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The Composition Effects of Tax-Based Consolidations on Income Inequality

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Abstract

Many advanced economies have recently embarked on fiscal austerity. As this has come at a time of high and rising income disparities, policy-makers have fretted about the inequality effects of fiscal consolidations. We shed new light on this issue by empirically investigating the (composition) effects of tax-based consolidations on income inequality, output and labour market conditions for a sample of 16 OECD countries over the period 1978-2012. We find that tax-based consolidations reduce income inequality, but at the cost of weaker economic activity. However, tax composition does matter. Indirect taxes reduce income inequality by more than direct taxes, possibly due to the operation of a positive labour supply channel. Higher indirect taxes increase the price of the consumption basket and create incentives for agents to increase their labour supply. We find this effect to be stronger for middle aged women. Looking at specific instruments, general consumption taxes and personal taxes are the most suited to reduce inequality while at the same time minimizing the equity-efficiency trade-off.

Keywords: Income distribution; Tax-based consolidation; Fiscal consolidation; Labour force participation; Tax composition.

JEL classification: E2; H2; O1.

1 Introduction

Following the recent build-up of large public debt stocks, consolidating public finances has become a priority for several governments in developed countries. For instance, in the Euro Area the primary balance grew from -3.8% of GDP in 2009 to 0.1% in 2015. Fiscal policy in the United Kingdom and the United States followed a similar path, with the primary balance ratio being increased respectively from -9.4% to -2.8% and from -11.2% to -1.7% during the same period (IMF (2016)).

Many commentators have raised concerns that the recent wave of fiscal consolidations may exacerbate high and rising income and wealth disparities, with adverse consequences for long-term economic growth. Indeed, a vast strand of the literature argues that inequality may compromise economic growth through a number of channels. First, it creates political instability, which may discourage investments (Alesina and Perotti (1996); Berg and Ostry (2011)). Second, in a highly unequal society, the majority of citizens are not in a condition to save or to invest in education, which reduces investments and the accumulation of human capital (Perotti (1996); Aghion et al. (1999); Galor and Moav (2004); OECD (2014); OECD (2015b)). Third, inequality may also create financial instability. Some studies maintain that inequality played a major role in the great financial crisis of 2007-2008 by creating the conditions for low interest rates, which ultimately fuelled a rapid rise in debt accumulation among lower and middle-income class agents (Fitoussi and Saraceno (2009); Rajan (2010); Kumhof et al. (2015)). In this light, policy-makers have now become more concerned about the consequences for inequality of their policy actions.

Turning to the relation between fiscal consolidation and inequality, there are numerous channels through which the former can influence the latter. The most direct one works through changes in the amount of government redistribution, and its effect is likely to depend on which policy is implemented. As an example, lowering government transfers reduces the disposable income of low-income agents, thereby raising inequality. Conversely, raising the top marginal income tax rate penalises richer agents and therefore should decrease inequality. We refer to this as the government redistribution channel.

Other more indirect channels may also be relevant. A theoretical prediction about their effects is complicated by the fact that the same policy instrument can induce different behavioural responses by agents, depending on what particular economic environment is assumed. This is especially true for what concerns labour supply decisions. As an example, a higher labour tax lowers the net wage and may induce agents to either substitute away labour for leisure (substitution effect) or supply more labour in order to maintain a similar level of consumption (income effect). Considering that a higher consumption tax reduces agents' purchasing power given a fixed nominal wage, the same argument can be made about higher indirect taxes. Hence, depending on which effect dominates – and assuming agents' heterogeneity in either the type of utility function or labour supply elasticities – the inequality effects of higher taxes through the labour supply channel may differ.

Further, fiscal consolidations can induce changes in inequality through the response of the economy. For instance, Ball et al. (2013) argue that fiscal adjustments reduce output and increase unemployment. This decreases the wage share, which in turn tends to increase inequality due to the relatively higher share of wage income in lower-income groups. Moreover, Bastagli et al. (2012) suggest that the tendency of employers to hoard high-skilled workers, who usually have higher income levels, could be another factor potentially raising inequality at times of fiscal restraint. On the other hand, in countries with rigid labour markets, capital owners might find it difficult to

shed off labour and they might decide to forgo income instead. Assuming that capital owners are the richest agents in the economy, this would decrease inequality. Given the highlighted channels, a theoretical prediction on the impact of fiscal consolidations on inequality depends on both the specific policy measures used and the assumptions underlying the economic structure.

In this context, the aim of our analysis is twofold. First, we empirically assess the effects of tax-based consolidations (i.e. consolidations in which tax hikes are larger than spending cuts) on income inequality, output and labour market conditions. Second, we investigate the composition effects, distinguishing between direct and indirect taxes and their main sub-components. Although we are aware of the centrality of both income and wealth inequality in the debate, we focus on income inequality due to limited time series data availability on wealth inequality. Moreover, as income directly impacts living standards, rising income inequality has likely played a more prominent role in fuelling the recent wave of social discontent that policy-makers are now trying to address (Rajan (2010)).

Our primary focus is on disposable income inequality, since ultimately this is what matters for the relation between inequality and growth. However, in order to assess the direction and strength of the government's redistribution channel, we also evaluate the impact of fiscal adjustments on market income inequality. Further, we investigate the effects of tax-based consolidations not only on inequality, but also on economic activity and labour market outcomes. We do so in order to disentangle the other channels through which consolidations affect inequality. We only analyse tax-based consolidations since, as we will see below, this is the area with most disagreement in the literature.

The empirical literature on the effects of fiscal consolidations on income inequality has been limited in scope and has provided mixed evidence. Ball et al. (2013), Woo et al. (2013) and Agnello and Sousa (2014) all start from the same action-based consolidations dataset of Devries et al. (2011), which contains information about spending cuts and tax hikes during fiscal consolidation episodes in 17 OECD countries between 1978 and 2009. However, they employ different empirical methodologies: Ball et al. (2013) use local projections, Woo et al. (2013) adopt seemingly unrelated regressions (henceforth SUR) and fixed effects, and Agnello and Sousa (2014) use SUR. All these contributions distinguish between tax-based and spending-based consolidation episodes, where tax-based consolidations are defined as having tax hikes larger than spending cuts, and *vice versa* for spending-based consolidations. While they all conclude that spending-based consolidations increase income inequality, a consensus on the effects of tax-based consolidations has not been reached. In fact, Ball et al. (2013), Woo et al. (2013), and Agnello and Sousa (2014) find, respectively, significant positive, insignificant and significant negative effects of tax-based consolidations on income inequality.

Our analysis contributes to the existing literature in two aspects. First, most of the empirical works on the effects of fiscal consolidations is carried out in a single-equation setup and assesses the impacts either on growth (Guajardo et al. (2014), and Alesina et al. (2015b)) or on inequality (Ball et al. (2013), Woo et al. (2013), and Agnello and Sousa (2014)).¹ On the contrary, we use a multi-equation setup to take into account both the direct effects of changes in fiscal policy on inequality, output and labour market variables and the indirect (feedback) effects among them. Second, the literature limits the analysis to the effects of overall tax changes and neglects potential composition effects (Ball et al. (2013), Woo et al. (2013) and Agnello and Sousa (2014)). An attempt

¹ An exception is Mourelo and Escudero (2016) who consider the impact of fiscal consolidations on both employment and growth (but not inequality) for 32 countries during the Great Recession.

to empirically study the impact of tax policy changes on inequality in a multivariate framework is carried out by Martínez-Vázquez et al. (2012) and Muinelo-Gallo and Roca-Sagalés (2013). However, these contributions study the effects of budget-neutral tax changes rather than of consolidation episodes. Moreover, Martínez-Vázquez et al. (2012) and Muinelo-Gallo and Roca-Sagalés (2013) do not address the potential endogeneity between fiscal variables and economic activity. Our paper fills this gap in the literature by analysing the effects of specific tax instruments on income inequality in the context of fiscal adjustments that are exogenous to output conditions.

Our sample includes 16 OECD countries during the period 1978-2012. To identify episodes of fiscal consolidations, we use the action-based datasets compiled by Devries et al. (2011) and extended by Alesina et al. (2015b). These two databases exclusively consider consolidation episodes aiming solely at reducing the government deficit, and not at stabilizing economic activity. This allows us to identify exogenous fiscal shocks and limit the potential endogeneity between tax-based consolidations and GDP. Next, we make use of the OECD Revenue Statistics Database (OECD (2015c)) in order to quantify changes in specific tax instruments during fiscal consolidation years. In this way, we are able to pin down which particular instrument was most used during each consolidation year and analyse its effects. As proxies for income inequality, we use both the market and the disposable income Gini indexes, as well as data on top income shares and income ratios. For the estimation, we rely on a panel vector auto regressive (PVAR) methodology.

