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RESEARCH ARTICLE

Fiscal Consolidation and Automatic Stabilization: New Results

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Abstract
We derive a novel measure of household income stabilization and analyze how reforms of tax-benefit systems in the period 2007–2014 have affected the workings of automatic stabilizers in the EU-27. Our results reveal that the heterogeneity in automatic stabilizers across EU countries has become slightly smaller over the period under consideration. With a few exceptions, automatic stabilizers could operate freely in the early phase of the financial and economic crisis, but were constrained in several EU countries by subsequent fiscal consolidation measures. A comparison of our estimates of automatic stabilizers inherent in tax-benefit systems with macro measures such as changes in cyclically adjusted budget balances reveals that micro-based estimates provide more precise information about the degree of household income stabilization.

Keywords Automatic stabilizers · Fiscal consolidation · Euro-area debt crisis

JEL Classification E63 · E62 · H31 · H12

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1 Introduction

The Great Recession and the resulting sovereign debt crisis in Europe have caused many countries to take fiscal consolidation measures. Tax increases and spending cuts aimed at reducing soaring government budget deficits, but in many cases they exacerbated losses in household incomes, undermining fiscal stabilization effects. This paper is the first to investigate the effects of fiscal expansions during the Great Recession and subsequent fiscal consolidation measures (often labeled "austerity") in Europe on automatic stabilizers. In the post-COVID-19 recovery, public debt levels have risen again all throughout Europe, and monetary policy is near or at the zero lower bound. In this situation the right balance between fiscal support for the economy and fiscal consolidation is again of key importance (McKay and Reis 2016; Blanchard and Summers 2020).

Automatic stabilizers are those elements of the tax and transfer system that mitigate fluctuations in output without discretionary government action. Previous work on automatic stabilizers has mostly relied on macro data (see, e.g., Fatás and Mihov 2001; in't Veld et al. 2013; Di Maggio and Kermani 2016) or structural models (McKay and Reis 2016). Traditional approaches based on macro data typically used aggregate variables on government revenue and spending as proxies for automatic stabilizers.[1] However, these variables are endogenous to changes in household incomes as tax payments decrease (for a given progressive tax system) or (unemployment) benefits increase when households earn lower incomes or become unemployed.

To circumvent the problem of endogeneity, we follow the approach of Auerbach and Feenberg (2000) and Dolls et al. (2012) in using micro data and counterfactual simulation techniques for our analysis of automatic stabilizers.[2] Specifically, we analyze how changes in tax-benefit systems over the period 2007–2014 have affected the workings of automatic stabilizers in the EU member states. Our analysis allows to disentangle *automatic* effects from those that take place after explicit government legislature (*discretionary* policy changes). This is important in order to assess the shock-absorption capacity of the tax and transfer system and the interaction between discretionary policy measures and automatic stabilizers.

We build on the *income stabilization coefficient* proposed by Dolls et al. (2012), which is an extension of the *normalized tax change* (Pechman 1973, 1987; Auerbach and Feenberg 2000). Following Dolls et al. (2012), this measure of the stabilizing effect of the tax and transfer system is calculated for a stylized proportional shock of 5 percent to household gross incomes (*income shock*). The shock is the same in all countries and affects all households equally, thus enabling us to construct

[1] Other macro studies focus on the relation between output volatility, public sector size and openness of the economy (Galí 1994; Fatás and Mihov 2001; Auerbach and Hassett 2002).

[2] Other micro studies include Kniesner and Ziliak (2002a), Kniesner and Ziliak (2002b), Mabbett and Schelkle (2007).

a comparable measure across countries.[3] We compute how direct taxes, social insurance contributions as well as transfers change in response to the simulated income change. Relating the change in taxes and benefits to the income change yields the *income stabilization coefficient under constant policy* as a measure of automatic stabilization. In addition, we propose and derive a novel measure the *income stabilization coefficient under time-varying policy* that indicates to what extent governments let automatic stabilizers play out taking discretionary changes of the tax-benefit system into account.

