public labor. The public wage bill, $(1+\tau_t^s)w_{g,t}L_{g,t}$, is thus calibrated using the Compensation to employees in the public sector. Transfer of resources, Z_t, is matched with all social benefits and transfers other than in kind, $C_{pg,t}$, whereas social benefits in kind are used to match the transfer of privately produced goods consumed by households and provided by the government. Intermediate consumption $C_{gi,t}$ includes all of the production expenses that are borne by the government, and $I_{g,t}$ denotes gross capital formation in the public sector. As for private capital, we assume that public investment accumulates into a stock of public capital, $K_{g,t}$, according to the law of motion $K_{g,t+1} = (1-\delta_g)K_{g,t} + I_{g,t}$, in which $0 < \delta_g < 1$ is the public capital specific depreciation rate. Finally, because the government only gathers resources from private agents by issuing bonds, *Property income* is used to calibrate the service of debt, $r_t^B B_t$, in which r_t^B is the implicit interest rate on the stock of public debt B_t. Eventually, total government spending can be written as

$$G_t = (1+\tau_t^s)w_{g,t}L_{g,t} + I_{g,t} + Z_t + C_{pg,t} + C_{gi,t} + r_t^B B_t \tag{10}$$

3.3 Public Production

Public spending on employment and intermediate goods points to a role of government as a producer. Thus, we include public production $Y_{g,t}$ in the model using the general form technology

$$Y_{g,t} = A_{g,t}\Psi\left(K_{gg,t}, L_{gg,t}, C_{gi,t}\right) \tag{11}$$

where output is produced using a strictly positive fractions of public capital $K_{gg,t} \leq K_{g,t}$ and public labor $L_{gg,t} \leq L_{g,t}$, and $A_{g,t}$ represents a multi-factor productivity following an exogenous stochastic process. In this framework, we take a neutral stance on public production choices. We understand that governments do not decide the amount of public production by merely maximizing profits, but they pursue a variety of economic and political objectives (e.g., welfare, redistribution, and re-election probability) and they take many non-market factors into account (e.g., externalities, goods nature—non-excludable or non-rival). Alternatively, the choice is how much to produce and which factors can be used to determine side economic reasons, such as reducing unemployment or setting optimal public wages [Gomes (2015,2018)]. We disregard these processes and fix the amount of public production as its counterpart in data. Consequently, we exploit the SNA rules which dictate that public production must be evaluated at factors cost to pin down its market value. Production-related costs are identified as the sum of *intermediate consumption*, *compensation of employees*, *consumption of fixed capital*, and *other taxes on production*.[8] We match the value of each production factor with its counterpart in data, as reported in Section 2.2, i.e.

$$p_{g,t}Y_{g,t} = C_{gi,t} + (1+\tau_t^s)w_{g,t}L_{gg,t} + \delta_g K_{gg,t} \tag{12}$$

where $p_{g,t}$ is the relative price of public goods in terms of private goods. Three remarks are worth noting here. First, in accordance with the simplifying assumption used in Section 3.1, we do not include the consumption of fixed capital. Second, this framework admits either perfect arbitrage between public and private wages—that is, $w_{g,t} = w_{p,t}$—or the existence of a wage premium in the public sector [Afonso (2014), De-Córdoba, Pérez and Torres (2012)]. Finally, equations (12) and (11), together with the wage rate $w_{g,t}$ that is endogenously computed in equilibrium, are sufficient to separately identify $p_{g,t}$ and $Y_{g,t}$ once a normalization for the exogenous level of technology $A_{g,t}$ is chosen.

[8]Subsidies on production are not deducted. Meanwhile, government purchases of intermediate goods only refers to government spending on privately produced goods because National Accounts are computed by consolidating sectors, and therefore own-produced goods are not included among intermediate consumption.