Our results, which are robust to several different specifications, can be summarized as follows. First, tax-based consolidations significantly lower income inequality. However, this comes at the cost of a contraction in economic activity. Second, we show that using different tax instruments matters; we find that indirect taxes reduce income inequality by more than direct taxes. Looking at the specific tax instruments, general taxes (such as value added and sale) and personal taxes seem to be the most suited to reduce inequality while at the same time minimizing the equity-efficiency trade-off. General taxes also have substantial positive short-run effects on the labour force participation rate, which dampens their recessionary effects. Finally, we do not find corporate taxes to have any effects on income inequality.

Our findings point to the existence of a positive labour supply channel of indirect taxes. Higher indirect taxes decrease the amount of goods that households can buy given a certain income and create incentives for agents voluntarily out of the labour force to start searching for a job. In other words, the income effect dominates the substitution effect. This in turn promotes labour force participation, especially of middle-aged women, and reduces income inequality. Instead, we do not find evidence backing the hypothesis of a negative labour demand channel through which fiscal consolidations jeopardise income equality. In fact, although some taxes do cause the unemployment rate to increase, this is not accompanied by an increase in income inequality. Lastly, we do not find strong evidence pointing to a positive government redistribution channel of tax-based consolidations.

The remainder of the paper is structured as follows. Section 2 presents the dataset and explains the empirical methodology. Section 3 contains our baseline results on the overall effects of tax-based consolidations and reports several robustness checks. Section 4 focuses on the composition of tax-based consolidations and disentangles the specific effects of each single tax instrument. Section 5 concludes.

2 Dataset and Methodology

2.1 Dataset and descriptive statistics

Our empirical analysis covers 16 OECD countries between 1978 and 2012 at annual frequency. To identify exogenous fiscal consolidation shocks, we follow a narrative approach and start from the action-based dataset compiled by Devries et al. (2011). Devries et al. (2011) make use of official policy records to gather real-time data on estimated changes in tax revenues and public spending resulting from consolidation measures decided in 17 OECD countries during the period 1978-2009. The peculiarity of this dataset is that it only selects those consolidation episodes having the sole objective of reducing the budget deficit and hence are exogenous to GDP, labour market variables or inequality developments. Examples of such episodes include consolidations that are caused by the operation of fiscal rules, by the presence of a ceiling on public debt or by commitments to reduce the public debt taken by governments in a supranational context. Next, we use another action-based dataset compiled by Alesina et al. (2015a), which identifies additional fiscal consolidation episodes in 11 countries between 2010 and 2013, employing the same method of Devries et al. (2011).²

After merging the two action-based datasets of Devries et al. (2011) and Alesina et al. (2015a), we have an unbalanced panel with data on consolidation episodes occurred in Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Portugal, Spain, the United Kingdom and the United States over the period 1978-2013, and in Australia, Canada, Finland, Japan, the Netherlands and Sweden over the period 1978-2009. In carrying out the analysis, we restrict the sample to the period between 1978 and 2012 due to the availability of data on the Gini index. Following Alesina et al. (2015b), we exclude the Netherlands from the sample, as for this country the consolidation episodes identified by Devries et al. (2011) can be predicted using their own past values and lagged values of output growth. Therefore, these can not be considered as exogenous shocks (for more information we refer the reader to Alesina et al. (2015b) and Jordà and Taylor (2016)).

The consolidation episodes in our dataset differ significantly in their size and nature. We classify them into three categories: (i) any kind of consolidation episode, (ii) spending-based consolidations (i.e. when spending cuts are larger than tax hikes), (iii) tax-based consolidations (i.e. when tax hikes are larger than spending cuts). We identify 188 consolidation episodes, of which 112 are spending-based, 73 tax-based, and 3 featured tax hikes exactly equal to spending cuts (hence, we do not classify them as neither spending- nor tax-based consolidations). Since tax hikes and spending cuts are likely to affect income inequality differently, including episodes of spending-based consolidations in the analysis may confound the results on the effects of tax changes. Therefore,

² An alternative approach to identify episodes of fiscal adjustments consists of simply considering periods of large changes in tax revenues and government spending. We refer to it as the statistical approach. The narrative approach and the statistical approach may yield very different results when analysing the effects of fiscal policy. For instance, Guajardo et al. (2014) analyse the growth impact of fiscal consolidations using first the dataset compiled by Devries et al. (2011), based on the narrative approach, and then a dataset compiled by Alesina and Ardagna (2013), based instead on the statistical approach. Estimates based on the former suggest that fiscal consolidation has Keynesian contractionary effects. On the contrary, estimates based on the latter find neoclassical expansionary effects (for similar findings see also Afonso and Jalles (2014)). Potential reasons behind these opposite results may be that the statistical approach (i) tends to classify periods in which the budget balance improved simply due to favourable economic conditions as periods of fiscal consolidation, and (ii) gives less weight to unsuccessful episodes of fiscal consolidation (i.e. when the government does not succeed in consolidating the budget). We acknowledge that the narrative approach may also have some drawbacks. First, it largely relies on subjective judgements to identify exogenous fiscal consolidations and quantify their magnitude. Second, it may not eliminate completely the endogeneity between fiscal policy and growth, if the debt level and changes in output are correlated. As it will be clear later, we try to address the first point by combining data from the action-based datasets with real ex-post fiscal data. Overall, we believe that the narrative approach, although not immune from criticisms, is the most suited approach to address the endogeneity problem.

we mainly focus on tax-based consolidations. We use data on spending-based consolidations for a robustness check.

Besides distinguishing between spending cuts and tax hikes, the action-based dataset of Devries et al. (2011) does not always provide additional information about the composition of each consolidation episode. To gather data about the different tax instruments used by governments, we rely on the OECD Revenue Statistics Database (OECD (2015c)). This provides information on revenues generated by different tax instruments, measured as a share of GDP. Particularly, we focus on two broad categories: direct and indirect taxes. Property and wealth taxes show only small changes relative to direct and indirect taxes during tax-based consolidations. Hence, we do not consider them in the analysis.

Direct taxes include (i) personal taxes, (ii) corporate taxes, (iii) social security contributions (henceforth SSC) and (iv) payroll taxes. Indirect taxes include: (i) general consumption taxes (henceforth GT), such as value added and sale taxes, (ii) taxes on specific goods and services (henceforth SGS), such as for instance excises and fiscal monopolies, and (iii) taxes on the use of goods and services (henceforth UGS), such as taxes on vehicles. For illustrative purposes, a flow-chart of the composition of direct and indirect taxes is depicted in Appendix A. Due to the marginal change of payroll and UGS tax revenues during tax-based consolidations we exclude them from the analysis.

Our identification strategy is summarized in Appendix B. Table 1 shows the mean values of tax hikes and spending cuts identified through the narrative approach and the corresponding ex-post changes in tax revenues for the three different categories of consolidation episodes discussed above.

Table 1: Mean values of consolidation episodes during 1978-2012 (% of GDP)

	Narrative approach		Realization	Obs.
	Tax	Spending	Tax	
Any consolidation	0.45	0.64	0.45	188
Spending-based	0.28	0.91	0.37	112
Tax-based	0.72	0.24	0.57	73

Notes: Narrative approach refers to the real-time consolidation episodes identified by Devries et al. (2011) for the 1978-2009 period and Alesina et al. (2015a) for the 2010-2013 period. Realization refers to tax data provided by OECD (2015c). Tax and spending refer respectively to changes in total tax revenues and general government spending. The spending-based sample comprises episodes in which spending cuts, as identified through the narrative approach, were larger than tax hikes, and *vice versa* for the tax-based sample. All numbers are expressed as averages. The column obs. denotes the number of observations in the sample.

Source: Devries et al. (2011), Alesina et al. (2015a), OECD (2015c) and authors' own calculations.

Table 1 leads us to some interesting considerations. The average ex-post change in tax revenues during tax-based consolidations (0.6% of GDP) was lower than the government's real-time estimate (0.7% of GDP). Potential explanations may be that in some cases policy-makers have either relied on over-optimistic assumptions concerning the response of the business cycle and of the tax base to changes in the tax policy or have backtracked from their original plans. We will come back on this issue when performing robustness checks.

