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Dynamic Scoring of Tax Reforms in Real Time

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Barrios, S., Reut, A., Riscado, S., van der Wielen, W.

Contact information
Name: Salvador Barrios
Address: Edificio Expo, Calle Inca Garcilaso 3, 41093
Email: salvador.barrios@ec.europa.eu
Tel.: +34 954 48 82 36

EU Science Hub
https://joint-research-centre.ec.europa.eu

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Contents

1 Executive Summary

The assessment of the fiscal impact of tax reforms is a long-standing issue in EU fiscal policy, especially so in the euro area context as fiscal policy is the main instrument left to national governments in order to offset macroeconomic shocks. Unsurprisingly, fiscal surveillance under the Stability and Growth Pact has also increasingly focused on the assessment of the so-called discretionary tax measures. One key question regarding these measures concerns their impact on tax revenues, and the ability for tax policy analysts to identify their impact independently from the changes in tax revenues brought about the business cycle. This is what allows in particular the assessment of the fiscal policy stance, which represents the relation between fiscal policy and the business cycle and which draws specific attention in the EU fiscal surveillance context. Accordingly, fiscal policy should be counter-cyclical, in order to effectively play its role as stabilisation mechanism *vis-à-vis* economic fluctuations, and to avoid amplifying the impact of changes on economic activity. Existing approaches to determine the fiscal policy stance have relied on variety of techniques based on econometric or structural models. Yet, the usefulness of these approaches largely rests on their ability to provide an assessment in real time, in order to make useful policy recommendations and eventually implement corrective measures. In addition, the approaches actually used by the EU Member States to assess the impact of discretionary tax measures is left either undetermined or largely based on qualitative assessment (e.g. expert judgement). Furthermore, tax revenue projections carried out by national governments are usually not assessed ex-post, which makes it difficult to gauge their accuracy and therefore to determine whether alternative approaches could possibly do a better job.

In this paper, we propose a novel common approach for the ex-ante assessment of tax reforms accounting for second-round effects, usually called dynamic scoring of tax reforms. Our approach stands in contrast with existing approaches based on structural models which prove less tractable for real-time analysis. Instead, we combine the EUROMOD microsimulation model with Vector Auto-Regression (VAR) estimates of macro responses and, exploiting a unique database of tax reforms in the EU, compare our estimates with the real-time assessment of tax reforms conducted by the EU Member States as well as with ex-post realisations. VAR models are warranted for monitoring the impact of discretionary tax reforms for a number of reasons. These models are known for being more performant for short-term policy analysis compared to structural models. They also require fewer assumptions and provide greater flexibility, which makes them practical for real-time fiscal policy analysis. Combining the precision of the microsimulation models with the power and flexibility of our macro-econometric estimates allows us to incorporate the economy-wide effects into the assessment including, in particular, labour market adjustments corresponding to the tax reform.

Our results suggest that on average personal income tax cuts resulted in medium-term increases in output and employment; however, the second-round revenue impact is found to be small relative to the first-round microsimulation results. These results are in line with existing studies based on the dynamic scoring approaches and further underline the fact that most tax reforms do not have a significant impact on economic activity and that their direct budgetary impact is likely to represent their most relevant aspect for policy making.

We believe that a common and flexible approach as proposed in this paper would promote the use of common definitions for variables and the no policy change scenario, which play a key role for policy analysis. In addition, it would improve the transparency about the underlying assumptions and provide a basis for policy discussions. The tool presented in this paper is freely available through the EUROMOD-JRC web interface available here: https://euromod-web.jrc.ec.europa.eu/web-interface/, where the user can simulate policy changes (either hypothetical or real) affecting personal income taxes, social security contributions and benefits, and obtain estimates on their medium-term budgetary impact (up to three years) based on our approach. The interface provides default parameter values obtained from a real-time database of past tax reforms using a VAR model, detailed in van der Wielen (2020). Importantly the default elasticity parameters can be changed and adapted depending on the user´s prior concerning their country or time-specific value.

2 Abstract

In this paper, we propose a novel approach for the ex-ante assessment of tax reforms accounting for second-round effects, i.e. the dynamic scoring of tax reforms. We combine a microsimulation model for selected European countries with VAR estimates of macro responses and, exploiting a unique database of tax reforms in the EU, compare our estimates with the real-time assessment of tax reforms conducted by the EU Member States as well as with ex-post realisations. This is the first time dynamic scoring of tax reforms is conducted in real-time and compared to ex-post realizations in a systematic way. The novelty of our approach hinges on the use of a macro-econometric model combined with a microsimulation model which represents a more flexible tool than (computable) general equilibrium models in order to conduct real-time dynamic scoring analysis. Our results suggest that on average personal income tax cuts resulted in modest medium-term increases in output and employment; while the second-round revenue impact is found to be small relative to the first-round microsimulation results.

3 Introduction

Fiscal policy is seen as the main policy instrument left to euro area Member States in order to offset idiosyncratic shocks, see Leith and Wren-Lewis (2011). Absent nominal exchange rate adjustments, fiscal policy in general and tax policy in particular have become key instruments of economic policy. Unsurprisingly, fiscal surveillance under the Stability and Growth Pact has also increasingly focused on the assessment of the so-called discretionary tax measures in order to assess EU Member States fiscal policy stance, see European Commission (2016a). Since 2014 the European Commission requires the Member States to provide a quantification of the tax revenue impact of the main discretionary tax reforms, see European Commission (2016b). Importantly, the assessment of the budgetary impact of a discretionary tax revenue measures should take into account any behavioural responses and second-round effects on economic activity. The ex-ante assessment of tax reforms must therefore inform about the mechanisms through which these potentially impact the economy. This question is especially relevant in the case of tax cuts which are expected to trigger economic activity. Tax cuts are often justified by policy makers arguing that they can be self-financed through increased tax revenue collection to the extent that the behavioural responses (and corresponding changes in the tax bases) more than compensate the direct tax revenue losses.

A common, model-based approach to assess the impact of discretionary tax measures om the EU is yet absent. The approach used by the EU Member States to assess the impact of discretionary tax measures is left either undetermined or largely based on qualitative assessment, see Barrios and Fargnoli (2010) and Princen et al. (2013). In addition, these tax revenue projections are usually not assessed ex-post, which makes it diffcult to gauge their accuracy.[1] A common approach would ascertain the use of common definitions for variables and the no policy change scenario. In addition, it would improve the transparency about the underlying assumptions (e.g. reliance on expert-based judgement) and consequently the replicability of results. Ideally, the proposed methodology also accounts explicitly for behavioural and macroeconomic wide effects.

The objective of this paper is to provide an integrated modelling framework for assessing discretionary tax measures. In order to do so, we develop a new dynamic scoring method, see in particular Gravelle (2015) and Mankiw and Weinzierl (2006), by linking the multi-country EUROMOD microsimulation model to macroeconomic response functions generated by vector autoregression (VAR) models. EUROMOD is a tax and social benefits calculator designed to provide results which are representative at country-level and validated against aggregate national statistics. The model codifies with precision the personal income taxes, social benefit and social security contributions in all EU countries. The economy-wide effects and behavioural adjustments of the tax shocks are estimated using a VAR set-up including, GDP growth, price and labour market adjustments. The combined use of microsimulation models with a macro model is not usual in dynamic scoring analysis, at least in the European context. Dynamic scoring, sometimes also termed Dynamic Laffer curve in macroeconomic analysis, is usually analysed through macro-structural models in Europe, see for instance Novales and Ruiz (2002) and Trabandt and Uhlig (2011). By contrast, in the U.S., the combination of micro and macro models is more common (see e.g.

[1] In contrast to the bottom-up approach, the ex-post accuracy of budgetary plans has been analysed and tested in numerous papers using a macroeconomic approach and highlighting the role played by factors such as the quality of GDP forecast, uncertainty regarding tax elasticities and potential political biases, see in particular Cimadomo (2016) for a review of the literature.

Altshuler et al., 2005), most notably because of the legal obligation adopted by the Congress in 2015 requiring the dynamic scoring of reforms with a potentially large budget impact (representing more than 0.25 percent of GDP). In such context, estimates must replicate the change in the tax code with high precision in order to obtain the first-round effect of reforms which, in turn, requires the use of a tax microsimulation model (or tax calculator).[2] The second-round effects (or macroeconomic impact) are usually considered by means of macro-models using stylized assumptions regarding behavioural effects, e.g. concerning the labour supply or consumption impacts of tax reforms, see for instance Congressional Budget Office (2012). Our use of a VAR model for dynamic scoring also stands in contrast with standard practice, where structural models are usually preferred.[3] However, VAR models are especially appropriate for our analysis for a number of reasons. First these models are known for being more performant for short-term policy analysis compared to structural models. They also require fewer assumptions and provide enough flexibility in order to be used in real-time analysis, see Polito and Wickens (2012). Combining the precision of the microsimulation model with the power and flexibility of our macroeconometric estimates allows us to incorporate the economy-wide effects and, in particular, labour market adjustments corresponding to the tax reform.

Despite the substantial use of macro-econometric models in the estimation of spending and revenue shocks, following the seminal work of Blanchard and Perotti (2002), macro estimates for individual revenue categories remain scarce (for the US see e.g. Mertens and Ravn, 2013). By contrast, building on van der Wielen (2020), we use a unique database of real-time estimates of the budgetary impact of discretionary tax measures implemented by each Member State.[4] In particular, using this real-time database, van der Wielen (2020) constructs an indicator variable as common in the narrative identification literature (see Romer and Romer, 2010), i.e. treating comparable, past tax reforms as exogenous shocks. Based on this methodology, he finds fiscal multipliers for EU Member States broadly in line with earlier panel studies for OECD countries (e.g. Guajardo et al., 2014), suggesting significant medium-term increases in output as a result of tax cuts. Exploiting our unique dataset nonetheless shows a considerable amount of heterogeneity in fiscal policy transmission mechanisms among Member States as well as types of reform.

Finally, we make our own real-time forecasts, i.e. using the same information as the one available to the policy makers at the moment of their assessment of tax reforms. Consequently, in contrast to previous studies, this allows us to test the validity of our dynamic scoring estimates by gauging their properties against alternative scoring in real time and the ex-post observed impact of the tax reforms. The second-round tax revenue impact of the reforms, however, is found to be small relative to the first-round microsimulation results. Overall, our results suggest that the established link between the EUROMOD microsimulation model and our VAR models enhances the accuracy of fiscal and distributional impact assessments of discretionary tax measures. While our work is clearly motivated by the European case, we believe that our approach is novel enough in order to be applied in other geographical areas and other tax categories. The remainder of this paper is structured as follows. In Section 2, we review the model set-up in light of the objective and its relation to the existing literature. Section 3 documents the real-time data

[2] For a discussion of dynamic scoring practice in the US see for instance Hodge, S.A. (2015), Dynamic scoring made simple, Fiscal facts #451, Tax foundation, https://taxfoundation.org/ dynamic-scoring-made-simple/.
[3] In this respect, we caution the reader familiar with the practices in Europe that our analysis is not intended to replace the usage of the QUEST and/or labour supply models used for the analyses underpinning the country-specific recommendations within the European Semester, as illustrated in Barrios et al. (2019).
[4] For a description of this database see Barrios and Fargnoli (2010).

used, explains the underlying macroeconomic estimates and highlights how the resulting macro responses are disaggregated to the household level to allow for the estimation of the fiscal policy shock. Next, it uses the proposed methodology to score a broad set of historic tax reforms. Section 4 concludes.

4 Background

4.1 Discretionary tax measures in EU fiscal surveillance

The impact of governments' discretionary tax measures (DTM) is a long-standing issue in EU fiscal policy surveillance (see e.g. Duchene and Levy, 2003; Wolswijk, 2007; Barrios and Fargnoli, 2010; Princen et al., 2013). Their impact can play a significant role in changes in the budget balance, can affect the respective tax elasticity used for the definition of the structural budget balance significantly, and tend to be pro-cyclical. Since the change in the structural budget balance will not always reasonably gauge discretionary fiscal policy actions, this has led to the systematic collection of data on discretionary measures to assess the fiscal policy stance. In this bottom-up approach, the fiscal effort is computed as the aggregate sum of the estimated budgetary impact of individual government measures.[5] For instance, the ECB estimates the impact of discretionary measures twice a year using this approach (Morris et al., 2009). A common, model-based approach to assess the impact of DTM, however, presents a threefold advantage, in particular given the reliance of the existing data on governments' own estimates and expert-based judgement. First, a common approach would ascertain the usage of common definitions for variables and the no policy change scenario. Second, it would improve the transparency about the underlying assumptions (e.g. reliance on expert-based judgement) and consequently the replicability of results. Third, the proposed methodology explicitly accounts for behavioural and macroeconomic wide effects, highlighting the mechanisms at hand. In the European context, a greater understanding of behavioural responses of tax reform is also required in the context of the increased emphasis in the implementation of the Stability and Growth Pact (SGP) on the maximum allowable expenditure growth rate net of discretionary revenue measures (cf. the expenditure benchmark). With this purpose, the estimation of discretionary measures has to take into account micro-level behavioural responses, including tax compliance effects.[6]

The main objective of this paper therefore is to present a framework assessing the revenue, behavioural and macroeconomic effects of tax reform proposals in the EU Member States, which is sometimes referred to as dynamic scoring (e.g. Auerbach, 2005; Adam and Bozio, 2009). In the US, for instance, dynamic scoring analyses are well-established by now and legally required before significant changes in tax legislation. Macro-micro model combinations are used for this in order to conduct in-depth evaluations of discretionary tax measures' full effects on governments' revenue. A key concern in this respect is to know whether tax reforms, in particular tax cuts, are self-financed. Consequently ex-ante impact assessments must account for second-round effects and behavioural responses in order to factor in possible changes in the tax bases resulting from changes in tax legislation. In an application to the EU Member States, Barrios et al. (2019) have used the European Commission's dynamic stochastic equilibrium (DSGE) QUEST model, in order to obtain second-round effects of tax reforms previously simulated with the use of the EUROMOD microsimulation model order to obtain second-round effects of tax reforms previously simulated with the use of the EUROMOD microsimulation model.[7] The

[5] his approach has also been applied in the economic literature on the macroeconomic impact of fiscal policy, e.g. Romer and Romer (2010).