Our results show that automatic stabilizers are heterogeneous across EU countries. Income stabilization coefficients range from 20 to 30 percent in some Eastern and Southern European countries to around 60 percent in Belgium, Germany, and Denmark. Changes in tax-benefit systems in recent years have led to a slight reduction in the dispersion of income stabilization coefficients. That is, countries with relatively low (high) stabilization coefficient in 2007 tended to be more likely to raise (reduce) taxes and social insurance contributions. Our analysis shows further that automatic stabilizers could operate freely in the early phase of the financial and economic crisis. Notable exceptions are Ireland and Estonia where the functioning of automatic stabilizers was hampered by discretionary policy changes. Automatic stabilizers have been constrained in several EU countries by subsequent fiscal consolidation measures. Especially in countries like Greece, Ireland, Italy, Portugal and Spain, the counter-cyclical effect of automatic stabilizers has been partly or completely offset by pro-cyclical benefit cuts or tax hikes, in particular during the euro-area debt crisis. A comparison of our estimates of automatic stabilizers inherent in tax-benefit systems with changes in the cyclically adjusted budget balance reveals that micro-based estimates provide more precise information about the degree of household income stabilization. In Ireland (2009) and Spain (2013), for example, tax-benefit reforms and other budgetary measures had opposite cyclical properties.

We make four contributions to the literature. First, we extend the work of Dolls et al. (2012), who assess the effectiveness of automatic stabilizers for 19 EU countries, by using more recent data and a larger set of countries and policy years. Second, we analyze the effects of tax-benefit policy changes on automatic stabilizers over time during and after the Great Recession.[4] Third, we make a methodological contribution by introducing the *income stabilization coefficient under time-varying policy* to shed light on the effects of discretionary policy changes on household income stabilization. This new measure takes into account that the actual stabilization provided by the tax-benefit system can be weaker (stronger) than in steady state if tax hikes or cuts in benefits (tax reductions or benefit extensions) coincide with macroeconomic shocks. It may provide important information for governments

[3] We also simulate an idiosyncratic *unemployment shock* leading to an increase in the national unemployment rate and the same aggregate income loss as in the income shock scenario. The results of the unemployment shock scenario are qualitatively similar to the income shock and are reported in Appendix.

[4] Callan et al. (2021) and Paulus and Tasseva (2020) analyze the automatic stabilization effect of tax-benefit systems on the income distribution for a subset of countries we focus on.

designing fiscal consolidation policies as macroeconomic effects of changes in the tax-benefit system may differ from other fiscal policy measures such as cutting government consumption. Fourth, our paper provides new evidence on the relationship between our micro-based estimates of automatic stabilizers and more conventional macro measures which are used in the EU fiscal governance framework (Mourre et al. 2014). We show whether and to what extent automatic stabilizers in the tax-benefit system could operate freely over the period under consideration and that this information cannot be inferred from cyclically adjusted budget balances. We therefore conclude that micro-based estimates provide valuable complementary information to macroeconomic indicators.

The paper proceeds as follows. Section 2 presents the theoretical framework. In Sect. 3 we discuss the data and our empirical approach. Section 4 presents the results and Sect. 5 concludes.

2 Framework to Measure Automatic Stabilizers

In this section, we first present the concept of income stabilization before the novel measure taking the effect of discretionary policy changes on the workings of automatic stabilizers is introduced.

2.1 Income Stabilization

Household income stabilization provided by tax-benefit systems is measured by a coefficient showing how household disposable income varies with respect to changes in gross income. The literature based on micro data typically uses the *normalized tax change* proposed by Pechman (1973, 1987) which measures the tax system's built-in flexibility (see, e.g., Auerbach and Feenberg 2000; Mabbett and Schelkle 2007). Dolls et al. (2012) extended this measure to account for social insurance contributions and benefits in addition to direct taxes. Their *income stabilization coefficient* measures the ratio of changes in disposable income to changes in gross income.[5]

The mechanism behind automatic stabilizers is as follows. Consider a household that has to pay a proportional tax of 30 percent and faces a decline in gross income of 100 Euros. Then 30 percent of the shock would be absorbed by the proportional tax, leaving a decline of 70 Euros of disposable income. For a progressive tax system, as is in place in the majority of the European countries, the stabilizing effect would be larger due to the drop in the marginal tax rate after a decline in income

[5] Dolls et al. (2012) also estimate a stabilization effect on the demand for goods and services (*demand stabilization coefficient*). It depends on how households adjust consumption expenditure to fluctuations in disposable income. However, McKay and Reis (2016) find the demand stabilization effect to be small over the business cycle, and the income stabilization effect to be quantitatively more important. Therefore, in this paper we focus on the income stabilization coefficient only.