Table 2 presents descriptive statistics of the change in the different tax instruments we focus on during (i) the full, and (ii) the tax-based consolidation samples. We notice that governments typically relied the most on direct taxes, and particularly personal taxes, to consolidate the budget. Among indirect taxes, GT were by far the most used instrument. The correlation between the changes in direct and indirect tax revenues during tax-based consolidations years is equal to 0. This suggests that in most cases governments resorted either to direct or indirect taxes, rather than to a combination of them, to consolidate the budget. Table 3 shows the correlation coefficients among the different direct and indirect tax instruments during tax-based consolidations. Personal and corporate taxes and SSC display very low correlations among each other. In this light, our aim to assess the composition effects of tax-based consolidations gains even more relevance.

Table 2: Mean changes of different tax instruments, 1978-2012

	Full sample	Tax-based
Total	0.13	0.57
Direct	0.09	0.41
Indirect	0.02	0.15
Personal	0.01	0.22
Corporate	0.02	0.07
SSC	0.05	0.09
GT	0.05	0.12
SGS	-0.04	0.02

Notes: The tax-based sample comprises consolidation episodes in which tax hikes, as identified through the narrative approach, were larger than spending cuts. For a precise definition of the different tax categories refer to Appendix A.

Source: OECD Revenue Statistics database and authors' own calculations.

Along with the series of tax shocks, we also include other variables in our dataset. As a proxy for inequality we rely on the Gini index, calculated both on the basis of market and disposable incomes.³ This measure has two main advantages: it is Lorenz-consistent and its estimates are widely available, both over time and across countries.⁴ We collect the Gini indexes from the Standardized World Income Inequality Database (SWIID), compiled by Solt (2016). The advantage of using the SWIID is that it provides the most comparable series across countries.

³ The Gini index measures the extent to which the distribution of income among individuals deviates from a perfectly equal distribution. It ranges between 0 (perfect equality) and 100 (perfect inequality). It is usually estimated from survey data and it can be based on both market and disposable income. The Gini index of market income (or gross Gini index) is calculated on income before taxes and transfers. The Gini index of disposable income (or net Gini index) is calculated on income after taxes and transfers.

⁴ A measure of inequality is said to be Lorenz-consistent if it satisfies the following four criteria: (i) the anonymity principle (i.e. it does not matter who is earning the income), (ii) the population principle (i.e. the population size does not matter), (iii) the relative income (i.e. only relative income matters), and (iv) the Dalton transfer principle (i.e. if an income distribution can be achieved from another by constructing a sequence of regressive transfers, then the newly created distribution must be deemed more unequal than the original one).

Table 3: Correlation of changes in tax revenues during tax-based consolidation years

	Personal	Corporate	SSC	GT	SGS
Personal	1.00	0.04	0.04	-0.07	-0.14
Corporate		1.00	-0.05	-0.10	0.12
SSC			1.00	0.11	0.06
GT				1.00	-0.34
SGS					1.00

Notes: SSC, GT and SGS stand for, respectively, social security contributions, general taxes and taxes on specific goods and services.

Source: OECD Revenue Statistics database and authors' own calculations.

For data on the labour force participation and the unemployment rates, as well as for real per capita GDP, we rely on information contained in OECD (2015a). The labour force participation rate is defined as the percentage of the population aged between 15 and 64 years which is either employed or unemployed. Similarly, the unemployment rate is the share of jobless people in the labour force between 15 and 64 years who are available to work and are actively seeking employment.⁵

To carry out some extensions and robustness checks, we collect additional data. As alternative inequality measures, we employ the share of income belonging to the richest 0.01%, 0.01-1%, and 1-10% individuals as well as the ratios of income of the individuals at the 90th, 50th and 10th percentiles of the income distribution.⁶ Both top income shares and the ratios of income measure market income inequality and are measured in percentage points. We obtain top income share data from the World Wealth and Income Database (WID). Income ratios are taken from OECD (2015a). Due to some missing values, we linearly interpolate these alternative inequality series.

To construct alternative tax shock variables, we retrieve data on the standard rate of the general consumption tax for all the countries in our sample except the United States, where consumption taxes are set by the states rather than the federal government. For European countries, we use information contained in EC (2016). For Australia, Canada and Japan we use information available on their respective government's websites.

To identify episodes of systemic banking crises, we use the dummy variable created by Laeven and Valencia (2012). Moreover, from OECD (2015a) we collect: (i) government consumption as a percentage of GDP, (ii) the consumer price inflation rate, (iii) the employment rate, defined as employed people as share of total population aged between 15 and 64 years, (iv) average hours worked per employed individual, (v) GDP per hour worked. Finally, we collect (i) imports and exports as a percentage of GDP, (ii) the trade balance as a percentage of GDP, and (iii) gross savings as a percentage of GDP from WB (2015).

⁵ The only exception is Austria, for which data for the 15-64 age group is not available before 1994. For this country, we use labour force participation and unemployment rates among all age groups.

⁶ Top income shares are estimated from tax filing data and are based on market incomes. They are used as proxies for the concentration of incomes in the right tail of the income distribution. The ratios of income are estimated from survey data.

2.2 Methodology

For the econometric analysis we make use of PVAR models. By adopting a multi-equation methodology, we account for potential interactions among variables that might be otherwise overlooked within a single-equation framework.⁷

Given that our dataset is at the annual frequency, we estimate the VAR model in a panel format by pooling together observations for all the countries considered. This approach implies imposing cross-country homogeneity on the relationships among the endogenous variables. To take into account cross-country heterogeneity, we follow Beetsma and Giuliodori (2011) and include in the regressions country-fixed effects and country-specific linear time trends.⁸ Additionally, we include time-fixed effects to control for unobserved common factors. In Section 1 of the Online Appendix we show that our main results are robust to the inclusion of alternative deterministic components.

Our PVAR takes the following standard form:

$$A_0 y_{i,t} = A_1 y_{i,t-1} + A_2 y_{i,t-2} + \alpha_i + \delta_t + \tau_{it} + \epsilon_{i,t} \quad (1)$$

where the sub-indexes (i, t) refer respectively to country and time, $y_{i,t}$ is the vector of endogenous variables, the A s are the coefficient matrices, and α_i , δ_t and τ_{it} denote respectively country-fixed effects, time-fixed effects and country-specific linear time trends. Finally, $\epsilon_{i,t}$ is a vector of error terms, which are assumed to be serially uncorrelated. The baseline PVAR model includes five variables, namely the tax shock (as a percentage of GDP), the real per capita GDP (in logs), the disposable Gini index (in units), the unemployment rate and the labour force participation rate (both in percentage points).

Following Sims (1980), the endogenous variables enter the PVAR in levels. This allows us to model possible cointegrating relationships among them. In line with a standard practice in the VAR literature on the macro effects of fiscal policy at the yearly frequency and consistently with the Akaike and Schwarz information criteria, we opt for a baseline specification containing two lags of the endogenous variables. In Section 1 of the Online Appendix we show that our results are robust to different lag specifications and to using first differences rather than levels. After adjustments, and due to some missing data, we have a total of 479 observations.

To construct our tax-based consolidation shock variable, we create a dummy d_t^1 taking value 1 in years where governments implement a tax-based consolidation and 0 otherwise. We then interact this dummy variable with the first difference of total tax revenues as a percentage of GDP. Next, we define direct (indirect) tax-based consolidations as those instances in which (i) governments implement a tax-based consolidation and (ii) the change in direct (indirect) tax revenues is larger than that of indirect (direct), property and wealth tax revenues. We then create a dummy variable d_t^2 (d_t^3) for direct (indirect) tax-based consolidations and we interact it with the change in direct (indirect) tax revenues. Among direct (indirect) tax-based consolidations, we further distinguish between personal, corporate and SSC (GT and SGS) tax-based consolidations. To create the respective shock variables we proceed in a fashion similar to that for direct and indirect tax-based consolidations.

⁷ Several contributions in the literature employ the VAR methodology to estimate the macroeconomic effects of fiscal policy shocks and identify these through the narrative approach. For references, see Ramey (2011), Guajardo et al. (2014), and Alesina et al. (2015b).

⁸ We include linear trends since the real GDP, the Gini index and the labour force participation all display a trending behaviour.