[6] http://data.consilium.europa.eu/doc/document/ST-14814-2016-INIT/en/pdf.

[7] Benczúr et al. (2017) develop a closely related, yet markedly different, general equilibrium microsimulation approach for Hungary.

selected tax reforms were simulated in EUROMOD and introduced as policy shocks - changes in tax rates - and the QUEST model delivered the general equilibrium impact of such shocks on main macroeconomic variables - output, consumption, employment and wages - as well as on budgetary variables, such as the primary deficit/surplus, in the medium run. The resulting medium-term projections in prices and gross wages were then used back into the EUROMOD microsimulation model in order to evaluate the reform. DSGE models, however, and more generally structural models, while capturing second round effects including behavioural reactions, are known to have lower levels of accuracy than VAR models especially for short-term predictions (i.e. up to 3 years in the EU context). In addition, structural models are less flexible than VAR models for ex-post evaluation of predictive performance. Ideally, in order to test the validity of this approach for policy analysis, its properties should be gauged against alternative scoring in real time and the ex-post observed impact of the tax reforms. Accordingly, in this paper we intend to perform the dynamic scoring exercise on a large number of past reforms in order to provide sufficient observations to test the statistical significance of the differences in results obtained. A more flexible approach to the macro-micro model combination was therefore devised while preserving the properties of the dynamic scoring approach highlighted above.

4.2 Fiscal Multipliers

When it comes to forecasting medium-term output effects of fiscal policy reforms using real-time projections, VAR models perform comparatively well with respect to general equilibrium models and large-scale macro models (e.g. the MPS/FRB model of the US Federal Reserve). The VAR literature is typically classified into two strands based on the resolution of endogeneity problems. Structural VAR models achieve identification by exploiting institutional features of tax and transfer systems (see e.g. Blanchard and Perotti, 2002) or by introducing sign restrictions derived from economic theory (see Mountford and Uhlig, 2009).[8] Alternatively, rather than assuming that shocks are latent variables, narrative approaches identify exogenous sources of variation in fiscal adjustments, i.e. unrelated to macroeconomic conditions, and estimate their effects by regressing observables on those narratively identified policy shocks (e.g. Romer and Romer 2009, 2010).[9]

Despite the ongoing debate on the effectiveness of fiscal adjustments, some standard insights have emerged since the seminal work by Romer and Romer (2010). A full review of the recent findings on size of fiscal multipliers - even just that using VAR models - is outside the scope of this paper, however. In addition, various extensive overviews exist, including European Commission (2012), Coenen et al. (2012), Gechert (2015), Kilponen et al. (2015) and van der Wielen (2020). Therefore, we limit ourselves to highlighting some of the main insights. First, fiscal adjustments via tax increases or spending cuts are likely to have different multipliers. Similarly, the composition of spending cuts matters (e.g. whether it concerns cuts in consumptive spending or in investment). The idea that the impact of the

[8] Structural VAR models may be reliable even if there is shock foresight and small sample limitations (Sims, 2012). Nonetheless, structural approaches require assumptions on expectations, e.g. future tax rates, that are often important in shaping the short-run effects.

[9] Mertens and Ravn (2013) and Mertens and Montiel Olea (2018) develop an estimation strategy that exploits the attractive features of both.

adjustment is conditional on the position within the cycle and the degree of monetary accommodation, moreover, gained traction.[10]

The labour market is not a standard a component in fiscal VAR models, as it is in DSGE models. While monetary VAR models used for forecasting typically encompass a large number of variables, the fiscal policy VAR models found in the literature are more restricted (e.g. Auerbach and Gorodnichenko, 2012). Nonetheless, its inclusion is not exempted either. For instance, Mertens and Ravn (2013) included labour market effects - employment and hours worked - in their analysis of personal income tax (PIT) and corporate income tax (CIT) changes in the US. They find that a 1 percentage point cut of the average PIT rate raise employment per capita by 0.3 percentage points on impact, peaking at 0.8 percentage points after five quarters. Given the objective of our analysis including a labour market adjustments, i.e. the behavioural response to tax changes, is required. Therefore, we build on the work by van der Wielen (2020), estimating output, employment, wage and price responses for the EU.

4.3 Real-time fiscal policy

Finally, the paper contributes to a third strand of literature given its usage of real-time data. Real-time data pertain to the information available to policy makers at the moment of their decision; in our case, the moment the fiscal reform was agreed on. The recent work by Cimadomo (2016) discusses the growing use of real-time data in the fiscal policy literature in length. For instance, he reviews the use of real-time data for the analysis of the distributional characteristics of fiscal data revisions and the estimation of fiscal reaction functions (i.e. the cyclical properties of real-time fiscal policy) at the macro level. Our contribution will be in the use of real-time data to analyse possible bias and errors in (fiscal) forecasts considering specific tax reforms. Identifying forecast errors or, more structural, bias at the outset underpins the quality of fiscal governance. Hence, we compare our detailed, real-time simulations of fiscal reforms to the real-time forecasts by Member States and the ex post observations. To the authors' knowledge, this analysis comprises the first comparative analysis of isolated fiscal reforms (vis-à-vis balance targets) using real-time data.

While EU Member States only face repercussions for past and current-year fiscal variables, medium-term budgets play a role in the European Fiscal Surveillance framework and several reform proposals for the simplification of the SGP envisage greater emphasis on medium-term ceilings for nominal expenditure net of discretionary revenue measures (Bénassy-Quéré et al., 2018). In particular, sound fiscal institutions, including independent fiscal watchdogs, have been found to contribute to more reliable budgets. For instance, Larch et al. (2021) show that compliance with EU fiscal rules is conducive to countercyclical fiscal policy. The early work by Strauch et al. (2004) stressed the importance of the form of fiscal governance in explaining the variety of fiscal (and growth) forecast accuracy and biases across Member States. Beetsma et al. (2009) and Beetsma et al. (2013), on the

[10] Together with their results for the limited impact on participation (via hours worked), the result for employment lead Mertens and Ravn (2013) to conclude that a 1 percentage point cut of the average PIT rate decreases unemployment by 0.3 percentage points on impact and reaches a maximum decrease of about 0.5 percentage points in the fifth quarter. Holden and Sparrman (2018) present panel data evidence for the OECD that an increase in real government purchases of 1 percent of GDP reduces unemployment by 0.3 percentage points in the same year, conditional on the labour market institutions. Similarly, Woo et al. (2016) and that a 1 percent of GDP consolidation increases unemployment by 0.19 percentage points in the same year and 1.5 percentage points cumulative over 5 years.

other hand, added that the implementation of ambitious budgetary adjustments benefits from stronger national fiscal institutions. Brück and Stephan (2006) and Pina and Venes (2011), in their turn, focussed on the political determinants of the fiscal forecast errors, while controlling for the role of the SGP.[11] Jonung and Larch (2006) further highlighted a more strategic overestimation of real GDP growth - thus, underestimation of budget deficits - to minimize the consequences of the European fiscal governance framework. In the same vein, Gilbert and de Jong (2017) showed that the EC's fiscal forecasts, which take into account information supplied by national officials, are biased upwards in the Eurozone when the budget deficit is likely to exceed the 3% of GDP benchmark. From a policy perspective, the importance of conducting a sound and independent assessment of fiscal reforms was underpinned in the "Two-Pack" reforms which advocated the creation of independent fiscal institutions in the EU Member States.

[11] The distinction between delegation and strong rules or contracts as a means of governance is investigated by von Hagen (2010). He finds under the latter system appear to use more cautious projections.
Strauch et al. (2004) moreover found that forecasts under delegation and contracts are more cautious than those under fragmented systems.

5 Dynamic scoring

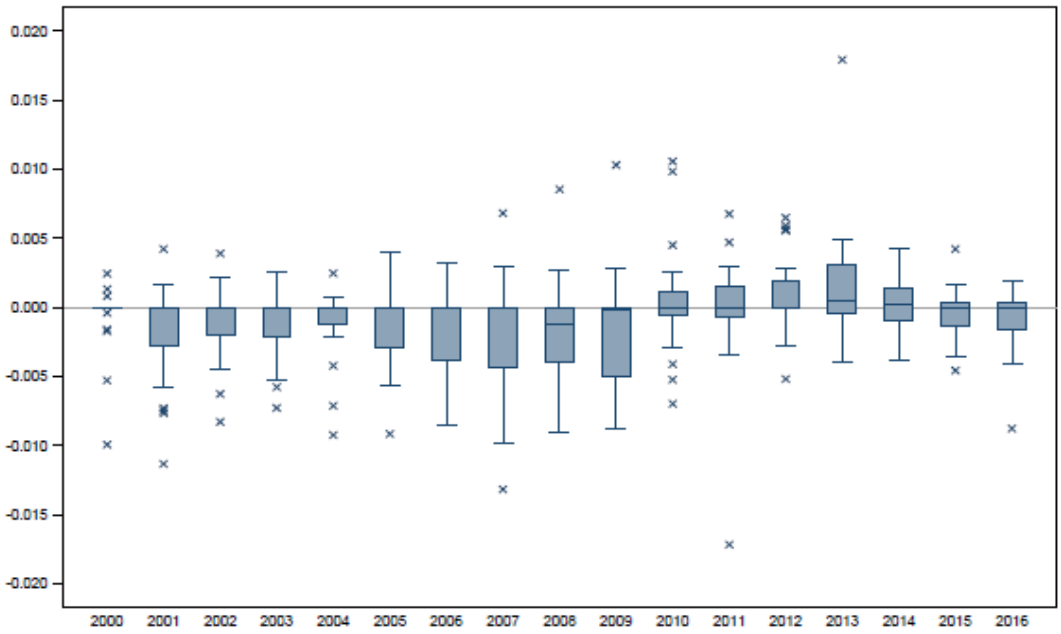
After a description of the real-time data used (Section 3.1), we explain in detail how we perform our real-time analyses, in particular how we construct the first-round and second-round impact of tax reforms, while incorporate the macroeconomic feedback from the VAR model (Section 3.2). Next, we detail the macroeconomic model (Section 3.3). Then, we are able to compare our real-time forecasts to those of the Member States (Section 3.4). Finally, we take the analysis one step further in order to explore the sources of possible discrepancies between the real-time forecasts and the ex-post realizations (Section 3.5).

5.1 Real-time data

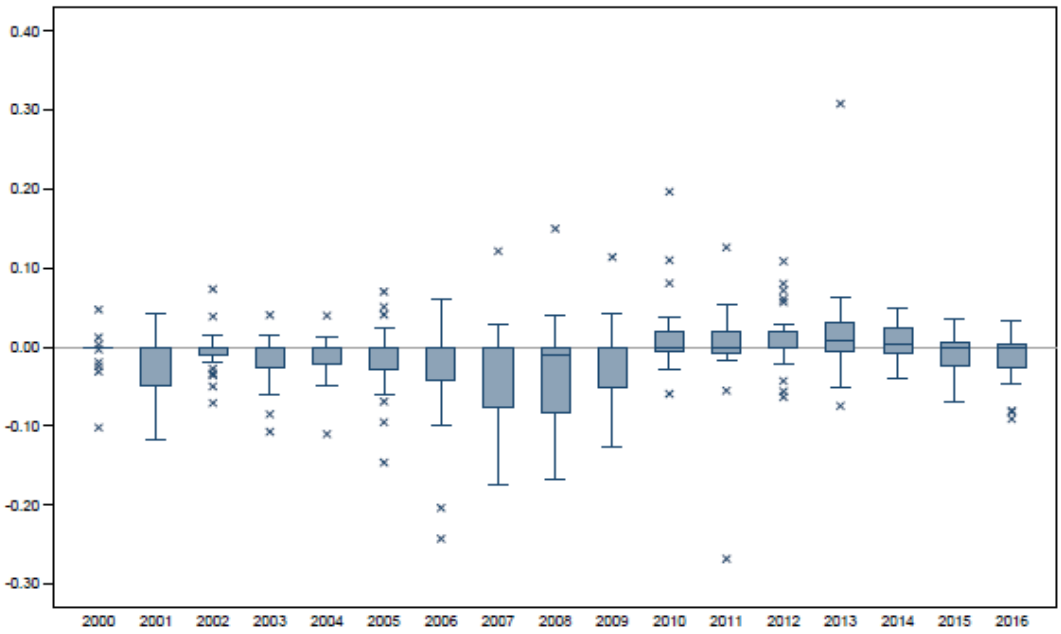
The Output Gap Working Group (OGWG) of the Economic Policy Committee annually collects data on discretionary tax measures (DTM) by the EU Member States; where a DTM is defined as any legislative or administrative change in policy that has an impact on tax revenues, whether it is already finally adopted or only likely to be implemented. In this regard, Member States submit a questionnaire to the OGWG, consistent with the information that the Member States are required to report in the context of the assessment of their Stability and Convergence Programmes (SCP). The corresponding database is employed in light of the implementation of the SGP. For example, under the preventive arm of the SGP the growth rate of spending net of discretionary revenue measures should not exceed a reference medium-term rate for potential GDP growth. Under the corrective arm, the evaluation of adherence with Council recommendations is based on the budgetary impact of discretionary revenue measures. More generally, interpreting the annual development in the discretionary component of the changes in the budget balance is a key indicator for fiscal surveillance. The database's original purpose nonetheless was analytical (see Barrios and Fargnoli, 2010), with a view to sharing a better understanding of DTM patterns over time. For instance, the reported information is more detailed than in the SCPs. DTMs representing at least 0.05 percentage point of GDP in terms of revenue loss or gain are presented as historical time series starting in 2000. Using this database, Barrios and Fargnoli (2010) performed a cross-country comparison of the elasticity of tax revenue with respect to GDP and found evidence of pro-cyclical fiscal policy. More recently, Princen et al. (2013) carried out an update of this analysis. Figure 1 illustrates the distributions of discretionary PIT measures over the period between 2000 and 2016 in 27 EU Member States.[12]

[12] Greece was omitted as it was in the support program during the period considered, leading to large variation due to the ample reforms.