(Dolls et al. 2012). This effect provides an additional cushioning of the decline in disposable income.

Market income $Y_{i,t}^M$ of individual i in year t is equal to gross income in our context and is defined as

$$Y_{i,t}^M = Y_{i,t}^E + Y_{i,t}^Q + Y_{i,t}^I + Y_{i,t}^P + Y_{i,t}^O, \tag{2.1}$$

where $Y_{i,t}^E$ denotes labor income, $Y_{i,t}^Q$ business income, $Y_{i,t}^I$ capital income, $Y_{i,t}^P$ property income, and $Y_{i,t}^O$ other income. Disposable income is equal to market income minus net government intervention, which consists of direct taxes $T_{i,t}(Y_{i,t}^M, X_i, \chi_t)$, social insurance contributions $S_{i,t}(Y_{i,t}^M, X_i, \chi_t)$ and social benefits $B_{i,t}(Y_{i,t}^M, X_i, \chi_t)$, for example unemployment benefits. We define tax payments, social insurance contributions and benefit payments to be functions of market income $Y_{i,t}^M$ and its components[6], socio-demographic characteristics X_i (e.g., number of children, marital status, age) and parameters of the tax-benefit system χ_t (e.g., tax rate, bracket thresholds, deductions). Defining net government intervention as $G_{i,t}(Y_{i,t}^M, X_i, \chi_t) = T_{i,t}(Y_{i,t}^M, X_i, \chi_t) + S_{i,t}(Y_{i,t}^M, X_i, \chi_t) - B_{i,t}(Y_{i,t}^M, X_i, \chi_t)$, disposable income can be written as

$$Y_{i,t}^D(Y_{i,t}^M, X_i, \chi_t) = Y_{i,t}^M - G_{i,t}(Y_{i,t}^M, X_i, \chi_t) \tag{2.2}$$

$$= Y_{i,t}^M - \left(T_{i,t}(Y_{i,t}^M, X_i, \chi_t) + S_{i,t}(Y_{i,t}^M, X_i, \chi_t) - B_{i,t}(Y_{i,t}^M, X_i, \chi_t)\right). \tag{2.3}$$

The income stabilization coefficient is denoted by τ and measures how changes in market income ΔY^M translate into changes in households' disposable income ΔY^D. In the empirical analysis, both changes in market income $(\sum_i \Delta Y_{i,t}^M)$ and in disposable income $(\sum_i \Delta Y_{i,t}^D)$ are added up over all individuals in our sample. We use cross-sectional weights which make the samples representative for the respective population. We follow Dolls et al. (2012) and consider two stylized scenarios of macroeconomic shocks (cf. Sect. 3). In the following example, gross incomes are proportionally reduced by 5% for all individuals (income shock):

$$\sum_i \Delta Y_{i,t}^D = \sum_i \left(Y_{i,t}^D(0.95 Y_{i,t}^M, X_i, \chi_t) - Y_{i,t}^D(Y_{i,t}^M, X_i, \chi_t)\right) = \left(1 - \tau_t\right) \sum_i \Delta Y_{i,t}^M$$

The income stabilization τ_t coefficient can be written as

[6] Note that, for ease of notation, we write a dependence on market income $Y_{i,t}^M$ only and not a dependence on each of its components (see equation (2.1)), although our simulations based on EUROMOD respect the different income types (see Sect. 3.1).

$$\sum_i \Delta Y_{i,t}^D = (1 - \tau_t) \sum_i \Delta Y_{i,t}^M$$
$$\Leftrightarrow \tau_t = 1 - \frac{\sum_i \Delta Y_{i,t}^D}{\sum_i \Delta Y_{i,t}^M}.$$

τ_t can be interpreted as the fraction of the income shock that is absorbed by the tax-benefit system in place in year t.