To sum up, our shock variables are constructed according to the following formula:

$$X_{i,t}^j = d_{i,t}^j \Delta t_{i,t}^j \quad (2)$$

where $j = 1$ stands for overall tax-based consolidation, and $j = 2, \dots, 8$ for direct, indirect, personal, corporate, SSC, GT and SGS tax-based consolidation; $t_{i,t}^j$ denote revenues stemming from tax instrument j and Δ is the first difference operator.⁹ We report the number of observations for each tax-based consolidation sample and its mean value in Table 4.

Table 4: Mean value (in percentage of GDP) and frequency of tax-based consolidation shocks

	Overall	Direct	Indirect	Personal	Corporate	SSC	GT	SGS
Mean	0.57	0.66	0.51	0.52	0.52	0.41	0.61	0.27
Obs.	73	43	23	28	9	6	13	10

Notes: Mean refers to the mean value of tax-based consolidation shock variables. Obs. refers to the number of each tax-based consolidation shock. Direct and indirect tax-based consolidations do not sum up to the number of overall tax-based consolidations since in 7 instances the change in property and wealth taxes was higher than that of direct and indirect taxes.

Source: OECD (2015c) and authors' own calculations.

Our approach to construct the tax shocks using tax revenues has the advantage of capturing the effects of policy interventions on both the tax rate and the tax base. Indeed, changes to the tax base are fairly common. Tax credits, exemptions, or deductions are often introduced or removed. Even not indexing the nominal threshold defining the different brackets of the personal income tax to the price level amounts to a change in the base. Ideally, we would like to use a proxy for changes in the tax rate and one for the tax base. However, due to lack of a quantifiable measure for the tax base, using tax revenues is the most suited approach to address our research question.

Given the characteristics of the action-based datasets, which identify consolidation episodes that were motivated by the sole objective of reducing the budget deficit, the most natural way to identify the PVAR in equation (1) is to use a Cholesky decomposition. This strategy is particularly convenient when one of the variables is exogenous to the others, as in our case. By ordering our tax variable first, we impose this to be contemporaneously unaffected by GDP, the Gini index, the unemployment rate or the labour force participation rate. On the other hand, we allow these variables to be contemporaneously affected by the tax shock and by each other, thus capturing all potential feedback effects. Moreover, an important advantage of using the Cholesky decomposition is that the order of the variables after the shock does not matter (see Christiano et al. (1999) for a theoretical explanation).

In the following sections, we estimate impulse response functions (hereafter IRFs) to tax shocks over a 10-year horizon and construct confidence intervals as ± 1.645 standard errors (equivalent to a 90% confidence level) around the mean response.¹⁰ To compute standard errors we use Monte

⁹ We also estimate the model using alternative shock variables, which we construct by interacting the change of revenues stemming from each tax instrument with the dummy variable $d_{i,t}^1$ taking value 1 in years where governments implement a tax-based consolidation and 0 otherwise. The results are qualitatively in line with those obtained using our standard shock variables.

¹⁰ Alternative approaches to construct confidence intervals are also accepted in the literature (for instance, Ball et al. (2013) use ± 1 standard errors), but we opt for a more conservative approach.

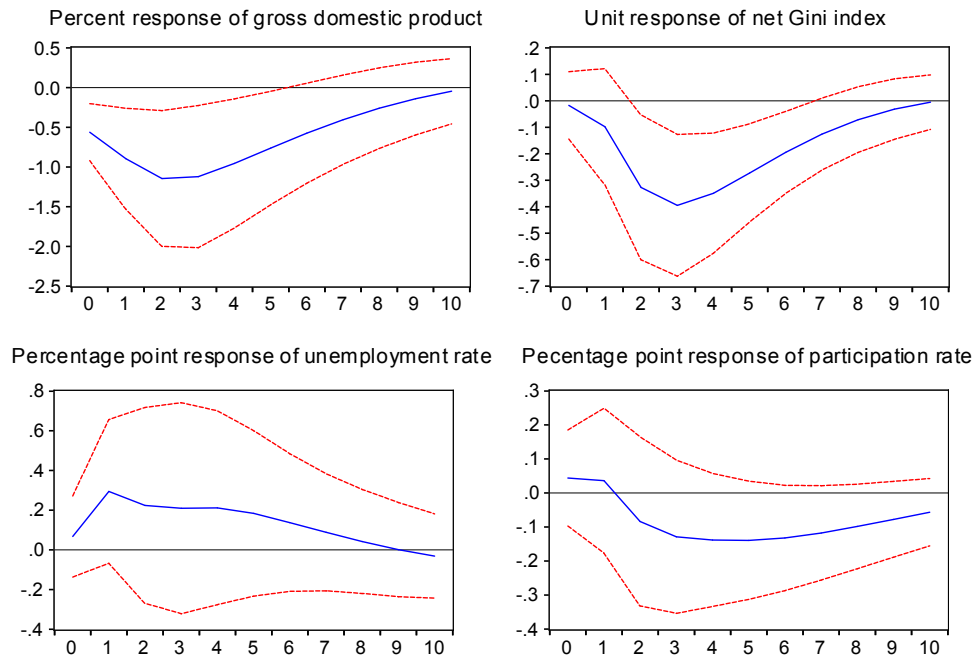
Carlo methods with 1,000 replications. The GDP response is measured in percentage change, while the response of the Gini index is in units and the response of both the unemployment and the labour force participation rates are in percentage points.

3 Overall effects of tax-based consolidations

In this section, we present our baseline results. Figure 1 shows the response of real GDP, the disposable income Gini index, the unemployment rate and the labour force participation rate to a 1% of GDP increase in total tax revenues during tax-based consolidations. The response of the Gini index is not statistically different from 0 on impact, but it turns negative and significant 2 years after the shock (in the order of -0.3 percentage points), and it remains significant up to 6 years after the shock. In absolute value, the 0.4 drop in the Gini index after 3 years (the peak response) is equal to about a tenth of its sample standard deviation. Hence, our estimates suggest that tax-based consolidations have statistically significant and economically meaningful effects in decreasing disposable income inequality.

Higher equality is achieved at the cost of a decline in economic activity. Looking at the other variables, a 1% of GDP increase in tax revenues has significant negative short to medium run effects on real GDP. Output decreases by 0.6% on impact, by 0.9% after 1 year, 1.1% after 3 years, and 0.8% after 5 years. The effect becomes insignificant in the long run. The responses of the unemployment rate and the labour force participation rate are respectively positive and negative in the short to medium term, which can be interpreted as a consequence of the economic contraction. However, neither of them is statistically different from 0.

Figure 1: IRF to a 1% of GDP tax-based consolidation shock



Note: The central solid blue line represents the response to a 1% tax shock, the solid red lines represent the 90% confidence intervals.

We now investigate to what extent changes in government redistribution may be driving our result that tax-based consolidations decrease income inequality. To do so we estimate a 6-variable PVAR featuring both the market and the disposable income Gini indexes. The difference between them can be interpreted as a measure of the reduction of inequality that is achieved through taxes and transfers, with higher values indicating more redistribution. If the two variables exhibit similar responses, then we could hypothesize that changes in disposable income inequality are mostly driven by changes in the market income distribution. Conversely, if the responses are different, changes in the amount of government redistribution would (also) be driving the response of disposable income inequality.

Table 5 reports relevant results. The estimates for the market and the disposable Gini indexes are very similar. This suggests that the reduction in inequality observed in our baseline specification is achieved mainly through a reduction in market income disparities.

Overall, our analysis points to a medium-term trade-off between income equity and economic efficiency. This is partially in line with what was found by Agnello and Sousa (2014), who employ the SUR methodology and find that tax-based consolidations have beneficial effects on income equality, which however disappear within two years.

Table 5: Augmented specification with both the market and disposable income Gini indexes

	Impact	1y	3y	5y	10y
GDP	-0.64	-1.00	-1.15	-0.65	0.10
Disposable Gini	-0.04	-0.13	-0.41	-0.26	0.02
Market Gini	-0.12	-0.18	-0.57	-0.30	0.03
Unemployment	0.06	0.29	0.19	0.12	-0.09
Participation	0.06	0.04	-0.14	-0.16	-0.04

Notes: The table reports the response to a 1% of GDP tax-based consolidation shock.

Bold numbers indicate significance at the 10% confidence level.