Figure 1: Discretionary PIT measures in 28 EU Member States



(a) Discretionary PIT reforms as a % of GDP_{t-1}



(b) Discretionary PIT reforms as a % of PIT_{t-1}

Note: Note: The narrative shocks measure discretionary measures taken concerning personal income taxes as specified by the Member State, based on the latest available data vintage (2016) at the time of writing. It is worth acknowledging that these data are not always readily comparable across countries. Moreover, Greece was omitted as it is in the support program.

On average, the discretionary PIT measures (relative to the previous year's GDP) indicate a slightly pro-cyclical trend; see Figure 1 (a). The second panel of Figure 1, which shows these reforms as a share in total personal income tax revenue, gives an overview of the size of these reforms.

In what follows, we use the DTM panel data twice. First, the data are employed to identify comparable discretionary tax reforms to be included in the estimation of the macro model. Second, the real-time database is used for the analyses in Section 3.4, gauging our dynamic scoring estimates against an alternative scoring in real time as well as the ex post observed impact of the tax reforms. It is important to remark that we are analysing permanent shocks to PIT, since temporary and permanent fiscal measures may have different effects. For example, in standard New Keynesian models permanent tax hikes are much more contractionary than temporary ones (see e.g. Erceg and Lindé, 2013). Hence, at the outset of our analysis we went through all the detailed disaggregated measures covered by the DTM to exclude those that were reversed or expected to be reversed within the foreseeable future. Overall, we identified 507 permanent PIT reforms consisting of 1148 individual observations, as some reforms' impact is foreseen over multiple years. Next, aggregating the various observations for each Member State in a specific year results in 321 country and year specific shocks to PIT revenue. Almost two-fifth of these aggregate adjustments were revenue increasing. The median real adjustment is -0.06% of GDP and the average is -0.10% of GDP, with a standard deviation of 0.36 pp.

5.2 Procedure

EUROMOD is a tax/social benefits calculator designed to provide results which are representative at country-level and validated against aggregate national statistics. EUROMOD codifies with precision the personal income taxes, social benefit and social security contributions in all EU countries. For this it relies on the detailed EU-SILC micro-data, including information on working status, qualification (education and occupation) and sector of activity.[13] The EUROMOD model is therefore a tool suitable for the quantification of the direct fiscal impact of tax and benefit reforms. Earlier work that has done so includes, but is not restricted to, Militaru and Cristescu (2016) and Figari et al. (2018).[14] The model's importance as a tool for tax policy reforms is also illustrated by its prominent use within the European Semester (see e.g. Picos and Schmitz, 2016, McQuade et al., 2017).

Ultimately, the models allow us to evaluate PIT reforms. First, we need to establish a point of reference. In particular, the baseline estimate of tax revenues, E0 [Tt], is defined as a the revenue generated by applying last year's tax function, $E^0[T_t] = \tau_{t-1}(M_{t-1})$, to last year's macroeconomic circumstances (M_{t-1}), i.e. the observed evolutions in variables such as prices, wages and GDP as well as the household incomes corresponding to them. The notation of the simplified baseline is as follows:

$$E^0[T_t] = \tau_{t-1}(M_{t-1}) \quad (1)$$

In brief, the baseline comprises last year's tax revenue. We kindly refer the readers to Appendix A.1 for a full derivation of the definitions used.

[13] The reader is referred to Sutherland and Figari (2013) for a more extensive overview of the nuts and bolts of the EUROMOD microsimulation model.

[14] The EUROMOD model also lends itself to other types of analysis. For example, Bargain et al. (2014) use it to estimate own-wage, cross-wage and income elasticities to compare work preferences and labour supply responses. Furthermore, EUROMOD is highly suitable for inferences on inequality, redistribution and poverty: see e.g. Jara and Tumino, 2013; Navicke et al., 2014; and Figari et al. (2016). Similarly, Dolls et al. (2012) quantify (the effectiveness of) automatic stabilizers through taxes and transfers using EUROMOD. Finally, given its scope it is the pre-eminent tool to study supranational benefit schemes. Dolls et al. (2018), for instance, consider a Euro area wide unemployment insurance scheme and Levy et al. (2013) a EU basic income per child.

Second, we use the EUROMOD model to estimate the revenue in case of the respective tax reform without taking into account any second-round effects. We denote this first-round aggregate by $E^1[T_t]$. For this simulation we rely on the tax systems for the corresponding pre and post reform years as modelled by the respective EUROMOD country teams.

$$E^1[T_t] = E^0[T_t] + [\tau_t(M_{t-1}) - \tau_{t-1}(M_{t-1})\,] = E^0[T_t] + E^1[\Delta\Gamma_t] \quad (2)$$

The focus of our analysis is on the magnitude of the expected (first-round) impact of the tax reform, not the direct revenue impact of other reforms (e.g. temporary shifts in revenues collection). Hence, in what follows we abbreviate it by $E^1[\Delta\Gamma_t]$.

Finally, we incorporate the macroeconomic impact of the implemented PIT reform into EUROMOD in order to estimate second-round effect. In particular, we use macro-econometrically estimated impulse-response functions to obtain the output, price and labour market effects corresponding with $E^1[\Delta\Gamma_t]$, see Section 3.3. Next, we translate the changes in the following variables from the VAR back to EUROMOD: prices, private and public sector wages, GDP growth and the employment rate.[15] The macro responses are fed into EUROMOD, via its disaggregated data, in two ways. On the one hand, the price, wage and GDP responses are used to adjust the respective EUROMOD parameters employed to align the micro data used in the simulation to the policy year considered. Since EU-SILC data are not available every year, a simulation of a policy reform in, for instance, 2013 may have to rely on micro data from income year 2012. To bridge such gaps EUROMOD adjusts the underlying micro data (e.g. employment earnings) in accordance to the macro evolutions realized between the date of observation of the micro data and the policy year considered. On the other hand, the employment response is used to adjust the weights of the share of employed and unemployed individuals in the population sample. Below, this macro impact is captured by the aggregate multiplier *m*:

$$E^2[T_t] = E^0[T_t] + \underbrace{[\tau_t(M_{t-1}) - \tau_{t-1}(M_{t-1})] + \tau_t(m_1 E^1[\Delta\Gamma_t])}_{=E^2[\Delta\Gamma_t]}$$

In the end, this results in a second EUROMOD simulation of the revenue in period t: $E^2[T_t]$.

5.3 Macroeconomic Effects of Tax Changes

This subsection details how the economy-wide effects and behavioural adjustments of the tax shocks are estimated, drawing heavily upon van der Wielen (2020). First, we detail the methodology used, its underlying assumptions and how it relates to previous fiscal multiplier estimates. Next, we present and discuss the estimates. This all builds up to the incorporation of our macro responses into EUROMOD in Section 3.4.

[15] In EUROMOD some Member States' private and public sector wage evolution is determined separately. The existing evidence on the relation of public and private sector wages in the EU, see e.g. Lamo et al. (2012) and Marzinotto and Turrini (2017), points towards considerable co-movement and feedback effects.Therefore, using a single response for the total economy wages seems justied. Nevertheless, given the limited share of public sector wages in the overall total, this assumption has a marginal effect on our results.

5.3.1 Dynamic Framework for Estimation

We start by elaborating the dynamic framework commonly used to estimate tax multipliers. The output multiplier follows from a simple regression of changes in output (Δy_t) on changes in tax revenues (ΔT_t) in period t:

$$\Delta y_t = \beta_0 + \beta_1 \Delta y_{t-1} + \beta_2 \Delta T_t + \vartheta_t \quad (4)$$

In equation (4), β_2 can be interpreted as the contemporaneous tax multiplier. Such straightforward interpretation of β_2, nonetheless, is not without problem. The construct ΔT_t is a compound of revenue changes resulting from both endogenous (mainly, non-fiscal policy effects, automatic stabilizers and fiscal policy changes in response to the business cycle) and exogenous, discretionary sources. Even if ΔT_t is measured using the cyclically adjusted revenue adjustments, fiscal policy changes in response to the business cycle pose a problem. The estimates may be clouded due to reversed causality. Romer and Romer (2010) showed that aforementioned issues can be overcome by estimating:

$$\Delta y_t = \beta_0 + \beta_1 \Delta y_{t-1} + \beta_2 x_t + \varepsilon_t \quad (5)$$

instead, where x_t only encompasses the revenue impact of exogenous fiscal reforms. Nevertheless, researchers are often interested in more elaborate dynamics. Instead of the single equation (panel) regression, systems of equations are considered. The systems simultaneously estimate the interrelation of multiple variables of interest (e.g. revenues, spending and GDP). A reduced form panel vector autoregression (VAR) model takes the following form:

$$Y_{it} = \sum_{\tau=1}^{T} F_\tau Y_{it-\tau} + G_0 X_{it} + \varepsilon_{it} \quad (6)$$

where Y_{it} is the vector of macroeconomic variables encompassing economy *i* at time *t*, $F_{t-\tau}$ is the vector of coefficients for lag τ , vector X_{it} contains the exogenous regressors and ε_{it} is the vector of reduced form residuals. Lags of vector X_{it} can be included to filter out the impact of reforms implemented in earlier periods.[16] Identifying the fiscal multipliers by incorporating a variable of exogenous, discretionary fiscal measures such as x_{it} in X_{it} is commonly referred to as narrative identification, since it requires going through a variety of legal documents by hand to construct x_{it}.[17]

The lion's share of previous narrative multiplier estimations build on the indicators of fiscal adjustment constructed by Romer and Romer (2010) for the US, Cloyne (2013) for the UK and Devries et al. (2011) for a subset of OECD countries. In contrast, we follow van der Wielen (2020) who uses a database of real-time estimates of discretionary tax measures (DTM) implemented by each EU Member State over the period 2000-2016.[18] Using the DTM database, he computes the aggregate revenue impact of past and present tax measures for each year under consideration. For each measure, the database reports the prospected

[16] More complex specifications allow for the transition between different states within the economy (e.g. Auerbach and Gorodnichenko, 2012), but are beyond the scope of this paper.

[17] An alternative identification strategy to overcome endogeneity problems and identify the true fiscal policy shocks from the above system of equations, would be to impose a structure on the system to orthogonalize the error terms.