Using (2.2), it is possible to decompose the income stabilization coefficient into the stabilizing effects provided by taxes, social insurance contributions and benefits:

$$\tau_t = \tau_t^T + \tau_t^S + \tau_t^B = \frac{\sum_i \Delta T_{i,t}}{\sum_i \Delta Y_{i,t}^M} + \frac{\sum_i \Delta S_{i,t}}{\sum_i \Delta Y_{i,t}^M} - \frac{\sum_i \Delta B_{i,t}}{\sum_i \Delta Y_{i,t}^M}. \tag{2.4}$$

Throughout the paper, we will make the assumption that all taxes and transfers are borne by employees and that employers have to bear their share of the social insurance contributions. Hence, employers' social insurance contributions are assumed not to be shifted to employees, so that they will not affect employees' wages. The stabilizing effects of social insurance contributions will thus only reflect employees' social insurance contributions.[7]

2.2 Interaction with Discretionary Policy Changes

The income stabilization coefficient presented above measures the cushioning effect of the tax-benefit system under the assumption of constant policy, i.e., it relates the change in taxes, social insurance contributions and benefits following the shock to market income to the change in market income. It does not take into account any additional effect on disposable incomes that may occur when the income shock coincides with changes in the tax and transfer system.

Consider as an illustration a tax hike which is introduced as a fiscal consolidation measure in an economic downturn with declining market incomes. The income stabilization coefficient under constant policy that is based on the tax system *after* the policy change has been implemented would indicate an increase in the automatic stabilization capacity of the tax system as compared to the income stabilization coefficient that is based on the tax system *before* the policy change.[8] This higher stabilization effect only materializes, however, if the income shock occurs after the policy change has been implemented. If, in contrast, the tax hike coincides with the decline in market incomes so that the lower market income is taxed at a higher rate as it would have been without

[7] Dolls et al. (2012) calculate income stabilization coefficients with and without social insurance contributions by employers and find that the inclusion of employers' social insurance contributions does change the country ranking only slightly. The results including employers' social insurance contributions are available upon request.

[8] A larger share of taxes relative to aggregate incomes ceteris paribus raises the income stabilization effect.

the policy change, the effectiveness of the tax-benefit system to act as an automatic stabilizer will be diminished.

Arguably, the income stabilization coefficient under constant policy can be interpreted as measuring the long-term ("steady state") stabilization capacity of a tax and transfer system. In the short-run, discretionary fiscal policy might constrain the ability of the tax-benefit system to act as an automatic stabilizer. We therefore complement the income stabilization coefficient under constant policy by a new measure that takes into account that taxes, social insurance contributions and benefits might change at the same time as market incomes. More precisely, we calculate the difference in disposable incomes for individual i when subject to tax policy in period $t-1$ (before the change in market income) and when subject to tax policy in period t (after the change in market income which is again assumed to go down by 5% in the equation below). Again, let $T_{i,t}(Y^M_{i,t}, X_i, \chi_t)$ be the tax function. We can write the income stabilization coefficient under time-varying policy – here for taxes only – as

$$\theta^T_t = \frac{\sum_i \left(T_{i,t}(0.95Y^M_{i,t}, X_i, \chi_t) - T_{i,t-1}(Y^M_{i,t-1}, X_i, \chi_{t-1}) \right)}{\sum_i \Delta Y^M_{i,t-1}} \tag{2.5}$$

$$= \frac{\sum_i \left(T_{i,t}(0.95Y^M_{i,t}, X_i, \chi_t) - T_{i,t-1}(Y^M_{i,t-1}, X_i, \chi_{t-1}) \right)}{\sum_i 0.05Y^M_{i,t-1}} \tag{2.6}$$

Using shorthand notation for the equations above, we can write:

$$\begin{aligned}
\theta_t &= \frac{\sum_i (T^1_{i,t} - T^0_{i,t-1}) + \sum_i (S^1_{i,t} - S^0_{i,t-1}) - \sum_i (B^1_{i,t} - B^0_{i,t-1})}{\sum_i \Delta Y^M_{i,t-1}} \\
&= \frac{\sum_i \left(T^1_{i,t} + S^1_{i,t} - B^1_{i,t} \right) - \sum_i \left(T^0_{t-1} + S^0_{t-1} - B^0_{t-1} \right)}{\sum_i \left(Y^{M1}_{i,t-1} - Y^{M0}_{i,t-1} \right)} \\
&= \frac{\sum_i \left(Y^{M1}_{i,t} - Y^{D1}_{i,t} \right) - \sum_i \left(Y^{M0}_{i,t-1} - Y^{D0}_{i,t-1} \right)}{\sum_i \left(Y^{M1}_{i,t-1} - Y^{M0}_{i,t-1} \right)} \\
&= \frac{\sum_i \left(Y^{M1}_{i,t} - Y^{M0}_{i,t-1} \right) - \sum_i \left(Y^{D1}_{i,t} - Y^{D0}_{i,t-1} \right)}{\sum_i \left(Y^{M1}_{i,t-1} - Y^{M0}_{i,t-1} \right)}
\end{aligned} \tag{2.7}$$