To verify the validity of our results, we carry out a number of robustness checks on our baseline model. We report relevant results in Section 1 of the Online Appendix. We first estimate responses to a 1% increase in total taxes during both any consolidation year and a spending-based consolidation year. The estimated coefficients suggests that the contemporaneous presence of spending cuts and tax hikes might confound the results on the effects of tax hikes. That is why we focus exclusively on tax-based consolidations. Next, we show that our baseline results are not biased by (i) anticipation effects, (ii) reverse causality issues, (iii) or episodes of consolidations during which revenues actually decrease. We also show that our results are robust to using alternative shock variables to control for potential endogeneity between GDP and tax revenues. Specifically, we estimate the model employing both cyclically adjusted taxes and the original real time tax estimates compiled by Devries et al. (2011) and Alesina et al. (2015a).

As additional robustness checks, we repeat the estimation (i) including different deterministic components, (ii) using different lags specifications, and (iii) relying on the local projection method. Moreover, we show that our results are not driven by (i) particular countries, (ii) time periods, and (iii) shock outliers. We also estimate the model including a set of control variables commonly used in the literature. Finally, we use alternative measures of inequality, such as income ratios

and the top income shares. Overall, these robustness checks confirm the validity of our baseline results.

4 Composition effects of tax-based consolidations

4.1 Direct and indirect tax-based consolidations

In the previous section, we have analysed the effects of changes in overall taxes during fiscal consolidation episodes. In what follows we disentangle the effects of specific tax instruments. As a first step, we estimate IRFs to a 1% of GDP in direct and indirect tax-based consolidation shocks. Results are presented in Table 6.

Table 6: Composition effects of tax-based consolidations

	Impact	1y	3y	5y	10y
<i>a) Tax-based consolidation (baseline)</i>					
GDP	-0.56	-0.90	-1.12	-0.76	-0.05
Disposable Gini	-0.02	-0.10	-0.40	-0.27	-0.01
Unemployment	0.07	0.29	0.21	0.18	-0.03
Participation	0.04	0.04	-0.13	-0.14	-0.06
<i>b) Direct tax-based</i>					
GDP	-0.59	-0.72	-1.13	-0.80	-0.06
Disposable Gini	0.03	0.13	-0.14	-0.17	0.00
Unemployment	0.06	0.19	-0.06	-0.04	-0.10
Participation	-0.06	0.06	-0.08	-0.08	0.00
<i>c) Indirect tax-based</i>					
GDP	-1.79	-4.10	-4.90	-3.86	-0.74
Disposable Gini	-0.32	-0.79	-1.25	-0.88	-0.17
Unemployment	0.75	1.90	2.43	1.82	0.10
Participation	0.59	0.22	-0.26	-0.56	-0.32

Notes: The table reports the response to a 1% of GDP overall, direct and indirect tax-based consolidation shock respectively. Bold numbers indicate significance at the 10% confidence level.

A typical direct tax-based consolidation does not have significant positive effects in reducing disposable income inequality, while an indirect-based one does. The Gini index decreases on average by 0.8 percentage points the year after an indirect tax-based consolidation shock. After 3 years the decline is equal to 1.3, while after 5 years it is 0.9. Regardless of the instrument used, a tax shock has always a negative and significant effect on real GDP on impact. However, this effect is stronger and more persistent in the case of indirect tax-based consolidations. Consistently with the large and persistent decline in output, the unemployment rate significantly increases both on impact and in the short to medium term in the case of indirect taxes. Instead, the labour force participation rate increases by 0.6 percentage points on impact after an indirect tax shock. The reaction of the labour force participation rate decreases and even turns negative and significant

after 5 years, which we interpret as a lagged response to the contraction in economic activity. In contrast, neither the unemployment rate nor the participation rate display significant reactions to a direct tax-based consolidation.

Concerning the estimated response of real GDP, our results are supported by recent theoretical work by Gehrke (2014). In analysing fiscal policy rules in a new Keynesian model with labour market frictions, Gehrke (2014) finds that multipliers are large for indirect taxes, such as consumption taxes, while they are small for direct taxes, such as labour taxes.

Instead, our results contrasts those of Muinelo-Gallo and Roca-Sagalés (2013), who find that an increase in direct taxes has a negative impact on both net inequality and growth whereas increasing indirect taxes does not have significant effects. However, Muinelo-Gallo and Roca-Sagalés (2013) analyse the effects of budget-neutral changes in fiscal policy rather than of fiscal consolidations. Moreover, their model neglects potential dynamic effects and it assumes market income inequality to be exogenous, whereas it may well be endogenous to both growth and fiscal policy.

We now narrow the focus on the effects of indirect taxation on inequality. Most of the literature assumes indirect taxes to be regressive, since low-income agents normally spend a larger fraction of their income on consumption goods relative to high-income households. However, following this argument, in order to find a direct positive effect of indirect taxes on inequality, a measure of consumption-based inequality should be used. Unfortunately, limited cross-country data prevents us from investigating further the validity of this line of thought.

On the other hand, using data on income inequality we find that indirect taxes improve equity. This outcome may be partly explained by the operation of a positive labour supply channel. In fact, our results suggest that indirect taxes create incentives for agents to participate more actively in the labour market. This may be due to a negative income effect, since indirect taxes raise the price of the consumption basket. Although we cannot estimate it due to lack of data on labour market outcomes by income groups, the extent of the labour supply channel is likely to be stronger for lower-income agents. The reason for this is that they tend to spend a larger fraction of their income on consumption goods. Hence, they should be relatively more affected by an increase in indirect taxes.

In this respect, the hypothesis that the marginal propensity to work may vary with income or wealth has been recently investigated on a theoretical level by Athreya et al. (2016). In their analysis, a wealth-based redistribution program from high-income to low-income households can decrease the labour supply of low-income agents by more than it raises that of high-income agents, if at least some of the former are borrowing-constrained. This is because borrowing-constrained agents will not save any portion of the transfer, thus increasing their consumption and leisure time.

Additionally, Blundell et al. (2016) have further highlighted another form of labour supply heterogeneity, namely within household heterogeneity. In their model, spouses can react differently to wage changes. This is consistent with their empirical findings evidencing female labour supply as an important household insurance mechanism. In this respect, we next investigate the role of female labour supply in the context of our analysis.

We extend our baseline specification on the effects of an indirect tax-based consolidation by adding more variables. Results are reported in Table 7. First, we add the inflation rate (Panel (b)). This goes up by 1.9 and 2.3 percentage points respectively on impact and after one year, thus confirming that the price of the consumption basket does increase following an indirect tax-based consolidation.

Table 7: Additional results on indirect tax-based consolidations

	Impact	1y	3y	5y	10y
<i>a) Indirect-tax based</i>					
GDP	-1.79	-4.10	-4.90	-3.86	-0.74
Disposable Gini	-0.32	-0.79	-1.25	-0.88	-0.17
Unemployment	0.75	1.90	2.43	1.82	0.10
Participation	0.59	0.22	-0.26	-0.56	-0.32
<i>b) Inflation rate</i>					
GDP	-1.64	-3.81	-4.56	-3.70	-0.90
Disposable Gini	-0.29	-0.72	-1.17	-0.85	-0.17
Unemployment	0.67	1.72	2.23	1.70	0.17
Participation	0.53	0.13	-0.21	-0.51	-0.34
Inflation rate	1.88	2.34	-0.41	-0.48	-0.13
<i>c) Men and women participation</i>					
GDP	-1.76	-3.93	-4.48	-3.41	-0.64
Disposable Gini	-0.26	-0.67	-1.06	-0.75	-0.16
Unemployment	0.70	1.77	2.16	1.55	0.05
Men participation	0.06	0.19	-0.24	-0.41	-0.20
Women participation	1.08	0.21	-0.22	-0.54	-0.30
<i>d) Men and women participation and employment</i>					
GDP	-1.85	-4.10	-4.75	-3.68	-0.77
Disposable Gini	-0.27	-0.66	-1.04	-0.76	-0.18
Men employment	-0.64	-1.70	-2.16	-1.72	-0.10
Women employment	0.64	-0.56	-1.48	-1.55	-0.49
Men participation	0.08	0.21	-0.20	-0.37	-0.22
Women participation	1.13	0.24	-0.17	-0.48	-0.35
<i>e) Men and women participation and employment, 45 to 54 year age group</i>					
GDP	-1.89	-5.27	-6.86	-4.82	-1.11
Disposable Gini	-0.39	-0.86	-1.30	-0.97	-0.36
Men employment, 45 to 54 age group	-0.55	-1.90	-2.75	-2.21	-0.41
Women employment, 45 to 54 age group	1.35	-0.01	-1.34	-1.53	-0.85
Men participation, 45 to 54 age group	-0.16	-0.51	-0.54	-0.45	-0.12
Women participation, 45 to 54 age group	1.59	0.66	0.01	-0.34	-0.56

Notes: Panel (a)-Panel (e) report the response to a 1% of GDP indirect tax-based consolidation under alternative PVAR specifications. Bold numbers indicate significance at the 10% confidence level.