[18] Carnot and de Castro (2015) used an earlier vintage of the same database to construct a yearly measure of discretionary fiscal effort to estimate EU-wide multipliers in a limited panel regression set-up.

annual revenue impact for *K* consecutive years, with *K* varying across tax changes and Member States. Consequently, one can compute the aggregate change in PIT revenue in year *t* by adding up the projected changes in tax revenues for year *t* of all tax measures adopted between *t* and *t-K*. Thus, the exogenous (x_{it}) tax shock is defined as:

$$x_{it} = x_{it}^{u} + x_{it}^{a} \text{ with } x_{it}^{a} = \sum_{k=1}^{K} x_{it}^{a,t-k} \quad (7)$$

where it captures unforeseen tax revenue changes implemented in year *t*, i.e. that were in all likelihood not anticipated or not perceived likely in any period before t. By contrast, x_{it}^{a} is the sum of tax revenue changes anticipated for year *t* across all tax measures introduced in year *t-k* expressed as percentage of GDP in *t-1*, hereafter referred to as anticipated tax measure.[19]

While the unexpected shocks are by definition only impacting the economy upon their implementation, anticipated shocks may cause changes in the economy before their implementation. Hence, the above specifications should be extended to capture those effects prior to implementation by including $x_{it+\tau}^{a,t}$, which measures the sum of all anticipated PIT changes known at date t to be implemented at date $t+\tau$. Consequently, van der Wielen (2020) estimates

$$Y_{it} = \sum_{\tau}^{T} F_{\tau} Y_{it-\tau} + \sum_{\tau=0}^{T} G_{\tau} X_{it-\tau} + \sum_{\tau=1}^{M} h_{\tau} x_{it+\tau}^{a,t} + \varepsilon_{it} \quad (8)$$

Fiscal adjustments typically are part of a larger reform agenda. Among other things, fiscal reforms may aim to initiate labour market adjustments, e.g. via work incentives. The possible impact on employment and wages codetermines the final budgetary impact. Therefore, in what follows, vector Y_{it} is composed of primary government spending (GP_{it}), employment (E_{it}), wage compensation (W_{it}), inflation derived using the GDP deflator (P_{it}), and GDP in real terms (GDP_{it}). GP_t is defined as the sum of public consumption (purchases of goods and services plus compensation of civil servants) and public investment, but excluding interest payments on government debt. Fiscal variables refer to the whole general government sector as defined in ESA 2010. The GDP deflator is employed to obtain the corresponding variables in real terms. All variables are seasonally adjusted and enter the model specification in log differences except the employment and inflation rates, which enter in differences.[20] Time-demeaning is used to correct for the impact of time fixed effects not necessarily properly accounted for by the endogenous variables, e.g. sudden drops in market confidence as a result of the financial and sovereign debt crisis. This all leaves us with an unbalanced panel covering the period 1999Q1-2017Q3.

[19] In what follows the nominal equivalent of x_{it} is referred to as $\boldsymbol{\Delta\Gamma}$, see e.g. Appendix A.1.

[20] Stationarity of the individual series was confirmed using the Phillips-Perron and augmented Dickey-Fuller unit root tests as well as using the less well-known, but more powerful Dickey-Fuller GLS regressions. The panel was tested for unit roots using the Im-Pesaran-Shin test.

5.3.2 Panel results

Table 1 summarizes the macroeconomic effects of an unanticipated 1 per cent of GDP increase in tax receipts obtained by estimating VAR specification (8) on a yearly panel of EU Member States. The cumulative multiplier for a given year is obtained as the ratio of the cumulative response of GDP and the cumulative response of (discretionary) tax revenues. The results are shown up to five years after the shock, i.e. including the time horizon also used in EU fiscal surveillance. The panel VAR results suggest that a medium-term deterioration of GDP growth by 2 percentage points can be expected as Member States increase tax revenues. Table 1 also includes the macroeconomic responses to anticipated tax reforms, therefore starting from an earlier announcement date. While anticipated tax hikes show an output decreasing impact upon implementation, the VAR estimates also show an output enhancing effect of the anticipated reform at the announcement date. Overall, by increasing the after-tax return from working, saving, and investing, a reduction in income tax rates has two opposing effects on economic activity. It encourages work effort (substitution effect), which increase economic activity, but it also reduces their need to work, save, and invest (income effects).[21] The short, medium and long-term effect on the economy depends on the financing of the personal income tax cut, in terms of possible increases in less distorting taxes, a reduction in government spending or higher government borrowing. See Gale and Samwick (2017) for a detailed discussion of the channels through which income tax changes affect economic performance. The results in Table 1 show that, in the medium term, tax cuts can lead to a more efficient reallocation of resources, resulting in higher output.

In keeping with the literature, the results should be interpreted as the average effects of exogenous tax changes. Moreover, it is important to note that every comparison among multipliers has to be taken with care. For example, one needs to differentiate between the impact of temporary and permanent shocks. Similarly, the type of fiscal shock considered may differ greatly, possibly due to the difference in identification or model decisions (e.g. DSGE vis-à-vis VAR models).[22] The magnitude of the output estimates are consistent with earlier narrative estimates of tax multipliers in high-income countries (e.g. Cloyne, 2013; Hayo and Uhl, 2014; Gil et al.,2019) as well as panel studies (e.g. Guajardo et al., 2014). Moreover, the size of the labour market responses found, is in line with earlier empirical findings, e.g. Mertens and Ravn (2013). The reader is referred to van der Wielen (2020) for a more extensive discussion.

[21] Labour market dynamics may also have an important regional dimension (see e.g. Bande et al., 2017 for the case of Spain), which is not considered in this application.

[22] In this respect, the reader may benefit from a more extensive overview of possible factors of conditionality (see e.g. European Commission, 2012): composition of the fiscal adjustment, types of consumers in the economy, the monetary policy stance, product or labour market liberalization, the states' degree of inequality, etc.

Table 1: Macroeconomic effects of unanticipated and anticipated tax changes

Unanticipated						
		Impact	1y	3y	5y	Cum.
Primary spending		-0.52	-0.09	-0.17	0.04	-1.00
		(0.82)	(0.80)	(0.25)	(0.09)	(1.80)
Employment		-0.39**	-0.27*	0.06	0.04*	-0.46*
		(0.15)	(0.15)	(0.08)	(0.04)	(0.37)
Wages		-0.36	-1.08*	0.08	0.01	-1.80*
		(0.65)	(0.56)	(0.24)	(0.08)	(1.33)
Prices		-0.14	-0.48*	-0.16	0.07	-1.18*
		(0.38)	(0.39)	(0.21)	(0.07)	(0.95)
Output		-1.06***	-0.81**	0.09	0.05	-1.91**
		(0.33)	(0.38)	(0.21)	(0.08)	(0.90)
Anticipated						
	Announc.	Impact	1y	3y	5y	Cum.
Primary spending	0.80*	-0.77	-1.20*	-0.33*	0.02	-0.93
	(0.58)	(0.83)	(0.71)	(0.30)	(0.11)	(1.87)
Employment	-0.28*	-0.64***	-0.13	0.10	0.05*	-1.16**
	(0.23)	(0.19)	(0.16)	(0.11)	(0.05)	(0.57)
Wages	1.39**	-0.67*	-2.05***	-0.05	-0.01	-1.04
	(0.61)	(0.62)	(0.57)	(0.28)	(0.10)	(1.49)
Prices	-0.26	-1.13**	-0.41	-0.24	0.07	-1.86*
	(0.50)	(0.44)	(0.44)	(0.28)	(0.09)	(1.39)
Output	0.91**	-1.45***	-0.99***	0.11	0.03	-2.00*
	(0.41)	(0.38)	(0.33)	(0.29)	(0.10)	(1.20)

Note: Except the cumulative multipliers after five years reported in the last column, all values are contemporaneous multipliers. The estimates for unanticipated tax reforms have been adjusted to correct for coinciding expectations about future parts of the measure. Standard errors are noted in parentheses and are based on 2,000 Monte Carlo draws using Gaussian approximation. Asterisks indicate significance of the estimate, referencing 68% (*), 90% (**) and 95% (***) confidence intervals.
Source: van der Wielen (2020)

5.3.3 Country-specific Results

Panel-based estimates serve a multitude of purposes: (i) they may help us understand economic dynamics characterizing multiple entities at the group level, e.g. unions with integrated financial markets; (ii) help fill in gaps where data are scarce; and (iii) suggest general trends that might be explored further at the unit level. Nevertheless, the fiscal policy transmission mechanisms may differ across countries. For example, Afonso and Sousa (2012) find strikingly different output multipliers for revenue shocks in Germany and Italy, attributable to differences in consumption and debt dynamics. Consequently, this section presents alternative country-specific estimates. In what follows, we extend our panel analysis to a quarterly set-up in order to estimate country-specific models. Nevertheless, to do so we also have to convert the narrative indicator to a quarterly frequency. To this end we construct a quarterly indicator, x_{itq}, that measures the exogenous, discretionary fiscal reforms of a permanent nature:

$$x_{itq}^{j} = \begin{cases} x_{it}^{j} \;\; for \;\; q = 3 \\ 0 \quad otherwise \end{cases} \tag{9}$$

where q denotes the quarter and $j \; \epsilon \; u, \; a$. Considering that the budget cycle typically requires budgets to be agreed upon by October, we assume that the measures are determined by the third quarter.[23]

Again, we generally observe a contractionary impact on economic growth following (un)anticipated tax hikes. For reasons of brevity, however, we do not report all estimation results, but restrict ourselves to a more in-depth discussion of the broadly representative results for Spain. In our baseline specification for Spain a 1% of GDP increase in personal income tax revenue results in a corresponding 0.34% increase in GDP on impact and a 0.45% decrease in GDP after three years. Inversely, tax cuts are found to have output enhancing effects in the medium-run, though they are likely costly at the start.

The magnitude of our estimates is notably smaller than earlier narrative estimates of tax multipliers mentioned above. One reason may be the differences in scope. Using a narrative model for GDP, public spending and the interest rate, Gil et al. (2019) find that an increase in overall tax liabilities by 1 percent of GDP decreases output per capita by 1.3 percentage points after one year. For direct tax liabilities this drops below unity, thereby instilling faith in our results.[24]

de Castro and Hernández de Cos (2008), on the other hand, estimate a SVAR for Spain similar to that used by Blanchard and Perotti (2002). Doing so they find similar dynamics to ours: both for shocks to overall net taxes and direct taxes there is a limited positive impact on GDP in the short run which becomes significantly negative in the medium term.[25] Furthermore, the positive short-run output response tends to be more short-lived in our model. Gil et al. (2019) in fact find none at all. This may be due to a more limited set-up. For instance, we find that including private consumption in the model (like de Castro and Hernández de Cos, 2008) lengthens this short-run dynamic.

5.4 Real-Time Comparison

To illustrate the benefits of the dynamic scoring procedure we apply our full blown model to estimate the impact of past fiscal reforms in Europe. The first panel of Figure 2, for example, summarizes the simulated revenue impact of four of Spain's recent PIT Reform. Further we also consider tax reforms in Bulgaria, Croatia, Poland, Romania and Sweden. Tables 2 to 13 in Appendix A.2 provide detailed microsimulation results for each of the reforms, both upon impact and at the typical medium-term policy horizon (i.e. three years ahead). The appendix also includes a comprehensive description of each of the reforms. All reform assessments are made in real time, i.e. as if the simulations were conducted at the time of the assessment carried out by the Member States. As a point of departure, we use the EUROMOD model to estimate the first-round revenue impact of the respective tax

[23] The robustness of this assumption was confirmed by testing the model results' sensitivity to bunching in other quarters.

[24] To allow for a full comparison we have also used their comprehensive appendix to reconstruct an indicator including the PIT subset of their direct tax measures indicator. Including this indicator in our baseline model instead, we find a 0.9 percentage point decrease of output after one year, which reduces to 0.2 in the long run.

[25] In turn, when we estimate a similar SVAR specification, we find small and positive multipliers in line with those observed by de Castro (2006), which uses a simple Choleski factorization to identify the impact of shocks to both direct and indirect net taxes in Spain. By contrast, he does find more negative multipliers in the long run.

reform ($E^1[\boldsymbol{\Delta\Gamma}_t]$), without allowing for any second-round effects. We do this by comparing the microsimulated revenue of the PIT system after reform to the baseline without reform (cf. equation (2)), while keeping all other elements (e.g. the administrative sample and macro conditions) fixed. For example, our first simulation of the 2015 reform using EUROMOD results in: $E^1[\boldsymbol{\Delta\Gamma}_{2015}]$ = -5,548 million Euro. The detailed nature of EUROMOD also documents the minor changes in social insurance contributions (SIC) and benefits accompanying the PIT cut (see Table 4 in the Appendix). The strongest effect among them is the increase in non means-tested benefits as a result of the tax credit for working large families and lone parents included (cf. Ley 26/2014).

Next, in order to incorporate the macroeconomic impact of the implemented PIT reform into EUROMOD, we compute the macroeconomic effects corresponding to the expected size of the first-round simulation. Specifically, given the estimated macro dynamics, it is expected that the 2015 PIT decrease (amounting to 0.6% of GDP) results in a 0.2 percentage point increase in GDP during the first four quarters of impact, while prices decrease by 0.2 percentage point.[26] On the labour market, the reform is expected to increase the employment rate by 0.4 percentage point in the first year, whereas the wage effect only gains speed after two years: a 0.3 (0.9) percentage point drop after one (two) year(s). A EUROMOD simulation of the tax reform taking into account aforementioned second round effects leads us to conclude that the final revenue impact ($E^2[\boldsymbol{\Delta\Gamma}_{2015}]$) will amount to -5,889 million Euro. Hence, including the second-round effect due to the macroeconomic impact of the PIT reform is estimated to further decrease PIT revenue by 341 million Euro. As time proceeds, the negative impact of depressed wages on PIT further outweighs the increase in employment, expanding the difference to 1,263 million Euro after three years. The interplay of the increase in employment and decrease in wages moreover results in lower social insurance contributions (SIC), especially on the employer side. Overall, for three out of four reform years our estimates are remarkably close to those recorded in the DTM database. Despite the apparently modest size of the second-round effects in Figure 2 (as portrayed by the difference between the dark and light grey bars), the second-round effects for PIT add up to non-negligible values. We obtain values of between 5.8% (18.5%) of the final reform impact in 2015 and 7.8% (23.9%) in 2012 after one (three) year(s). [27]

There are multiple explanations possible for the remaining difference between our real time estimates and the DTM in 2015. A first source of deviation may be the scope of the reforms included in both aggregates. While our simulations only capture those measures covered by the EUROMOD model, the aggregate submitted to the DTM by the Spanish government is noted to encompass the whole set of PIT measures included in Ley 26/2014. Unfortunately, the DTM database does not provide a further breakdown of the estimate - as it does for other years - to facilitate a more accurate comparison. A comparison of the reforms in EUROMOD to the respective law nonetheless suggests that all major components of the reform have been modelled. A second possible explanation lays in the assumptions made by the central government concerning regional governments' response to the federal reforms. We cannot verify the central government's assumption, but all public communication seems to suggest they assumed that the regional PIT rates would remain unchanged. EUROMOD, nevertheless, includes the regional PIT rates implemented, i.e. possible behavioural responses of sub-governments. Finally, in contrast to the other

[26] While the VAR model provides quarterly estimates, the EUROMOD model's microsimulations are on a yearly basis. Consequently, we use the cumulative impact after four quarters as macro impacts of a PIT shock to be included in the micro model.