Analogously to the decomposition of the income stabilization coefficient under constant policy, we decompose the income stabilization coefficient under time-varying policy θ_t into its components:

$$\theta_t = \frac{\sum_i (T^1_{i,t} - T^0_{i,t-1}) + \sum_i (S^1_{i,t} - S^0_{i,t-1}) - \sum_i (B^1_{i,t} - B^0_{i,t-1})}{\sum_i \Delta Y^M_{i,t-1}} \\ = \theta^T_t + \theta^S_t - \theta^B_t \tag{2.8}$$

The income stabilization coefficient under time-varying policy reflects how discretionary policy changes affect the cushioning effect of the tax-benefit system, or in other words, to what extent automatic stabilizers can operate freely. In an economic downturn, the following stylized scenarios can be differentiated (symmetrically in an economic upswing).

Automatic stabilizers operate freely. If there is no policy change from one year to the other, the government allows for inter-temporal stabilization. The automatic stabilizers of the tax-benefit system typically lead to a reduction in tax revenue if taxable income declines or to an increase in benefit expenditure if unemployment goes up ($T^1_t < T^0_{t-1}$ or $B^1_t > B^0_{t-1}$). In such a situation, the income stabilization coefficient under time-varying policy equals the income stabilization coefficient under constant policy: $\theta_t = \tau_t$. If governments pursue expansionary fiscal policy, for example by cutting taxes or raising benefits, the income stabilization coefficient under time-varying policy will exceed the income stabilization coefficient under constant policy: $\theta_t > \tau_t$.

Automatic stabilization channel constrained or shut down. If governments pursue contractionary fiscal policy, but still allow for a reduction in tax revenue or an increase in benefit expenditure from one year to the other, the income stabilization coefficient under time-varying policy will be larger than zero, but smaller than the income stabilization coefficient under constant policy: $0 < \theta_t < \tau_t$. If governments are credit-constrained and have to keep tax revenue or benefit expenditure constant from one year to the other ($T^1_t = T^0_{t-1}$ or $B^1_t = B^0_{t-1}$), the automatic stabilization channel is shut down through discretionary policy changes: $\theta_t = 0$. In the most severe scenario of contractionary fiscal policy, discretionary policy changes lead to an increase in revenue or a decrease in benefit expenditure even though the economy experiences a slump ($T^1_t > T^0_{t-1}$ or $B^1_t < B^0_{t-1}$). It can be seen that in this case $\theta_t < 0$.

3 Data and Empirical Approach

In the empirical analysis, we analyze the workings of automatic stabilizers in EU member states over the period 2007–2014 and how they were affected by discretionary changes in tax-benefit systems.

3.1 EUROMOD and EU-SILC Data

We use the EU-wide tax-benefit model EUROMOD (version G4.0) in order to calculate household disposable incomes (see Sutherland and Figari 2013; Sutherland 2018). EUROMOD contains the tax and benefit rules present in the EU-27 for different years and takes EU-SILC data as input. The main stages of the simulations are the following. First, EU-SILC data are read into the model. Then for each tax and benefit instrument, the model constructs corresponding assessment units, ascertains which are eligible for that instrument and determines the amount of benefit or tax liability for each member of the unit. Finally, after all taxes, social insurance contributions and benefits in question are simulated, disposable income is calculated.[9] EU-SILC is a harmonized, cross-sectional household micro dataset for the EU member states provided by Eurostat (2012). It contains rich information about the different income sources (e.g., employment income, capital income, income from self-employment) and household demographics that may influence tax and transfer policies (for instance, marital status, number of children or age).

The microsimulation approach allows us to separate the dataset containing market incomes and demographics from the rules of the tax and transfer systems. We use 2008 EU-SILC household data with an income reference period of 2007 for the whole analysis and simulate income taxes, social insurance contributions and benefits following the tax-benefit policy parameters of the years 2007–2014.[10] That is, we hold household characteristics X_i and market income Y_i^M constant (through the use of the same baseline dataset) and only vary the parameters of the tax-benefit system χ_t over time, yielding counterfactual disposable incomes that would have prevailed if household demographics and market incomes would not have changed over time.[11] Note that EUROMOD updates monetary variables in order to account for changes in market incomes that have taken place between the year of the data and the year of the simulated tax-benefit system.[12] This approach provides us – for each country – with a sample of repeated cross sections reflecting market incomes and household demographics from 2007 and disposable incomes based on tax-benefit policies of the period 2007–2014.