Second, we distinguish between women and men labour force participation rates (Panel (c)). In accordance with the several contributions emphasizing higher participation elasticities for women (see for instance Blundell et al. (2016) and Bargain et al. (2011)), we find a significant response of 1.1 percentage points in female labour force participation, while the response of male participation is not significant. Third, in order to check that higher participation is actually reflected in higher

employment, we estimate the model including employment rates as percentages of the population instead of the unemployment rates (Panel (d)). Women employment increases by 0.6 percentage points on impact, whereas the change in men employment is negative (-0.6), but not significant. In the medium term, as the depth of the recession gets larger, both male and female employment rates significantly decrease. However, the magnitude of the declines is smaller for women than for men.

Finally, we estimate the model including both female and male participation and employment rates for different age groups (15 to 24, 25 to 34, 35 to 44, 45 to 54 and 55 to 64). In line with the findings of Blundell et al. (2016), our hypothesis is that second earner spouses should display larger labour supply elasticities. In turn, these are more likely to be prime age women. Hence, we expect stronger responses for women in the 35 to 44 and the 45 to 54 age groups. In Table 7 we only report results for the 45 to 54 age group (Panel (e)). This, together with the 35-44 age group is the only one to have significant coefficients. For both groups the impact responses of female participation and employment are positive and significant, at 1.6 and 1.4 percentage points respectively, whereas those of men are not.

These findings confirm our earlier hypothesis about the existence of a positive labour supply channel of indirect taxes and further point to important gender and age heterogeneities in the agents' labour supply responses. Our results further suggest that, by boosting women participation and employment, higher indirect taxes might also reduce gender inequality.¹¹ Unfortunately, scarce data availability prevents us to also explore income as another source of heterogeneity in the agents' response to changes in indirect taxes. However, we believe income to be another important factors in determining the negative effects of indirect tax-based consolidations on income equality.¹²

Before narrowing the analysis further down, we perform a number of robustness checks. First, we check whether our results remain valid once including both direct and indirect tax-based consolidation shocks simultaneously rather than one at a time. Second, we check whether our results are driven by a particular country. To this purpose, we estimate the model excluding one country at a time. Finally, we estimate the model using our alternative measures of income inequality: the the top income shares and the income ratios. We report and discuss in greater detail relevant results in Section 2 of the Online Appendix. Overall, our results are robust to these different specifications.

4.2 Composition effects of direct tax-based consolidations

In this section, we examine the effects of specific direct tax instruments. In particular, we focus on personal, corporate and SSC tax-based consolidations. Our analysis so far has suggested that direct tax-based consolidations only have a significant negative impact effect on GDP. However, it may be that different instruments have different effects. For instance, personal taxes are generally deemed to be more progressive – and therefore more redistributive – than SSC. This is all the more true in those countries where SSC are directly used to finance the future pensions or where governments call for a cap on the maximum taxable income for SSC. Corporate taxes, instead, may

¹¹ We also estimated the model including both female and male participation by age group for direct tax-based consolidations and found again positive, although not significant, responses for middle-aged women, and negative responses for men.

¹² An alternative, but not mutually excluding, channel may be working through the effects of indirect taxes on inequality via capital income and labour demand. The fall in GDP and the rise in unemployment might affect high-skilled workers and capital owners particularly strongly, thereby lowering their market incomes more than for low-income households. This would also lead to a reduction in measured inequality.

have ambiguous effects on income inequality, as capital income owners may shift the tax burden on wage earners (see Bastagli et al. (2012) for a discussion).

Table 8 shows the estimates to a 1% of GDP personal, corporate and SSC tax-based consolidation shock.¹³ To ease the comparison, in Panel (a) we also display the baseline results for direct tax-based consolidations. The estimates point out that personal tax-based consolidations have some significant effects on the Gini index. Following a 1% of GDP shock, the Gini index decreases by 0.7 percentage points after 3 years and by 0.6 percentage points after 5 years. Real activity also drops in the short to medium term, with GDP declining by 0.9%, 1.3%, 2.1% and 1.7% respectively on impact and after 1, 3, and 5 years. Instead, neither the unemployment rate nor the labour force participation rate are significantly affected, although the estimates have the expected sign (respectively positive and negative).

Table 8: Composition effects of direct tax-based consolidations

	Impact	1y	3y	5y	10y
<i>a) Direct tax-based</i>					
GDP	-0.59	-0.72	-1.13	-0.80	-0.06
Disposable Gini	0.03	0.13	-0.14	-0.17	0.00
Unemployment	0.06	0.19	-0.06	-0.04	-0.10
Participation	-0.06	0.06	-0.08	-0.08	0.00
<i>b) Personal tax-based</i>					
GDP	-0.87	-1.34	-2.10	-1.72	-0.38
Disposable Gini	-0.08	-0.09	-0.66	-0.58	-0.05
Unemployment	0.31	0.50	0.52	0.47	0.04
Participation	-0.04	0.06	-0.21	-0.30	-0.16
<i>c) Corporate tax-based</i>					
GDP	-1.23	-1.59	-2.14	-1.45	-0.22
Disposable Gini	0.25	0.42	0.10	-0.04	-0.03
Unemployment	0.15	0.23	0.17	0.08	-0.20
Participation	-0.10	-0.14	-0.14	-0.10	0.03
<i>d) SSC tax-based</i>					
GDP	1.87	1.91	-3.40	-3.67	-1.88
Disposable Gini	-0.29	0.00	0.77	0.28	-0.23
Unemployment	-0.89	-1.27	-2.92	-0.62	0.05
Participation	1.24	2.63	1.27	0.82	0.26

Notes: The table reports the response to a 1% of GDP direct, personal, corporate and SSC tax-based consolidation shock. Bold numbers indicate significance at 10% level.

¹³ These results are robust to different PVAR specifications in which several shocks enter at the same time. Estimates are available upon request. This comes as no surprise given the small correlation coefficients between SSC, personal and corporate taxes (see Table 3).

A corporate tax-based consolidation does have negative, although not statistically significant, effects on GDP. The effects on the other variables are negligible. Since capital profit earners have normally higher incomes than wage earners, in principle we would expect that corporate taxes should reduce inequality. However, recent empirical evidence suggests that in advanced economies capital profit earners manage to shift between 45% and 75% of the corporate tax burden to the employees' wages (Bastagli et al. (2012)). This would explain the muted response in the Gini index. Our estimates of a SSC tax-based consolidation show a significant positive short-term response of the labour force participation. However, this result is driven by one particular country and does not survive when this country is excluded from the sample (see the country stability robustness check in Section 2 of the Online Appendix).

Our results are partly in line with those of Martínez-Vázquez et al. (2012), who analyse how changes in tax revenues affect inequality in a panel of 150 countries over the period 1970-2009 using the Generalized Method of Moments estimation. They find that personal income taxes have a significant negative effect on income inequality. The effects of corporate taxes in reducing inequality, instead, are estimated to be weaker in more open economies. Differently from our results, SSC are found to be positively associated with income inequality.

4.3 Composition effects of indirect tax-based consolidations

Indirect taxes comprise several instruments. We focus on GT and SGS taxes, as revenues stemming from other instruments only show marginal changes during tax-based consolidations. Concerning the potential impact of GT and SGS taxes on income inequality, we do not have a particular prior. Both of them are expected to increase consumption inequality. For what concerns income inequality, instead, the potential effects are more ambiguous and likely to depend on the contemporaneous responses of real economic activity and labour market variables. On the one hand, higher GT and SGS taxes decrease the marginal return of labour. Hence, agents might respond by substituting away labour for more leisure time (i.e. substitution effect). On the other hand, since agents' real income decreases, they could respond by supplying more labour (i.e. income effect). Our previous findings suggest that overall the income effect may dominate the substitution effect. We now investigate whether these results hold for both the sub-components of indirect taxes.