[27] More formally, the mentioned values are computed as follows: $\frac{\tau_t\,(m_1 E^1[\Delta\Gamma_t])}{E^2[\Delta\Gamma_t]}$ for all *t*.

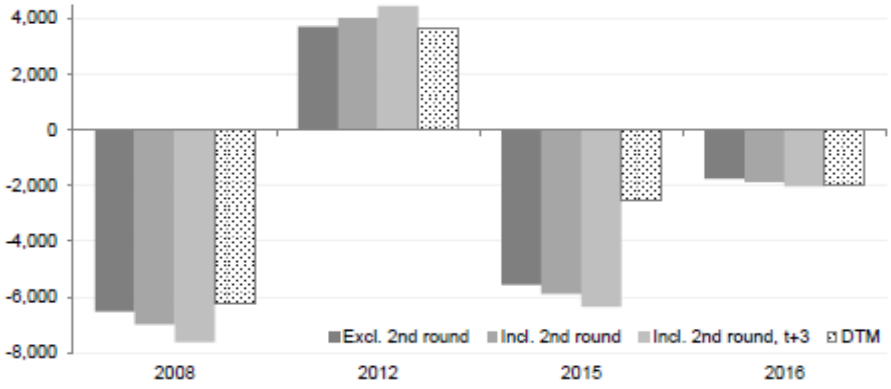
Spanish PIT reform estimates considered in Figure 2, the 2015 DTM estimate is recorded to include second-round effects. Therefore, the 2015 DTM listing may simply overestimate the expected second-round effects. This approach can be easily extended to other Member States' PIT reforms. Panel (b) in Figure 2, for instance, contains the revenue impact of the changes in the basic allowance and in-work tax credit introduced in Sweden during the last decade. Again the second-round effects are found to be marginal relative to the first-round revenue impact of the reforms. Furthermore, our simulation results are comparable to those submitted by the Swedish government to the DTM database.

The most important discrepancies are for the more drastic reforms in 2010 and 2014. In contrast to the reforms in 2011 and 2013 which only adjust the additional basic allowance for pensioners (introduced in 2009), these reforms also entailed changes to the in-work tax credit. Nevertheless, the source of the differences is different in each case. For the 2010 tax credit reform, the EUROMOD simulations only differ 211mln Krona from those submitted to the DTM database. The discrepancy mainly follows from the expected impact of the allowance. The opposite is true in case of the 2014 reform. Hence, there does not seem to be a systematic difference among the underlying methodologies.

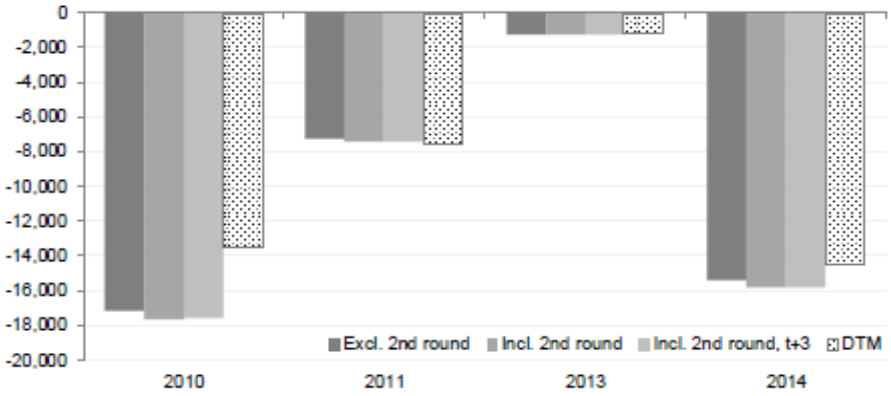
Unfortunately, some applications do not allow the use of country-specific macro estimates due to data availability issues. Nevertheless, in such cases panel estimates for a representative set of countries can be used as a proxy. Panel (c) in Figure 2 displays four such cases: (i) the replacement of the progressive income tax by a flat tax in Bulgaria in 2008; (ii) the 100 RON increase of the minimum wage in Romania in 2014; (iii) the increase in the threshold of the second income tax bracket in Croatia in 2015, jointly with increases of the tax free threshold as well as allowances for pensioners and children; and (iv) the switch from a three to a two-bracket income tax schedule in Poland in 2009. Also with the panel estimates the second-round revenue effects are found to be limited, especially after three years. The model moreover facilitates distributional analysis. Figure 3 plots the difference of the mean annual equivalised disposable income by decile before and after each of the Spanish reforms (in % of baseline), both excluding (dark grey) and including (light grey) the second-round effects 3 years after implementation.[28] For instance, the 2015 PIT cut resulted in higher disposable incomes across the board, even though it is comparatively less outspoken for the second to fourth decile. Accounting for the macroeconomic impact of the reform mitigates the positive effect on disposable incomes. In a limited number of cases the second-round effects may even reverse the increase in disposable income expected using solely a first-round analysis, as for the second decile in case of the 2016 reform. On balance, the short run second-round revenue impact of the reform is found to be small relative to the first-round microsimulation results. The supply side effects are not strong enough to prevent PIT cuts from being revenue losing, hence the tax cuts do not pay for themselves. In the medium run, the second-round effects de facto worsen the revenue outcome due to an adverse impact on wages.

[28] The plots for the other reforms considered above can be found in Figures 5 and 6 in the Appendix.

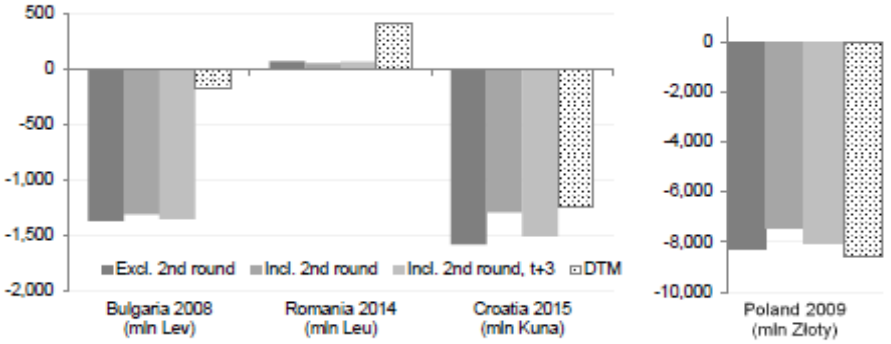
Figure 2: Real-time comparison of the revenue impact of PIT reforms



(a) Spain (mln Euro)



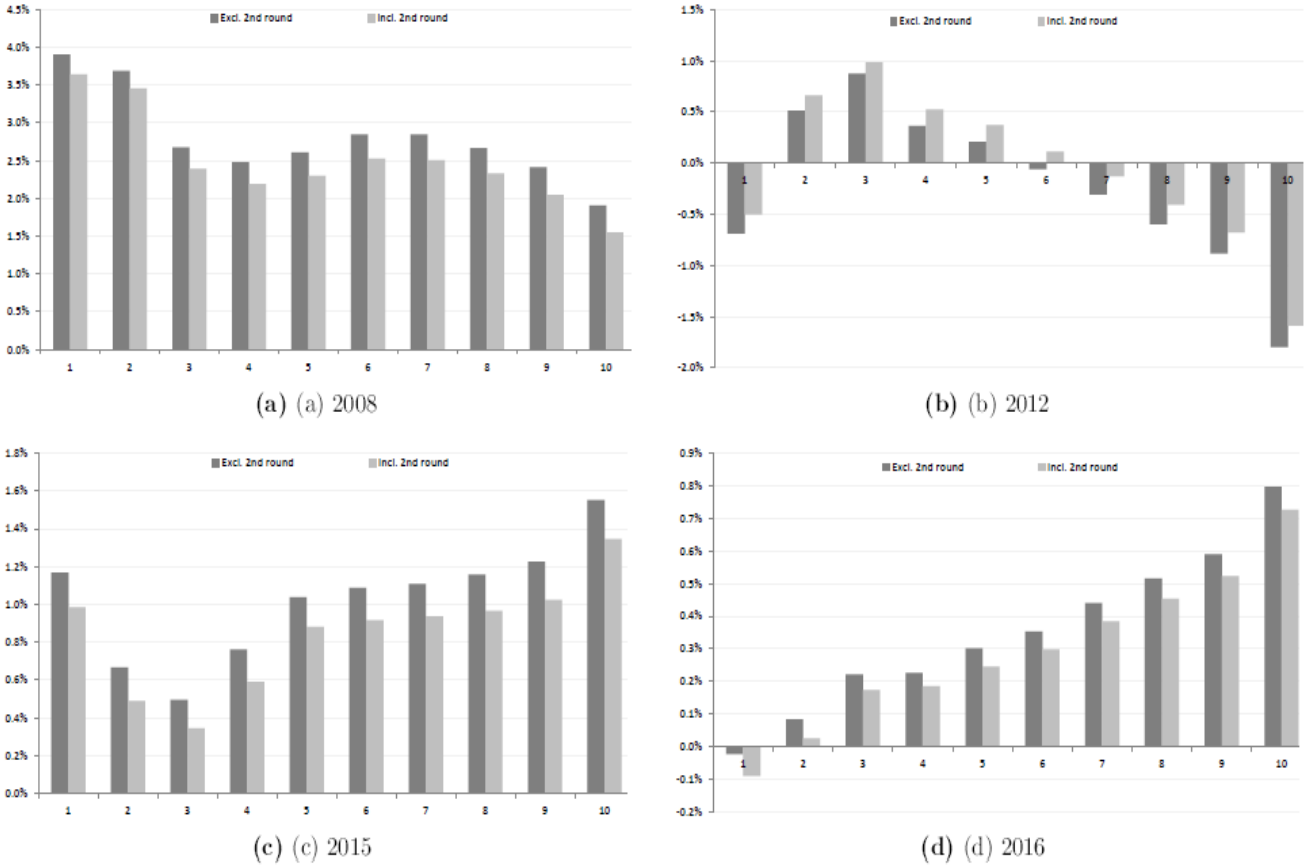
(b) Sweden (mln Krona)



(c) Miscellaneous

Note: The DTM aggregates included concern the discretionary measures affecting current taxes on income and wealth received from households implementable in EUROMOD. As a result, the 2008 aggregate for Spain excludes the expected effects of the fiscal reforms on final tax liability and on tax withholdings. The 2012 DTM aggregate excludes the expected impact of real estate tax reforms as received by municipalities, tax regularization linked to tax evasion, wealth taxation and increases in tax withholdings. Given the focus on personal income taxes, the 2014 aggregate for Sweden excludes the expected effects of the changes in social security contributions.