Keeping market incomes and demographics constant at their pre-crisis level allows us to isolate the effect of policy changes on the automatic stabilization effect of tax-benefit systems.[13] If both input data and tax-benefit policies were changed at the same time, it would not be possible to disentangle the effect of changing market incomes and demographics from the effect of changing tax-benefit policy parameters. As a robustness check, we use additional input data from 2010, 2012, 2014 and 2015 (with market incomes from 2009, 2011, 2013 and 2014) and show that the magnitude of the income stabilization coefficients only marginally changes if at all.

[9] EUROMOD simulation results for each policy year included in the model are validated extensively against administrative sources.

[10] The EUROMOD version used in this paper allows for some countries the simulation of tax-benefit systems up until 2015. For France and Malta, the 2006 and 2008 EU-SILC versions are used, respectively. Croatia is excluded from the analysis as no pre-crisis data have been available to us.

[11] Changes in tax-benefit systems include both structural changes and statutory uprating of monetary parameters according to the rules in each country (Paulus et al. 2020).

[12] Updating factors are generally based on changes in the average value of an income component between the year of the data and the policy year. See EUROMOD Country Reports for more information on market income updating and the specific CPI sources (https://euromod-web.jrc.ec.europa.eu/resources/country-reports).

[13] See, e.g., Bargain et al. (2015) or Paulus et al. (2017) who use similar simulation techniques to estimate distributional effects of changes in tax-benefit systems.

3.2 Scenarios to Measure Automatic Stabilization

We simulate a proportional *income shock*, i.e., a proportional decline of household gross incomes by 5% affecting all households equally. This is the usual way of modeling aggregate shocks in microsimulation studies analyzing automatic stabilizers (Auerbach and Feenberg 2000). This shock is simulated for all countries in our sample based on the tax-benefit systems in place over the period 2007–2014 (see Sect. 3.1). Following Dolls et al. (2012), we also simulate an idiosyncratic shock affecting only some individuals who lose their job. This *unemployment shock* is calibrated such that total household income decreases by 5% as well. Thereby, the severity of the two shock scenarios is comparable in terms of the aggregate income loss.[14] The results of these two shock scenarios differ quantitatively, but not qualitatively. The results of the unemployment shock scenario are therefore shown in Appendix.

Note that we do not strive to replicate actual changes in income and unemployment as observed over the simulation period. Economic conditions are endogenous to the overall fiscal impulse (discretionary fiscal policy and automatic stabilizers). The aim of the paper is to explore how effective built-in automatic stabilizers are to cushion (stylized and exogenous) income and unemployment shocks that are comparable across countries and to assess to what extent discretionary policy changes have had an impact on the workings of automatic stabilizers.

4 Results

We first present income stabilization coefficients for the period 2007–2014 and then show how discretionary changes in tax-benefit parameters have affected the degree to which automatic stabilizers could operate over this period.

4.1 Income Stabilization Coefficients

Figure 1 depicts the change in the income stabilization coefficient from 2007 to 2014 on the *x*-axis and its 2007 level on the *y*-axis. Focusing first on the *levels* of the income stabilization coefficients in 2007, we find strong differences across countries with coefficients ranging from 0.22 in Cyprus to 0.54 in Belgium. The

[14] The unemployment shock is modeled by increasing (decreasing) the weight of unemployed (employed) individuals in our sample, while the aggregate counts of individual and household characteristics are kept constant (Immervoll et al. 2006). The implicit assumption behind this approach is that the socio-demographic characteristics of the newly unemployed correspond to the existing pool of unemployed. The EUROMOD version used in this paper does not simulate unemployment benefits, but takes unemployment benefits from the input data. We therefore supplement EUROMOD with an unemployment benefit calculator that incorporates all important policy rules such as replacement rates, eligibility criteria and maximum benefit duration. Detailed policy rules are collected from country chapters of the OECD series "Benefits and Wages" (http://www.oecd.org/social/benefits-and-wages.htm) and from the EU's MISSOC-Comparative Tables Database (https://ec.europa.eu/social/main.jsp?langId=en&catId=815).