Estimates for GT and SGS tax-based consolidations are presented in Table 9 (Panels (b) and (c)). In the medium term, a GT shock significantly lowers inequality, with the Gini index decreasing 0.6 percentage points after 5 years. At the same time, GT produce a statistically significant decline in real economic activity, with GDP declining by 3.6 and 3.3 percentage points respectively after 3 and 5 years. The response of labour participation is positive and significant, at 0.5 percentage points, on impact and remains positive up to 3 years after the shock, although it loses significance. Therefore, the income effect seems to dominate the substitution effect.

To provide further empirical evidence backing our results on GT, we estimate responses to a one percentage point increase in either the standard VAT rate or the goods and service tax (GST) rate during both tax-based and GT-based consolidation years.¹⁴ We report IRFs in Panel (a) and (b)

¹⁴ Several countries introduced a GT tax only after the beginning of our sample. This is the case for Australia (in 2000), Canada (in 1991), Finland (in 1994), Japan (in 1989), Portugal (in 1986) and Spain (in 1986). Moreover, in the United States, GST rates are fixed by local (State) governments and not by the federal government. Hence we exclude the United States from this analysis. In total, we count 15 instances of tax-based consolidations that resulted in a change in the standard GT rate in the 15 countries of our sample excluding the United States. Of these 15 episodes, we exclude one episode, namely Ireland in 1984, since in that occasion the government drastically overhauled the VAT system. More precisely, it decreased the standard rate by 12 percentage points,

Table 9: Composition effects of indirect tax-based consolidations

	Impact	1y	3y	5y	10y
<i>a) Indirect tax-based</i>					
GDP	-1.79	-4.10	-4.90	-3.86	-0.74
Disposable Gini	-0.32	-0.79	-1.25	-0.88	-0.17
Unemployment	0.75	1.90	2.43	1.82	0.10
Participation	0.59	0.22	-0.26	-0.56	-0.32
<i>b) GT tax-based (sales and value added tax)</i>					
GDP	-1.02	-1.89	-3.61	-3.27	-1.10
Disposable Gini	-0.14	-0.43	-0.72	-0.61	-0.22
Unemployment	0.59	0.91	1.62	1.45	0.26
Participation	0.53	0.35	0.28	-0.19	-0.23
<i>c) SGS tax-based (excises, monopoly, customs and others)</i>					
GDP	-3.63	-10.75	-11.36	-8.10	-0.50
Disposable Gini	-0.97	-2.06	-3.06	-2.06	-0.16
Unemployment	1.37	4.95	5.86	4.10	-0.16
Participation	1.08	0.05	-1.66	-1.84	-0.77

Notes: The table reports the response to a 1% of GDP indirect, GT and SGS tax-based consolidation shock. Bold numbers indicate significance at the 10% confidence level.

of Table 10 below. The estimates confirm what already emerged above. A one percentage point increase in the standard GT rate raises the labour force participation rate by 0.2 percentage points both on impact and 1 year after the shock. The response of the disposable Gini index is negative throughout all the horizon, although not statistically significant.

As an attempt to disentangle which income group is more likely to benefit during a GT-based consolidation, we also report estimates using the income ratios of the agents in the 90th, 50th and 10th percentile of the income distribution (Panel (c), (d) and (e) of Table 10). These results suggest that both low and middle-income households gain relative to rich households, but low-income ones gain more.

To summarise, the underlying mechanism we have in mind works as follows: a hike in GT pushes up inflation and hence decreases households' real income. The income loss creates incentives for agents voluntarily out of the labour force to search for a job and for those working part time to increase working hours. In turn, as agents join the labour force, their probability of becoming employed increases. We believe this labour supply channel to be particularly strong for female second-earners in low- and middle-income households.

Turning to SGS taxes (Panel (c) of Table 9), the estimates we obtain are more difficult to rationalize. An SGS tax-based consolidation displays extremely large negative multipliers. However, this result is driven by a single country in the sample, namely Portugal (see the country stability robustness

but it also cut the number of reduced rates from 5 to 2, which could confound the effects of the change in the standard rate.

Table 10: Additional results on GT tax-based consolidations

	Impact	1y	3y	5y	10y
<i>a) Any tax-based consolidation year</i>					
GDP	-0.45	-0.68	-0.91	-0.63	-0.10
Disposable Gini	-0.03	-0.01	-0.12	-0.11	-0.06
Unemployment	0.06	0.11	0.16	0.19	0.04
Participation	0.18	0.18	0.00	-0.04	-0.04
<i>b) GT-based consolidation year</i>					
GDP	-0.30	-0.48	-0.79	-0.57	-0.10
Disposable Gini	-0.01	-0.03	-0.16	-0.13	-0.05
Unemployment	0.03	0.08	0.05	0.13	0.04
Participation	0.18	0.16	0.00	-0.04	-0.04
<i>c) P90/P10 Income ratio</i>					
GDP	-1.02	-2.67	-4.57	-3.32	-1.45
P90/P10	-16.11	-11.43	-4.03	-1.35	0.46
Unemployment	1.06	1.82	2.35	1.04	0.18
Participation	0.29	0.26	0.09	-0.17	-0.05
<i>d) P90/P50 Income ratio</i>					
GDP	-1.02	-2.65	-4.52	-3.31	-1.45
P90/P50	-6.56	-3.33	-0.56	-0.69	0.13
Unemployment	1.05	1.81	2.32	1.04	0.18
Participation	0.28	0.26	0.09	-0.16	-0.05
<i>e) P50/P10 Income ratio</i>					
GDP	-1.10	-2.73	-4.58	-3.26	-1.40
P50/P10	-2.67	-2.79	-2.31	-0.17	0.28
Unemployment	1.09	1.87	2.36	1.01	0.17
Participation	0.29	0.25	0.08	-0.18	-0.05

Notes: Panels (a) and (b) report the response to a 1 percentage point increase in the standard GT rate. Panels (c), (d) and (e) report the response to a 1% of GDP shock in GT tax-based consolidations, using income ratios as measure of inequality. Bold numbers indicate significance at the 10% confidence level.

check in Section 2 of the Online Appendix). When Portugal is excluded the response of GDP is still negative, but much smaller in absolute value. SGS tax-based consolidations have larger and more immediate effects in reducing the Gini index relative to GT-based consolidations, and this result is robust to the exclusion of Portugal. The Gini index decreases by 1 percentage points on impact and it keeps declining over a 5-year horizon. In parallel with the economic contraction, the unemployment rate increases in the short run, while the labour force participation rate decreases after 3 and 5 years. We expect that these two dynamics should exacerbate inequality. Hence, the

only possible channel explaining the observed decline in the Gini index is the contraction in real economic activity. This could be explained by deep recessions hitting high-income agents more strongly than low-income agents, thereby causing a decrease in disposable income inequality.

5 Conclusions and further extensions

In this paper, we use PVAR models to estimate the composition effects of tax-based consolidations on income inequality, real output and labour market variables in 16 OECD countries during the period 1978-2012. The results suggest that tax-based consolidations reduce both market and disposable income inequality, but at the cost of a decrease in output in the short to medium run.

This trade-off between equity and efficiency results to be smaller for some indirect taxes. More precisely, general indirect taxes (e.g. VAT) have a relatively large effect in reducing income inequality with limited medium-term contractionary effects on economic activity. The underlying reason behind this result may be that, by causing an increase in the price of the consumption basket, hikes in general indirect taxes affect low-income households particularly strongly, since they generally have a higher marginal propensity to consume. The increase in prices induces those agents who, before the tax hike, were voluntarily inactive or part-time workers to start searching for a job or to work more hours. We observe that this positive labour supply channel is particularly relevant for middle-aged women in low- and middle-income households. Higher participation rates increase the probability of being employed and ultimately reduce income inequality. Among direct taxes, only personal income taxes increase equity, without having significant negative effects on labour force participation.

In general, our results suggest that incentives to labour market participation represent an important channel through which different tax instruments may affect income inequality. Instead, we do not find much evidence supporting the hypothesis of a government redistribution channel through which tax-based consolidations decrease inequality.

A possible criticism to our analysis is that we only look at agents' aggregate behaviours. We acknowledge that different groups of population may react differently to taxation and hence we partially address this issue when we analyse the response of labour force participation for men and women separately. However, agents' heterogeneity should be further taken into account and, provided that disaggregated data are available for a large number of countries, a useful extension of this paper would be to disentangle the effects of taxation for different groups of agents.