3.4 Tax Revenues

Following the empirical analysis in Section 2.3, we assume that the government can gather resources from the economy by taxing consumption, labor, capital, and profits. The tax rates are $\{\tau_t^c,\ \tau_t^l,\ \tau_t^k,\ \tau_t^\pi\}$, respectively. Additionally, we consider a pay-as-you-go social security system with social security contributions denoted by τ_t^s. The following equation represents total fiscal revenues in each period

$$T_t = \tau_t^c C_{pp,t} + (\tau_t^l + \tau_t^s)(w_{p,t}L_{p,t} + w_{g,t}L_{g,t}) + \tau_t^k(r_t - \delta_p)K_{p,t} \\ + \tau_t^\pi \Pi_t + (1 - s_{p,t})C_{pg,t} + (p_{g,t} - s_{g,t})C_{gg,t} \quad (13)$$

where $C_{pp,t}$ and $C_{pg,t}$ indicate the households' consumption of privately produced goods, respectively, purchased by households or purchased by the government, and provided to households. Note that government gets fiscal income not only from taxes but also from the provision to households of privately-produced and publicly-produced goods. For private goods, the government pays the whole amount of $C_{pg,t}$ (see equation 10) and then collects the unsubsidized fraction of the price $(1-s_{p,t})$. For public goods, the government directly sells to households at a price $(p_{g,t}-s_{g,t})$ that already includes the subsidized discount $s_{g,t}$). Finally, private prices are represented by wages, $w_{p,t}$, and rental rate of private capital, r_t, whereas $L_{p,t}$ and $K_{p,t}$ represent private labor and capital, respectively. Finally, Π_t represents the profits of private firms.

3.5 The Rest of the Model

We need to characterize a few other elements to complete our design. To rationalize the presence of corporate taxes, the framework needs to feature positive profits for private firms. This can be done in a variety of ways, such as by assuming monopolistic competition, increasing returns to scale, or by nominal or real frictions. All these assumptions pose some form of constraint on the underlying DSGE setup, whereas we want to impose as few requirements as possible. Consequently, we link the profits of the firms to the presence of the public sector by assuming that private firms exploit public goods as freely-available production factors. Common examples are private transporters who use public roads, or financial aids and administrative services that are provided by the public administration and directed to firms and employers. The assumption of productive public capital has been already supported in the literature [Drautzburg and Uhlig (2015), Glomm and Ravikumar (1994)]. A similar argument for public labor has been supported by De-Córdoba et al. (2012, 2017). For instance, a construction firm cannot operate without construction permits that are issued by the municipality. The public office issuing these permits thus provides a free-for-the-customer service, which is used by private firms for their own production interest. In this sense, public labor can be seen as an exogenous factor that increases production.

In the following, we consider two alternative specifications to accommodate the links between public factors and private production. First, we assume that private firms' production employs a fraction of public factors, as in Pappa (2009). Private output $Y_{p,t}$ is thus produced using the general form technology

$$Y_{p,t} = A_{p,t}F(K_{p,t}, K_{gp,t}, L_{p,t}, L_{gp,t}) \tag{14}$$

where $K_{p,t}$ and $L_{p,t}$ are private factors, $K_{gp,t}$ and $L_{gp,t}$ are public factors, and $A_{p,t}$ represents a multi-factor productivity of private production, which follows an exogenous stochastic process. Public capital and employment are either used to produce public goods or to enhance private production. Accordingly, total public labor $L_{g,t}$ is $L_{g,t} = L_{gp,t} + L_{gg,t}$ and total public capital is $K_{g,t} = K_{gp,t} + K_{gg,t}$. In this setup, public output $Y_{g,t}$ is entirely given to households in the form of consumption and, accordingly, we define

$$C_{gg,t} = p_{g,t}Y_{g,t} \tag{15}$$

The second specification assumes that firms directly use a fraction $Y_{gp,t}$ of public goods as intermediate goods in private production. In this case, private production function is

$$Y_{p,t} = A_{p,t}F\left(K_{p,t}, L_{p,t}, Y_{gp,t}\right) \tag{16}$$

Accordingly, public output is split into two categories depending on the final user (e.g., households or firms); that is,

$$Y_{g,t} = Y_{gp,t} + Y_{gg,t} \tag{17}$$

where $Y_{gg,t}$ is the amount of public output given to households in the form of consumption. In this case, $K_{gp,t} = L_{gp,t} = 0$, and in equilibrium

$$C_{gg,t} = p_{g,t}Y_{gg,t} \tag{18}$$

In both cases, we assume that: (i) privately produced goods are sold in perfectly competitive markets, (ii) private production technology has constant returns to scale, and (iii) public goods/factors are given at no cost to firms. Thus, the firm's maximizing profits problem coincides with the standard case

$$\underset{\{K_{p,t},L_{p,t}\}_{t=1}^{\infty}}{Max} \Pi_t = Y_{p,t} - (1+\tau_t^s) w_{p,t} L_{p,t} - r_t K_{p,t}, \tag{19}$$

delivering the following inverse demand functions for private factors

$$r_t = F_{K_p} \tag{20}$$

$$(1+\tau_t^s) w_{p,t} = F_{L_p} \tag{21}$$

Finally, we impose the usual market clearing condition on the labor market, $L_t = L_{p,t} + L_{g,t}$, and private capital evolves according to the usual law of motion; that is, $K_{p,t+1} = (1-\delta_p)K_{p,t} + I_{p,t}$. As usual in general equilibrium models, the market clearing condition on the goods market is established in equilibrium by the Walras's Law.