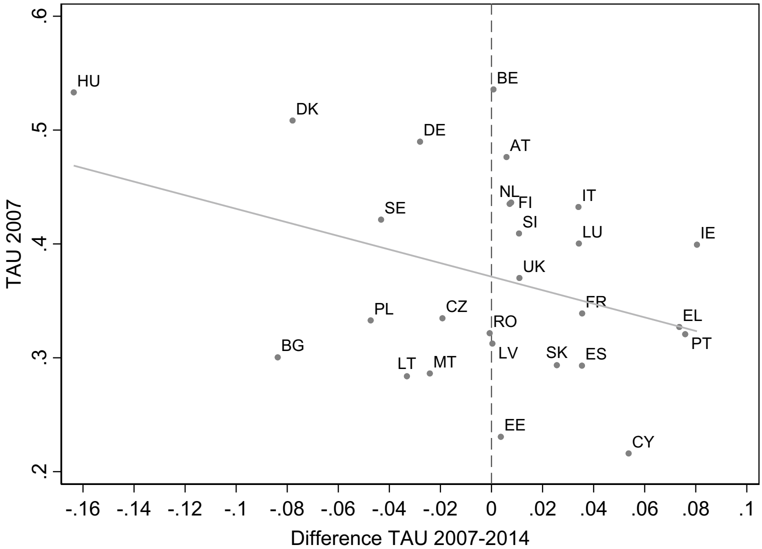
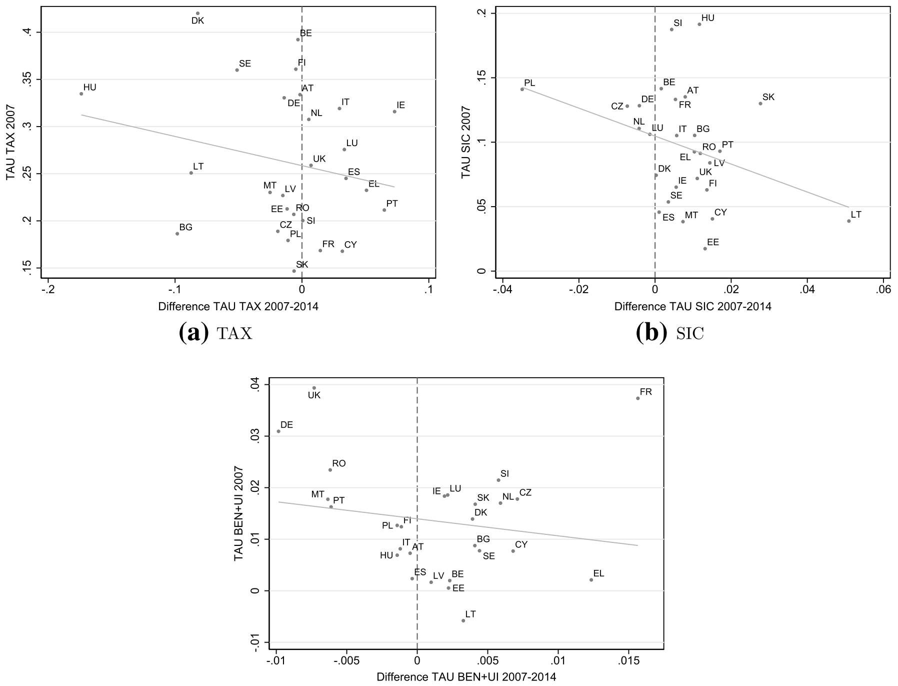


Fig. 1 Change in τ (Income Shock): 2014 vs. 2007.*Notes:* The graph shows the level of the income stabilization coefficient in 2007 following a proportional income shock on the vertical axis and the change from 2007 to 2014 on the horizontal axis. The solid line indicates fitted values of a linear regression of the variable on the vertical axis on the variable on the horizontal axis. The slope is statistically different from zero at the 10% level. Correlation coefficient: -0.36. Legend for country labels: AT: Austria, BE: Belgium, BG: Bulgaria, CY: Cyprus, CZ: Czech Republic, DE: Germany, DK: Denmark, EE: Estonia, EL: Greece, ES: Spain, FI: Finland, FR: France, HU: Hungary, IE: Ireland, IT: Italy, LT: Lithuania, LU: Luxembourg, LV: Latvia, MT: Malta, NL: Netherlands, PL: Poland, PT: Portugal, RO: Romania, SE: Sweden, SI: Slovenia, SK: Slovakia, UK: United Kingdom *Source:* Own calculations using EUROMOD

(population-weighted) average income stabilization coefficient for euro area (EU) member states amounts to 0.38 (0.39) as shown in Table 1 in Appendix. Generally, coefficients tend to be higher in Western European and Nordic countries and lower in Baltic, Eastern and Southern European countries, with Hungary being a notable exception.