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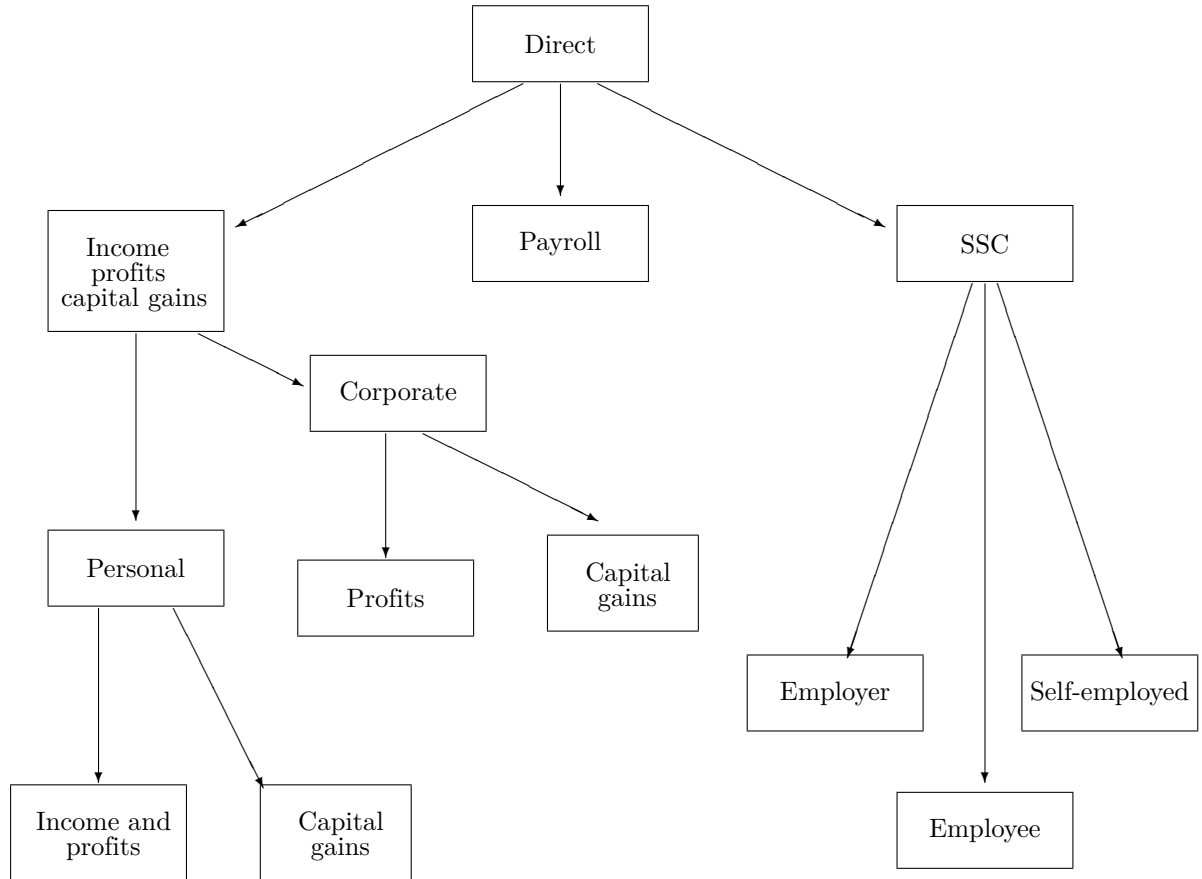
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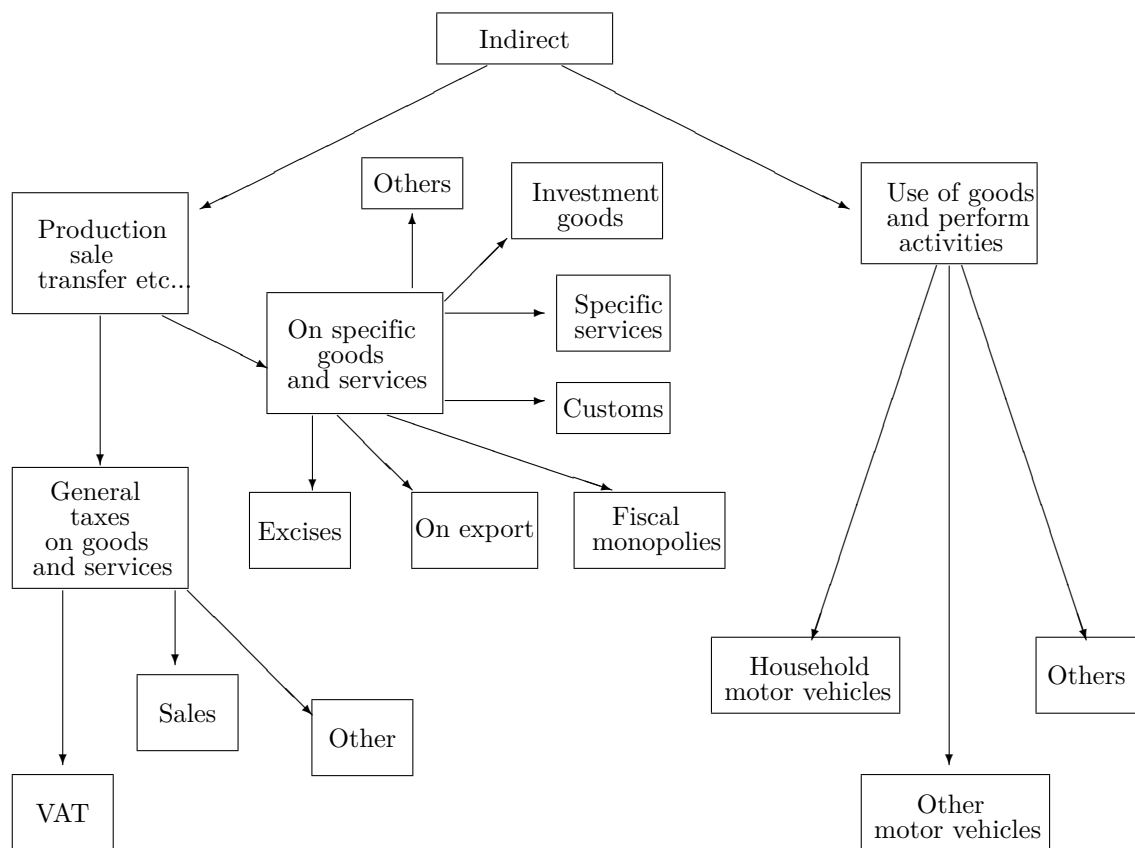
Appendix

A Breakdown of tax instruments

Figure A1: Direct taxes



Notes: Direct taxes are generally defined as to include (i) taxes on income, profits and capital gains, (ii) social security contributions and (iii) taxes on payroll and workforce. The breakdown of such tax categories presented above follows the OECD classification method. For more information refer to the OECD Interpretative guide and methodology.

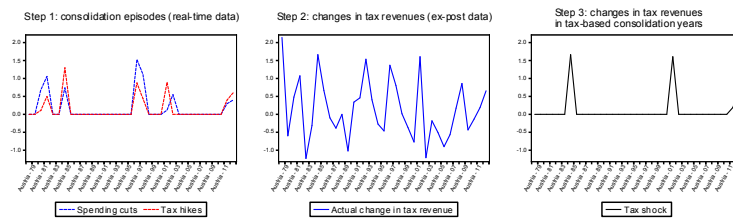
Figure A2: Breakdown of indirect taxes

Notes: Indirect taxes are generally defined as taxes on goods and services. The breakdown presented above follows the OECD classification method. For more information refer to the OECD Interpretative guide and methodology.

B Identification strategy

Figure B1 illustrates how we construct our tax shocks, taking the case of Austria as an example. We start from the action-based consolidation datasets compiled by Devries et al. (2011) and Alesina et al. (2015a) (step 1). Next, we consider changes in total tax revenues as recorded by OECD (2015c) (step 2). Finally, we select years in which tax hikes, as identified through the narrative approach, were larger than spending cuts (i.e. tax-based consolidation years). Ex-post realized changes of tax revenues during those years constitute our shocks (step 3).

Figure B1: Construction of the tax shocks



Source: Devries et al. (2011), Alesina et al. (2015a), OECD Revenue Statistics database and authors' own calculations.