Figure 3: Mean annual equivalised disposable income in Spain by decile (difference as % of baseline)



(a) (a) 2008

(b) (b) 2012

(c) (c) 2015

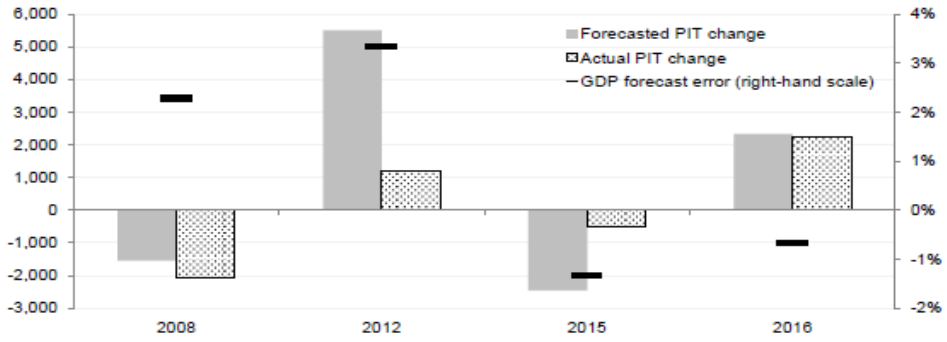
(d) (d) 2016

5.5 Ex Post Forecast Error

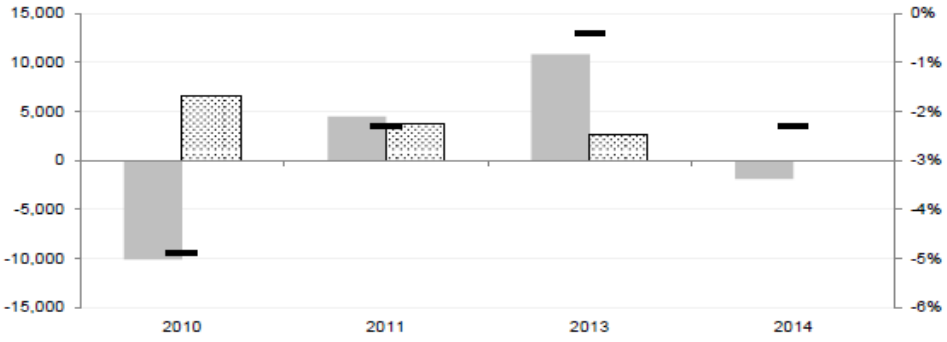
To allow comparing our estimate of the PIT revenue impact to the ex post realised revenue impact an additional adjustment is necessary. First, we need to include the expected PIT revenue impact of other discretionary policy measures taken. For instance, if labour market reforms were implemented simultaneously with the tax reform these would not have been considered in the above procedure. Yet such reforms are also expected to have possible revenue consequences via labour income and the taxation thereof. Second, we also need to account for the real-time expected trend growth with respect to the previous year (i.e. not the result of discretionary measures), since growth effects are included in the ex post realisations. A more comprehensive derivation of the ex post aggregate can be found in Appendix A.1. As discussed in the appendix, the revenue impact of both adjustments is proxied by means of the elasticity of PIT revenues with respect to the output gap. For example, in case of the 2015 reform other policy measures are expected to increase GDP growth by 1.03 percentage points and hence have a revenue increasing impact of about 1,294 million Euro. In addition, a trend growth of 1.70% was expected, likely to generate 2,132 million Euro in revenues. Accordingly, the final revenue change in 2015 was expected to be -2,463 million Euro on impact. Figure 4 summarizes the comparison of the growth adjusted real-time estimates to the realized PIT changes for all twelve reforms considered earlier in this section. In Spain, for example, the model appears to overestimate PIT revenues in 2008 and 2012, while underestimating them in 2015. Inasmuch as ex ante

estimates can forecast realizations our model seems to perform well, especially given the relatively turbulent crisis and post-crisis period under consideration. To demonstrate this, Figure 4 plots the GDP forecast error, i.e. the forecasted percentage real GDP growth rate as contained in the European Commission's Spring Economic Forecasts of the preceding year minus the actual percentage real GDP growth rate. A clear relationship between our ex post estimation error and the GDP forecast error is noticeable: our model overestimates PIT in years GDP is overestimated, and vice versa. Moreover, with some exceptions (e.g. the 2012 reform in Spain), our estimation error is proportional to the magnitude of the Commission's GDP forecast error, with a one percentage point overestimation of GDP leading to an overestimation of PIT revenues by 472 mln Euro. Nonetheless, 2012 was an exceptional year with an output gap of -7.8%. Overall, we observe a 70% correlation between the difference between forecast and realisation (in mln Euro) and GDP forecast error.

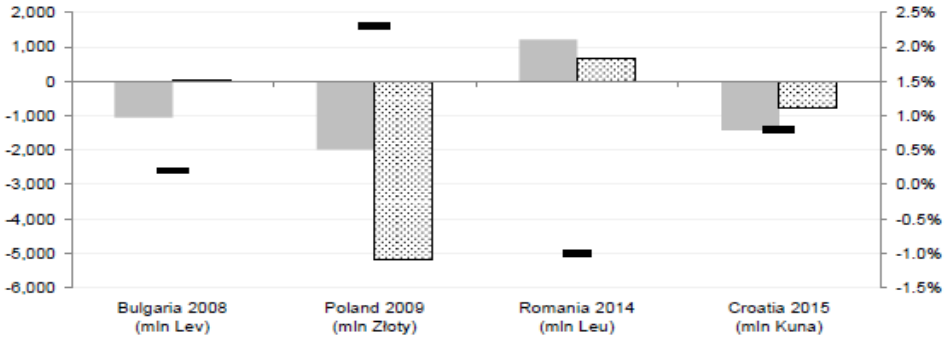
Figure 4: Comparison of real-time forecasts to realized PIT changes



(a) Spain (mln Euro)



(b) Sweden (mln Krona)



(c) Miscellaneous

Note: The forecasted and realized PIT change are expressed in million units of national currency. The GDP forecast error is defined as the difference between the forecasted percentage real GDP growth rate as contained in the European Commission's Spring Economic Forecasts of the preceding year and the actual percentage real GDP growth rate.

6 Conclusion

The budgetary and macroeconomic impact of fiscal policy reforms has become a topic of intense debate in the Euro area. First, fiscal policy remains the key macroeconomic policy lever Member States avail of in order to counter adverse economic shocks and to possibly foster economic growth. Second, EU fiscal policy surveillance has experienced significant reforms in the wake of the global financial crisis including among others the creation of national fiscal councils conducting independent assessments of national fiscal reforms. In this context growing attention has been paid to discretionary tax measures taken by Member States in order to assess fiscal policy stances in an accurate way. However, the ex-ante assessment of discretionary tax measures is notoriously difficult. It must clearly identify the channels through which these might impact the economy, especially so in the case of tax cuts intended to foster economic activity. In that case, policy makers must anticipate possible behavioural effects (e.g. in terms of increased labour supply or increased consumption) in order to possibly argue that at least part of the tax revenue losses entailed by the tax cut are recovered through increased employment (consumption). The same applies to tax hikes. Government might decide to privilege specific tax categories in order to raise extra tax revenues arguing that the adverse effects on economic activity would not be as important as to offset the potential revenue gains. It is arguably difficult to anticipate all possible effects of tax reforms, especially so at the time policy reforms are being designed, i.e. in real time. Since 2014, EU Member States must provide the European Commission services with an assessment on the budgetary impact of discretionary tax measures. However, in general, these assessments are judgemental and rely on qualitative analysis and/or models or quantitative approaches which are left unspecified. Against this backdrop, the assessment of Member States' fiscal reforms and the identification of their intended impact separately from the evolution of economic activity becomes highly challenging.

This paper provides a framework of a real-time dynamic scoring exercise and compare the results of this exercise with Member States' own real-time assessment by exploiting a rich database including information on discretionary tax measures. Using this database, we estimate the economy-wide effects of tax reforms by means of VAR modelling. We then incorporate the evolutions of the macro aggregates estimated with VAR model into the multi-country EUROMOD microsimulation model. In doing so, we are able to replicate with great precision the detailed legislative changes of the tax reforms and to obtain both the first round impact of tax reforms (or direct fiscal impact), and second-round impact incorporating behavioural changes and macroeconomic feedback provided by the VAR model. Importantly, by using the different vintages of EUROMOD, we are able to perform real-time analyses, i.e. as if our estimations were conducted at the time reforms were enacted by the Member States with the information available at that time. In doing so, we are also able to assess the predictive power of our approach compared to that of the Member States. In addition, we can analyse the role played by GDP forecast errors in order to explain the sources of discrepancy. Contrary to what is sometimes suggested in political discourse, the second-round revenue impact of personal income tax reforms is found to be small relative to the first-round microsimulation results. The supply side effects are not strong enough to prevent tax cuts from being revenue losing, hence the tax cuts do not pay for themselves. Our results suggest that our approach can significantly enhances the accuracy of fiscal and distributional impact assessments of tax reforms.

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Annexes

A Appendix

A.1 Derivation of Aggregates (1) to (3)

Definition of ex ante estimates The expected fiscal outcome, $E[T_t]$, can be expressed as a function τ_t of the corresponding macroeconomic situation:

$$E[T_t] = \tau_t(E[M_t]) \tag{10}$$

where the expected macroeconomic situation, $E[M_t]$, can be further split out into its lag and the changes since, as follows

$$E[M_t] = M_{t-1} + E[M_t - M_{t-1}] \tag{11}$$

As a result, the expected fiscal outcome in the next year can be rewritten as a function of last year's fiscal outcome, the ceteris paribus outcome of change in the tax system and the macroeconomic developments, as follows

$$\begin{aligned} E[T_t] &= \tau_t(E[M_t]) \\ &= \tau_t(M_{t-1} + E[\Delta M_t]) \\ &= \underbrace{\underbrace{\tau_{t-1}(M_{t-1})}_{\text{Baseline, } E^0[T_t]} + \underbrace{\tau_t(M_{t-1}) - \tau_{t-1}(M_{t-1})}_{\text{1st round: PIT reform}}}_{\text{EUROMOD simulation, } E^1[T_t]} + \tau_t(E[\Delta M_t]) \end{aligned}$$

We will abbreviated the revenue impact of the change in the tax system to $\Delta\Gamma_t$. Furthermore, both $E^0[T_t]$ and $E^1[T_t]$ can be readily simulated using the EUROMOD microsimulation model.

The macroeconomic developments consist of various components of interest. For instance, they comprise growth according to the trend $(\bar{M}_t - M_{t-1})$. But they also encompass the expected output effects, $m(\cdot)$, of all relevant policy changes $(E[\Delta X_t])$. Given our focus on fiscal reforms, we treat the PIT reforms $(\Delta\Gamma_t)$ included in ΔX_t separately from all other reforms, ΔZ_t. Specifically, for expository purpose, assume that the macroeconomic function m can be readily decomposed, allowing us to identify three specific channels with a fiscal impact: (i) trend growth; (ii) the macro impact of fiscal measures; and (iii) the macro impact of other policy measures, e.g. labour market reforms.[29]

$$\begin{aligned} E[T_t] &= \tau_{t-1}M_{t-1} + \Delta\Gamma_t + \tau_t(mE[\Delta X_t]) + \tau_t\left(E\left[\bar{M}_t - M_{t-1}\right]\right) \\ &= \underbrace{E^1[T_t] + \underbrace{\tau_t(m_1 E[\Delta\Gamma_t])}_{\text{2nd round: PIT reform}}}_{\text{EUROMOD-VAR simulations, } E^2[T_t]} + \underbrace{\tau_t(m_2 E[\Delta Z_t])}_{\text{2nd round: other reforms}} + \underbrace{\tau_t\left(E\left[\bar{M}_t - M_{t-1}\right]\right)}_{\text{trend growth}} \end{aligned} \tag{12}$$

[29] The proposed decomposition does not account for the possible impact of the interplay of fiscal and other reforms.

Finally, for the impact analysis of discretionary tax measures, estimating aggregate $E^2[T_t]$ allows for a comparison among ex ante estimates (such as the ones recorded in the DTM database). In fact, the first two components of equation (12) can be estimated using the model presented in this paper. While the EUROMOD model was specifically designed to simulate functions τ_t, parameter m_1 corresponds to the GDP multiplier in the VAR model.

Comparison to ex post results To allow a comparison of our estimates to the ex post realisation the last two components of equation (12), however, have to be approximated. This approximation can be done using the elasticity of PIT revenues with respect to the output gap (ε). First, the ex post realisations include the revenue impact of other measures taken, while the EUROMOD simulation focuses exclusively on the impact of the PIT reform. For instance, if labour market reforms were implemented simultaneously with the tax reform these are considered. Yet such reforms are also expected to have possible revenue consequences via labour income and the taxation thereof. To correct for this, we reconstruct the real-time estimate of the other reforms' output impact. That way, we can use the elasticity of tax revenue with respect to output to obtain their fiscal impact

$$\begin{aligned}\tau_{22}\left(m_2 E\left[\Delta Z_t\right]\right) &\approx \varepsilon T\left[\left(\frac{\hat{Y}_{EC}-\bar{Y}}{\bar{Y}}\right)-\left(\frac{\hat{Y}_{VAR}-\bar{Y}}{\bar{Y}}\right)\right] \\ &\approx \frac{\varepsilon T}{\bar{Y}}\left(\hat{Y}_{EC}-\hat{Y}_{VAR}\right) \end{aligned} \tag{13}$$

where $\hat{Y}_{EC}$ and $\hat{Y}_{VAR}$ refer to the real-time output estimates in the Commission's official communication and by our VAR model, respectively. In particular, $\hat{Y}_{VAR}$ consists of the expected growth and the impact of the PIT reform. The Commission's forecast is taken from the latest official communication before the reform decision. For instance, in the case of the 2015 PIT reform this was the 2014 Spring economic forecast. Consequently, the difference of both output estimates captures the remaining reforms.

Second, the real-time expected trend growth with respect to the previous year - i.e. not the result of policy changes - is added, given that growth effects are also included in the ex post realisations. As with the discretionary component not related to PIT reforms, the revenue impact can be estimated indirectly using the elasticity

$$\tau_3\left(E\left[\bar{M}_t - M_{t-1}\right]\right) \approx \varepsilon T\left(\frac{\bar{Y}-Y_{t-1}}{\bar{Y}}\right) \tag{14}$$

where $\bar{Y}$ refers to potential GDP and Y_{t-1} is previous year's GDP realization. Potential output is constructed using a HP-filter.

In the benchmark simulations, the parameter ε is taken from earlier work by Mourre et al. (2014). For the case of Spain, the time-invariant elasticity is found to be 1.84. Alternatives, for instance exploiting the extensive micro data available, are being explored.