3.6 GDP in the Model Economy

In this section, we show that the previous design of the government is compliant with SNA rules in terms of GDP calculation. Specifically, the Walras Law implies that household's budget constraint

$$\begin{aligned}(1+\tau_t^c)C_{pp,t} + (1-s_t^{pg})C_{pg,t} + (p_t^{gg} - s_t^{gg})C_{gg,t} + K_{p,t} - K_{p,t-1} + B_{t+1} - B_t = \\ (1-\tau_t^l)[w_{p,t}L_{p,t} + w_{g,t}L_{g,t}] + (1-\tau_t^k)(r_t - \delta_p)K_{p,t-1} + Z_t + (1-\tau_t^\pi)\Pi_t + r_t^B B_t\end{aligned}$$

establishes the following equilibrium relationship[9]

$$C_{pp,t} + C_{pg,t} + C_{gi,t} + I_{p,t} + I_{g,t} = Y_{p,t} \tag{22}$$

Then, we define GDP using the National Accounts definition of GDP (output approach): "*The value of all final goods and services produced in the economy during a given interval of time.*" In our model, when using equation (14) for private output, we count the following final goods: $\{C_{pp,t}, C_{pg,t}, I_{p,t}, I_{g,t}, p_{g,t}Y_{g,t}\}$. Thus, the definition of GDP implies

$$GDP_t \equiv C_{pp,t} + C_{pg,t} + I_{p,t} + I_{g,t} + p_{g,t}Y_{g,t} \tag{23}$$

[9]The proof is available upon request.

Using previous result (22), equation (23) yields

$$GDP_t = (Y_{p,t} - C_{gi,t}) + p_{g,t}Y_{g,t} \tag{24}$$

In other words, GDP in the model is equal to total public and private production minus intermediate goods, consistently with National Accounts. In addition, it can be shown that equation (24) is also consistent with the National Accounts definition of *GDP (expenditures approach)*. Using the definition of *Final Consumption expenditure of the General Government* provided in Section 3.1 and equation (15), we have

$$C_{g,t} = C_{pg,t} + p_{g,t}Y_{g,t} \tag{25}$$

and, therefore, equation (23) can be written as

$$GDP_t = C_{pp,t} + C_{g,t} + I_t \tag{26}$$

in which GDP is expressed as the sum of consumption, government spending and investment, with $I_t = I_{p,t} + I_{g,t}$ denoting *Gross Capital Formation*.

The same results can be obtained when the production function of private firms is given by equation (16). In this case final goods are: $\{C_{pp,t}, C_{pg,t}, I_{p,t}, I_{g,t}, p_{g,t}Y_{gg,t}\}$, and therefore

$$GDP_t = C_{pp,t} + C_{pg,t} + I_{p,t} + I_{g,t} + p_{g,t}Y_{gg,t} \tag{27}$$

or, using again result (22),

$$GDP_t = (Y_{p,t} - C_{gi,t}) + p_{g,t}\left(Y_{g,t} - Y_{pg,t}\right) \tag{28}$$

Hence, GDP in the model economy is the sum of total public and private production minus intermediate goods, consistently with National Accounts. As for previous modeling option, we can prove that GDP in the model economy is also consistent with the National Accounts definition of *GDP (expenditures approach)*. Using again the definition of *Final Consumption expenditure of the General Government* together with equation (18), we obtain

$$GDP_t = C_{pp,t} + C_{g,t} + I_t \tag{29}$$

which clarifies that GDP can also be expressed in this framework as the sum of consumption, government spending and investment.

4 Quantitative Results

In this section, we simulate a neoclassical growth model endowed with a SNA-compliant public sector, as detailed in Section 3. The setup assumes that all public labor is used in the public production, whereas all services from public capital are used by private firms. In terms of the modeling choices that are listed in Section 3.5, we choose alternative 1 and set $K_{gg,t} = 0$ in all t. The representative household's utility function is logarithmic, and private and public consumption enter separately. We abstract from Edgeworth complementarity between the two types of goods [Bouakez and Rebei (2007)] to implement a model with minimum deviation from the most neutral and commonly known RBC model. The simulation is performed by calibrating the policy vector (government spending and taxes) using data on the sample country, as presented in previous sections (France, 2016), and standard RBC-literature values for the model deep parameters.[10] Beyond our interest in the specific case of France, our intention is to offer a few brushstrokes on the different effects that changes in single spending components and different tax rates can have in the aggregate economy.

In the first set of exercises, we first simulate a 1% increase in government spending that proportionally increases all expenditure components. Then, we repeat the exercise by individually increasing each component of government expenditure by an amount that raises total government spending by 1% with no other component changing. Eventually, we compare the fiscal multiplier of each expenditure component to that of the total spending.[11] Figure 1 plots the transition dynamics from the initial non-stochastic steady state to the new steady state expressed as percentage changes from initial values. At each point in time, the value of the transition path can be interpreted as the fiscal multiplier for the corresponding period.

As depicted in Figure 1, a 1% increase in total spending that is distributed equally to all components determines a long-run increase of 2.6% in GDP and an increase of 1.4% in private production. At the impact, the fiscal multiplier of government spending is worth 1.3% for total output and 0.3% for private output. When only public investment increases, GDP skyrockets to 16.4% and private output rises to 13.7% in the long-run. These figures are not surprising given that a 1% increase in total government expenditures fully devoted to capital formation represents a 110.8% increase in productive public investment (France

[10]See the Technical Appendix in the online additional material.

[11]We rely on the relative comparison rather than on overall assessments because the literature has made it clear that the magnitudes of fiscal multipliers crucially depend on the model and methodology that are used; see Leeper et al. (2017) and references therein.

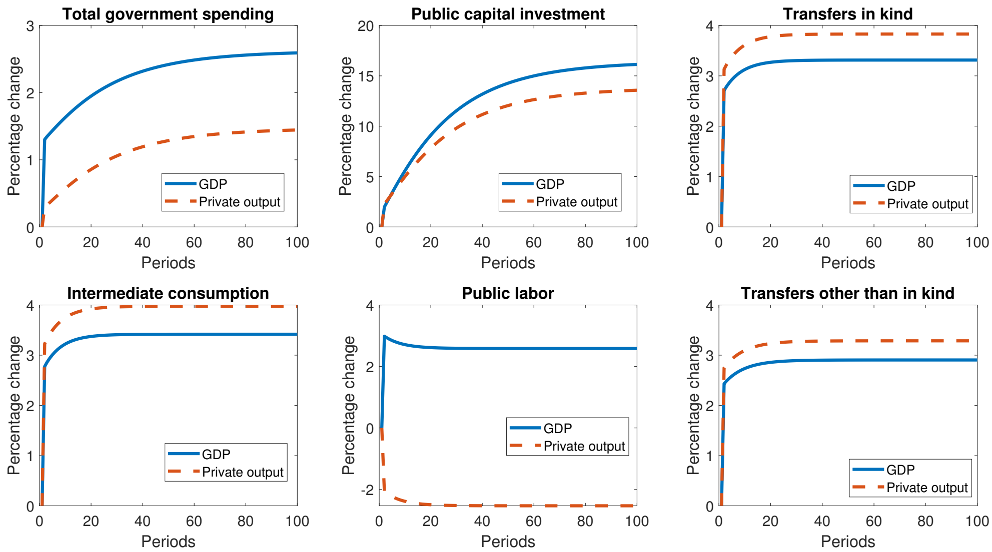

Figure 1: Transition dynamics after a 1% increase in government expenditure.

only devotes 6.2% of government budget to public capital formation). Fiscal multipliers for transfers in kind are sensibly smaller, 3.3% and 3.8% for GDP and private output in the long-run, respectively. At the impact, these multipliers are 2.7% an 3.1%. Similar values are obtained for the increase in government intermediate consumption, with long-run fiscal multipliers of 3.4% and 3.9%. An increase in public labor has a positive effect on GDP of 2.6% in the long-run but has a negative effect on private output of -2.5% in the long-run. This result is explained by the specification of the model in which all public labor is assigned to public production. As a result, private labor is affected by the negative wealth effect, as typically observed in RBC models after an expansionary fiscal policy. Finally, the effect of transfers other-than-in-kind is positive and is similar to that of transfers in kind but smaller in magnitude. Its long-run multipliers are 2.9% and 3.3% for GDP and private output, respectively. All in all, the results show that the fiscal multipliers of single spending components are all in the same ballpark except for public investment. Its externality on private firms' productivity appears the key feature to obtain the observed large effect on GDP. This suggests that the productive role of public capital should be accounted for in the literature on fiscal consolidation when assessing the most effective combinations of fiscal policy.