A.2 PIT Reform Details

2008 The most important measure introduced in 2008 was a 400 euro annual tax credit for wage earners. In particular, the measure was implemented retroactively in June 2008, hence also affecting the salaries from January to May. Moreover, an overall updating of the parameters of the PIT system took place. For example, the allowance for labour income, the personal and family allowances and the thresholds of the progressive schedule were increased by 2% to take into account inflation. Three autonomous communities (Comunidad de Madrid, La Rioja and Comunitat Valenciana) changed their progressive schedules. Finally, in addition to the adjustment of the means-tested birth/adoption benefit, a universal child benefit for birth/adoption was introduced.

The expected effects of the fiscal reforms on final tax liability and on tax withholdings were excluded from the analysis as they are not covered in EUROMOD.

2012 The PIT reforms considered for 2012 mainly concern the generalized PIT rise, as adopted in December 2011 (cf. Real Decreto-ley, de 30 de diciembre 2011, de medidas urgentes en materia presupuestaria, tributaria y financiera para la correccil deficit pblico). Specifically, austerity measures lead to a significant reform of the PIT system. The number of tax brackets enlarged as well as their rates for both the general tax base and the savings tax base. The increment for the tax base was also applied to State and Regional brackets. The Regions did not apply changes to the savings tax base. In addition, the child birth and adoption measures implemented in 2008 were reverted in 2011. The reversal of this measure was expected to have an ongoing effect until 2012.

The 2012 DTM aggregate excludes the expected impact of real estate tax reforms as received by municipalities, tax regularization linked to tax evasion, wealth taxation and increases in tax withholdings.

2015 The PIT reforms implemented in Spain in 2015 are enshrined in Ley 26/2014 de 27 de noviembre. Among other more marginal measures, the 2015 PIT reform simulated entailed: lower national tax brackets and rates, an increase of the income limits for the allowance for income earners, a lowering of the minimum amount and increase of the maximum amount of said allowance, the elimination of the main residence tax credit, the elimination of a tax credit for taxpayers of 65 years old or older, a tax credit for working large families and lone parents, a tax credit for youth, disabled or in a large family renting their main residence, an increase of the tax credit for child care of children aged 3 or less, an increase of the income limit for the regional, means-tested child benefit, a lower limit for the private pension expenditure allowance and lower capital income taxes.

2016 The reforms to the 2016 PIT system are a continuation of those started in 2015 based on the Ley 26/2014. Most noteworthy are the further reduction of capital income tax rates, national income tax rates and shifting up the upper limit for the third tax bracket of the national income tax system. Furthermore, the government implemented a reduction of the adjusted means-tested lump-sum benefit for children under 3 years. Finally, several

regional governments adjusted their regional income tax schedules (Andalusia, Aragon, Illes Balears, Cantabria, Castilla-La Mancha, Castilla y León, Galicia, La Rioja and Madrid), either by reducing rates and/or adding brackets. There also was an adjustment to the eligibility for the regional tax credit for young taxpayers renting a main residence.

Table 2: Microsimulation results Spain's 2008 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	52,168	45,652	45,188	43,944	-6,516	-6,980	-8,224	-12.49	-13.38	-15.77
PIT	50,307	43,791	43,327	42,084	-6,516	-6,980	-8,223	-12.95	-13.87	-16.35
Total SIC	130,661	130,524	129,992	128,550	-136	-668	-2,111	-0.10	-0.51	-1.62
employees	21,745	21,840	21,746	21,490	95	1	-255	0.44	0.00	-1.17
employers	101,676	101,273	100,836	99,649	-403	-841	-2,028	-0.40	-0.83	-1.99
self-employed	7,239	7,411	7,411	7,411	171	171	171	2.37	2.37	2.37
Total benefits	104,106	108,580	108,540	108,425	4,474	4,434	4,319	4.30	4.26	4.15
pensions	81,560	83,474	83,474	83,474	1,914	1,914	1,914	2.35	2.35	2.35
means tested	9,727	10,924	10,932	10,945	1,197	1,204	1,217	12.30	12.38	12.51
non-means tested	12,819	14,182	14,135	14,006	1,364	1,316	1,188	10.64	10.27	9.27
Net budgetary effect	78,723	67,597	66,640	64,069	-11,126	-12,083	-14,654	-14.13	-15.35	-18.61

Note: The standard EUROMOD definition of PIT has been adjusted to fit the Spanish system and include the corresponding tax credits. Columns (1) through (4) report the revenue impact of the simulations scenarios in million Euro. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Euro, while the last three columns express the differences as percentages of the baseline.

Table 3: Microsimulation results Spain's 2012 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	49,235	52,971	53,287	54,139	3,736	4,051	4,904	7.59	8.23	9.96
PIT	48,214	51,935	52,251	53,103	3,722	4,037	4,889	7.72	8.37	10.14
Total SIC	116,359	116,380	116,701	117,568	21	342	1,209	0.02	0.29	1.04
employees	19,817	20,025	20,083	20,241	208	266	424	1.05	1.34	2.14
employers	90,322	90,108	90,371	91,080	-214	49	758	-0.24	0.05	0.84
self-employed	6,220	6,247	6,247	6,247	27	27	27	0.44	0.44	0.44
Total benefits	137,374	138,665	138,693	138,789	1,291	1,319	1,416	0.94	0.96	1.03
pensions	101,227	102,213	102,213	102,213	986	986	986	0.97	0.97	0.97
means tested	19,879	20,155	20,144	20,134	276	265	254	1.39	1.33	1.28
non-means tested	16,268	16,296	16,336	16,443	29	68	175	0.18	0.42	1.08
Net budgetary effect	28,221	30,686	31,295	32,918	2,465	3,074	4,698	8.74	10.89	16.65

Note: The standard EUROMOD definition of PIT has been adjusted to fit the Spanish system and include the corresponding tax credits. Columns (1) through (4) report the revenue impact of the simulations scenarios in million Euro. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Euro, while the last three columns express the differences as percentages of the baseline.

Table 4: Microsimulation results Spain's 2015 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	70,482	65,838	65,497	64,573	-4,644	-4,985	-5,908	-6.59	-7.07	-8.38
PIT	69,138	63,590	63,249	62,327	-5,548	-5,889	-6,811	-8.03	-8.52	-9.85
Total SIC	125,812	125,992	125,668	124,792	180	-143	-1,019	0.14	-0.11	-0.81
employees	21,878	21,891	21,830	21,666	12	-48	-212	0.06	-0.22	-0.97
employers	96,096	96,184	95,920	95,208	88	-175	-888	0.09	-0.18	-0.92
self-employed	7,838	7,918	7,918	7,918	80	80	80	1.02	1.02	1.02
Total benefits	164,433	165,665	165,602	165,438	1,232	1,169	1,005	0.75	0.71	0.61
pensions	116,782	117,069	117,069	117,069	288	288	288	0.25	0.25	0.25
means tested	20,011	20,052	20,061	20,088	41	49	77	0.21	0.25	0.39
non-means tested	27,640	28,543	28,472	28,280	903	832	640	3.27	3.01	2.32
Net budgetary effect	31,861	26,165	25,563	23,928	-5,695	-6,297	-7,933	-17.88	-19.77	-24.90

Note: The standard EUROMOD definition of PIT has been adjusted to fit the Spanish system and include the corresponding tax credits. Columns (1) through (4) report the revenue impact of the simulations scenarios in million Euro. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Euro, while the last three columns express the differences as percentages of the baseline.

Table 5: Microsimulation results Spain's 2016 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	65,865	64,127	64,014	63,706	-1,738	-1,851	-2,160	-2.64	-2.81	-3.28
PIT	63,617	61,878	61,766	61,458	-1,739	-1,852	-2,160	-2.73	-2.91	-3.39
Total SIC	126,886	127,217	127,109	126,818	331	223	-68	0.26	0.18	-0.05
employees	22,060	22,100	22,080	22,025	40	20	-34	0.18	0.09	-0.15
employers	96,909	97,121	97,033	96,796	212	124	-112	0.22	0.13	-0.12
self-employed	7,918	7,996	7,996	7,996	79	79	79	0.99	0.99	0.99
Total benefits	165,918	166,530	166,514	166,460	612	596	542	0.37	0.36	0.33
pensions	117,074	117,651	117,651	117,651	578	578	578	0.49	0.49	0.49
means tested	20,075	20,103	20,111	20,120	29	37	46	0.14	0.18	0.23
non-means tested	28,770	28,775	28,752	28,689	5	-18	-81	0.02	-0.06	-0.28
Net budgetary effect	26,833	24,814	24,609	24,063	-2,019	-2,224	-2,770	-7.52	-8.29	-10.32

Note: The standard EUROMOD definition of PIT has been adjusted to fit the Spanish system and include the corresponding tax credits. Columns (1) through (4) report the revenue impact of the simulations scenarios in million Euro. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Euro, while the last three columns express the differences as percentages of the baseline.

Table 6: Microsimulation results Sweden's 2010 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	463,368	446,217	445,747	445,818	-17,150	-17,621	-17,549	-3.70	-3.80	-3.79
PIT	419,807	402,657	402,186	402,258	-17,150	-17,621	-17,549	-4.09	-4.20	-4.18
Total SIC	494,637	494,637	494,189	494,257	0	-447	-380	0.00	-0.09	-0.08
employees	86,546	86,546	86,489	86,498	0	-57	-48	0.00	-0.07	-0.06
employers	395,885	395,885	395,506	395,563	0	-379	-322	0.00	-0.10	-0.08
self-employed	12,206	12,206	12,194	12,196	0	-12	-10	0.00	-0.10	-0.08
Total benefits	541,132	541,100	541,058	541,063	-32	-74	-69	-0.01	-0.01	-0.01
pensions	396,255	396,255	396,255	396,255	0	0	0	0.00	0.00	0.00
means tested	21,288	21,256	21,262	21,259	-32	-27	-29	-0.15	-0.13	-0.14
non-means tested	123,588	123,588	123,541	123,549	0	-47	-40	0.00	-0.04	-0.03
Net budgetary effect	416,872	399,754	398,878	399,012	-17,118	-17,995	-17,861	-4.11	-4.32	-4.28

Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Krona. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Krona, while the last three columns express the differences as percentages of the baseline.

Table 7: Microsimulation results Sweden's 2011 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	448,273	441,047	440,872	440,898	-7,226	-7,401	-7,375	-1.61	-1.65	-1.65
PIT	405,482	398,256	398,081	398,107	-7,226	-7,401	-7,375	-1.78	-1.83	-1.82
Total SIC	499,832	499,832	499,662	499,688	0	-169	-143	0.00	-0.03	-0.03
employees	87,337	87,337	87,314	87,318	0	-23	-19	0.00	-0.03	-0.02
employers	400,214	400,214	400,072	400,094	0	-142	-120	0.00	-0.04	-0.03
self-employed	12,280	12,280	12,276	12,276	0	-4	-4	0.00	-0.04	-0.03
Total benefits	537,169	537,167	537,151	537,153	-2	-17	-16	0.00	0.00	0.00
pensions	390,707	390,707	390,707	390,707	0	0	0	0.00	0.00	0.00
means tested	21,856	21,854	21,856	21,855	-2	0	-1	-0.01	0.00	0.00
non-means tested	124,606	124,606	124,588	124,591	0	-18	-15	0.00	-0.01	-0.01
Net budgetary effect	410,936	403,712	403,383	403,433	-7,224	-7,553	-7,502	-1.76	-1.84	-1.83

Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Krona. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Krona, while the last three columns express the differences as percentages of the baseline.

Table 8: Microsimulation results Sweden's 2013 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	495,286	494,068	494,036	494,040	-1,218	-1,250	-1,246	-0.25	-0.25	-0.25
PIT	448,021	446,802	446,770	446,775	-1,218	-1,250	-1,246	-0.27	-0.28	-0.28
Total SIC	551,688	551,688	551,656	551,661	0	-32	-27	0.00	-0.01	0.00
employees	95,497	95,497	95,492	95,493	0	-5	-4	0.00	-0.01	0.00
employers	442,494	442,494	442,468	442,472	0	-26	-22	0.00	-0.01	-0.01
self-employed	13,697	13,697	13,696	13,696	0	-1	-1	0.00	-0.01	-0.01
Total benefits	586,039	586,038	586,035	586,035	-1	-4	-4	0.00	0.00	0.00
pensions	421,704	421,704	421,704	421,704	0	0	0	0.00	0.00	0.00
means tested	28,662	28,660	28,661	28,661	-1	-1	-1	0.00	0.00	0.00
non-means tested	135,673	135,673	135,670	135,670	0	-3	-3	0.00	0.00	0.00
Net budgetary effect	460,935	459,718	459,656	459,666	-1,217	-1,279	-1,269	-0.26	-0.28	-0.28

Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Krona. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Krona, while the last three columns express the differences as percentages of the baseline.