The second set of exercises simulates a 1% increase in one tax rate at a time, leaving the other tax rates and government spending unchanged. Figure 2 depicts the transition dynamics from the initial non-stochastic steady state to the new steady state for GDP

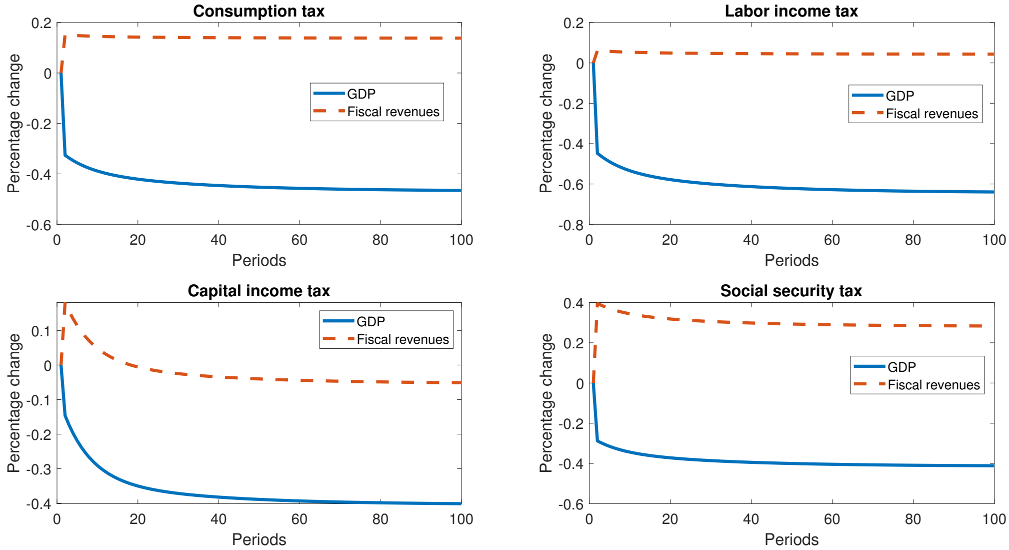

Figure 2: Transition dynamics after a 1% increase in various tax rates.

(total output) and fiscal income. The effects on private output are fairly similar to those for total output because public output remains almost constant after tax variations. In the simulations, long-run tax multipliers are in the range of −4.0% to −6.3%. The lowest tax multiplier is the one of labor income tax, which is due to the large distortionary effect that this tax has on labor supply decisions. The transitional dynamics for the other taxes are fairly similar; except for the case of the capital income tax, whose transition to the new steady state appears smoother than in the other cases. The effects for fiscal income are all positive, both at the impact and in the long run; except for the capital income tax, which eventually reduces fiscal income. All transition dynamics exhibit an overshooting behavior that is due to the distortionary effects of taxes on the economic activity (the so-called *snowball effect*), which in the model translates to diminishing tax bases along with the reduction in output. The largest positive effect on fiscal income, in both the short and long run, is obtained by increasing social security contributions. This is the result most interesting in the light of fiscal consolidation literature, given that social security taxes are usually neglected in DSGE models.

5 Conclusions

In the literature, most DSGE models focus on the role of households and firms as drivers of the aggregate dynamics, and only a few include the government as a key player in the aggregate economy. This paper develops a prototype DSGE model in which the government is fully parameterized according to SNA rules. We first characterize the government using fiscal data and National Accounts, and we then establish rules of consistency between data and the model economy. We show that the introduction of disaggregated government spending in DSGE models is tractable and has important implications, not only on the aggregate demand but also on aggregate production. Finally, we present a prototype specification of a SNA-compliant government in a RBC model. We draw two main conclusions: first, we underline how the composition of government expenditures in the model affects the response of the economy to private and public exogenous shocks; and second, this paper provides different modelling approaches for the government sector that are consistent with both SNA rules and the general equilibrium, such as the Walras Law.

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