Table 9: Microsimulation results Sweden's 2014 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	509,079	493,712	493,273	493,339	-15,367	-15,807	-15,740	-3.02	-3.10	-3.09
PIT	463,626	448,259	447,819	447,886	-15,367	-15,807	-15,741	-3.31	-3.41	-3.40
Total SIC	563,811	563,811	563,382	563,447	0	-429	-364	0.00	-0.08	-0.06
employees	97,944	97,944	97,884	97,893	0	-61	-51	0.00	-0.06	-0.05
employers	451,814	451,814	451,457	451,511	0	-357	-303	0.00	-0.08	-0.07
self-employed	14,053	14,053	14,042	14,043	0	-11	-10	0.00	-0.08	-0.07
Total benefits	611,104	611,057	611,022	611,026	-46	-82	-77	-0.01	-0.01	-0.01
pensions	445,965	445,965	445,965	445,965	0	0	0	0.00	0.00	0.00
means tested	28,072	28,025	28,033	28,031	-46	-38	-41	-0.17	-0.14	-0.15
non-means tested	137,067	137,067	137,024	137,031	0	-43	-37	0.00	-0.03	-0.03
Net budgetary effect	461,787	446,466	445,632	445,760	-15,321	-16,155	-16,027	-3.32	-3.50	-3.47

Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Krona. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Krona, while the last three columns express the differences as percentages of the baseline.

Table 10: Microsimulation results Bulgaria's 2008 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	3,422	2,054	2,113	2,069	-1,368	-1,308	-1,353	-39.97	-38.24	-39.54
PIT	3,315	1,947	2,006	1,962	-1,368	-1,308	-1,353	-41.26	-39.47	-40.82
Total SIC	6,905	6,905	7,089	6,950	0	184	45	0.00	2.67	0.66
employees	2,082	2,082	2,140	2,096	0	58	14	0.00	2.77	0.68
employers	3,983	3,983	4,094	4,010	0	110	27	0.00	2.77	0.68
self-employed	840	840	856	844	0	16	4	0.00	1.91	0.47
Total benefits	5,463	6,675	6,667	6,674	1,212	1,205	1,211	22.19	22.05	22.17
pensions	4,765	5,989	5,989	5,989	1,224	1,224	1,224	25.70	25.70	25.70
means tested	264	251	244	251	-12	-20	-13	-4.70	-7.49	-5.02
non-means tested	434	434	434	434	0	0	0	0.00	0.00	0.00
Net budgetary effect	4,864	2,284	2,535	2,345	-2,580	-2,329	-2,519	-53.04	-47.88	-51.79

Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Lev. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Lev, while the last three columns express the differences as percentages of the baseline.

Table 11: Microsimulation results Romania's 2014 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	26,299	26,595	26,573	26,589	296	274	290	1.12	1.04	1.10
PIT	16,010	16,079	16,063	16,075	70	53	66	0.43	0.33	0.41
Total SIC	42,021	42,027	41,991	42,018	5	-31	-4	0.01	-0.07	-0.01
employees	13,367	13,367	13,356	13,364	0	-12	-3	0.00	-0.09	-0.02
employers	27,351	27,351	27,327	27,345	0	-24	-6	0.00	-0.09	-0.02
self-employed	1,304	1,309	1,309	1,309	5	5	5	0.39	0.39	0.39
Total benefits	55,498	57,191	57,191	57,191	1,693	1,693	1,693	3.05	3.05	3.05
pensions	46,370	48,110	48,110	48,110	1,740	1,740	1,740	3.75	3.75	3.75
means tested	4,301	4,254	4,255	4,254	-47	-46	-47	-1.09	-1.07	-1.09
non-means tested	4,827	4,827	4,826	4,827	0	-1	0	0.00	-0.01	0.00
Net budgetary effect	12,822	11,430	11,372	11,416	-1,392	-1,450	-1,407	-10.86	-11.31	-10.97

Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Leu. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Leu, while the last three columns express the differences as percentages of the baseline.

Table 12: Microsimulation results Croatia's 2015 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	9,746	7,986	8,311	8,065	-1,760	-1,435	-1,681	-18.06	-14.72	-17.25
PIT	8,543	6,963	7,254	7,034	-1,579	-1,288	-1,508	-18.49	-15.08	-17.66
Total SIC	41,394	41,394	42,173	41,585	0	779	191	0.00	1.88	0.46
employees	20,520	20,520	20,937	20,622	0	417	102	0.00	2.03	0.50
employers	17,795	17,795	18,157	17,884	0	362	89	0.00	2.03	0.50
self-employed	3,079	3,079	3,079	3,079	0	0	0	0.00	0.00	0.00
Total benefits	39,982	39,982	39,984	39,988	0	2	6	0.00	0.01	0.02
pensions	34,057	34,057	34,057	34,057	0	0	0	0.00	0.00	0.00
means tested	2,713	2,704	2,684	2,705	-9	-30	-9	-0.33	-1.09	-0.31
non-means tested	3,211	3,221	3,243	3,226	9	32	15	0.29	0.99	0.46
Net budgetary effect	11,158	9,397	10,500	9,662	-1,760	-658	-1,496	-15.78	-5.90	-13.40

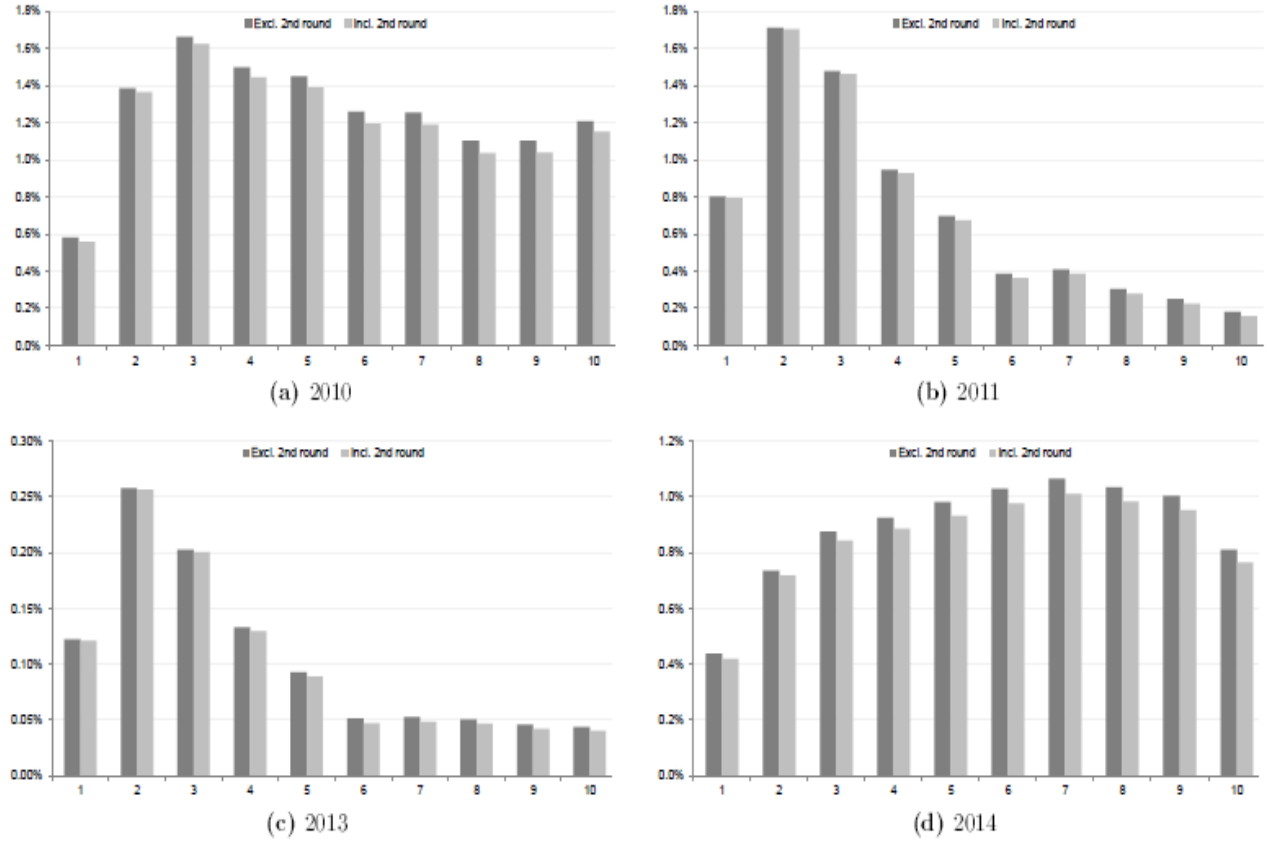
Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Kuna. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Kuna, while the last three columns express the differences as percentages of the baseline.

Table 13: Microsimulation results Poland's 2009 PIT reform

	Baseline	After reform								
		1st round	incl. 2nd round							
		t	t	$t+3$						
	(1)	(2)	(3)	(4)	(2)-(1)	(3)-(1)	(4)-(1)	$\frac{(2)-(1)}{(1)}$	$\frac{(3)-(1)}{(1)}$	$\frac{(4)-(1)}{(1)}$
Total taxes	98,049	89,698	91,111	90,046	-8,351	-6,938	-8,003	-8.52	-7.08	-8.16
PIT	47,652	39,361	40,177	39,563	-8,291	-7,475	-8,089	-17.40	-15.69	-16.97
Total SIC	141,766	141,766	144,053	142,337	0	2,287	571	0.00	1.61	0.40
employees	55,647	55,647	56,626	55,888	0	979	241	0.00	1.76	0.43
employers	75,769	75,769	77,110	76,099	0	1,341	330	0.00	1.77	0.44
self-employed	10,350	10,350	10,318	10,350	0	-32	0	0.00	-0.31	0.00
Total benefits	180,372	180,358	180,301	180,351	-13	-70	-21	-0.01	-0.04	-0.01
pensions	155,716	155,716	155,716	155,716	0	0	0	0.00	0.00	0.00
means tested	14,455	14,441	14,370	14,430	-13	-84	-24	-0.09	-0.58	-0.17
non-means tested	10,201	10,201	10,215	10,204	0	14	3	0.00	0.13	0.03
Net budgetary effect	59,443	51,106	54,864	52,032	-8,338	-4,580	-7,411	-14.03	-7.70	-12.47

Note: Columns (1) through (4) report the revenue impact of the simulations scenarios in million Złoty. The fifth, sixth, seventh column report the corresponding changes with respect to the baseline in million Złoty, while the last three columns express the differences as percentages of the baseline.

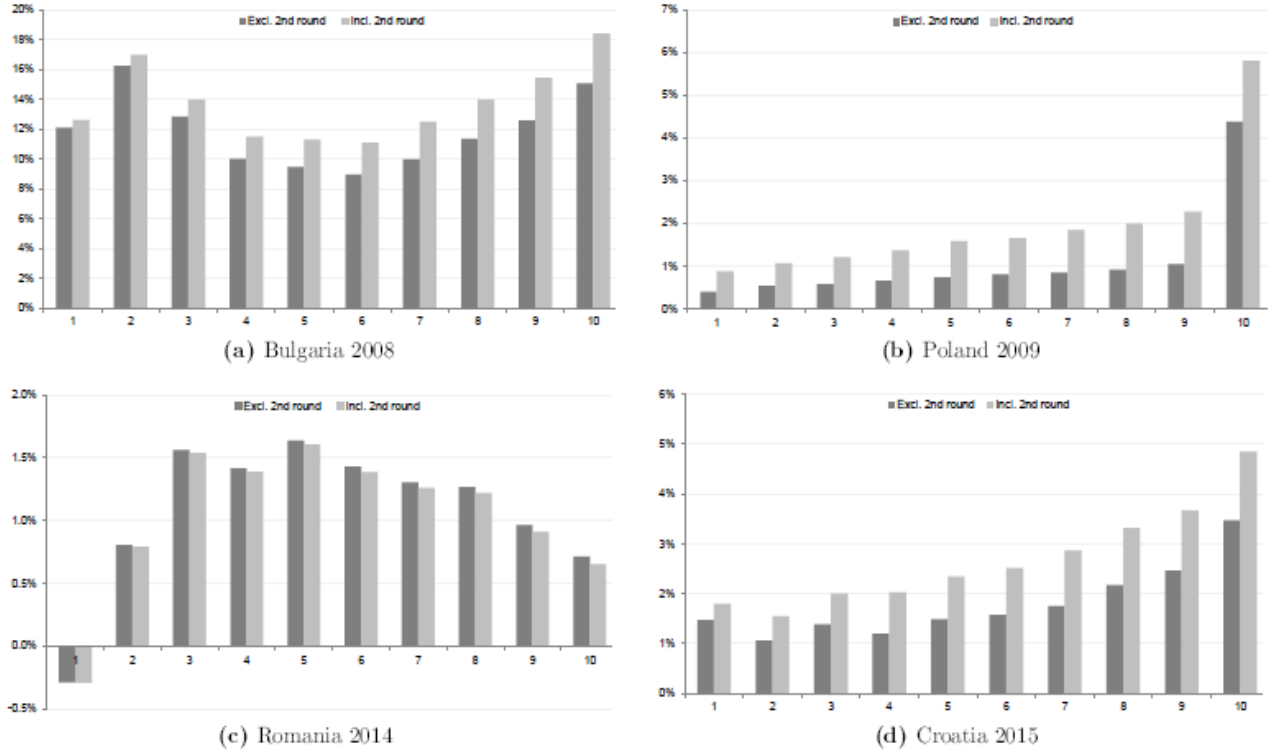
Figure 5: Mean annual equivalised disposable income in Sweden by decile (difference as % of baseline)



(a) 2010 (b) 2011

(c) 2013 (d) 2014

Figure 6: Mean annual equivalised disposable income by decile (difference as % of baseline)



(a) Bulgaria 2008 (b) Poland 2009

(c) Romania 2014 (d) Croatia 2015

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