The largest *change* in the stabilization capacity of the tax-benefit system occurred in Hungary with a reduction in the income stabilization coefficient of 0.16 percentage points from 2007 to 2014. During this period, Hungary adopted a flat tax which reduced the stabilizing effect of the income tax considerably from 0.34 in 2007 to 0.16 in 2014 (cf. Table 1). On the other side of the spectrum, countries such as Ireland, Greece, Portugal and Cyprus raised taxes and/or social insurance contributions which has led to higher income stabilization coefficients.[15] The negative slope of the regression line in Fig. 1 indicates that the dispersion of income stabilization coefficients across countries has become slightly more compressed, that is, countries with

[15] The European Commission's LABREF database provides an overview of tax-benefit reforms undertaken in the period under consideration (see also Turrini et al. 2015 for an overview).



(a) TAX **(b)** SIC **(c)** Benefits

Fig. 2 Change in τ by Component (Income Shock): 2014 vs. 2007. *Notes:* The graph shows the level of the income stabilization coefficient by component in 2007 following a proportional income shock on the vertical axis and the change from 2007 to 2014 on the horizontal axis. The solid lines indicate fitted values of a linear regression of the variable on the vertical axis on the variable on the horizontal axis. The slopes in panels **a** TAX and **c** Benefits are not statistically different from zero. The slope in panel **b** SIC is statistically different from zero at the 10% level. Correlation coefficients: −0.22 (TAX), −0.34 (SIC), −0.18 (Benefits). *Source:* Own calculations using EUROMOD

a relatively low (high) stabilization coefficient in 2007 have been more likely to raise (reduce) taxes and social insurance contributions.

Next, we decompose the overall change in the income stabilization coefficient into its components. As can be seen in Fig. 2, in particular changes in income taxes and to a smaller extent in social insurance contributions have affected the stabilizing potential of tax-benefit systems. Ireland, Portugal, Greece and Spain are the countries with the largest increase in income stabilization provided by the income tax. Benefits are of minor importance in the case of an (intensive margin) income shock. All three categories of the tax-benefit system have contributed to a slight reduction in the dispersion of income stabilization coefficients, as exemplified by the negative slopes of the regression lines. We find similar patterns for the unemployment shock (Figs. 6 and 7 in Appendix), with the only exception that countries with initially stronger automatic stabilizers in their unemployment insurance system have made them slightly more counter-cyclical compared to countries with initially weaker automatic stabilizers.

4.2 The Effect of Discretionary Policy Changes on the Workings of Automatic Stabilizers

This section first compares income stabilization coefficients under constant and time-varying policy in order to show how discretionary policy changes have affected the cushioning effects of tax-benefit systems in EU member states. In the subsequent analysis, we study the relationship between our micro-based estimates of fiscal stabilization and conventional measures based on macroeconomic variables.

Income Stabilization Coefficients: Constant vs. time-varying policy.

Figure 3 plots income stabilization coefficients under constant (y-axis) and time-varying (x-axis) policy for the period 2008–14. The latter capture policy changes from year $t-1$ to t. Country dots to the right (left) of the dashed 45 degree line indicate that the income stabilization coefficient under time-varying policy is larger (smaller) than the income stabilization coefficient under constant policy, pointing to expansionary (contractionary) changes in the tax-benefit system.

Panel (a) shows that in 2008, most countries are relatively close to and, in the majority of cases, to the right of the dashed line. Discretionary changes in tax-benefit policies have been expansionary in the early phase of the crisis (European Central Bank 2010). This is confirmed in panel (b), showing that at the height of the economic crisis in 2009, reforms of tax-benefit systems contributed to the stabilization of household incomes, with income stabilization coefficients under time-varying policy even further to the right of the 45 degree line than in panel (a). Notable exceptions are Ireland and Estonia with income stabilization coefficients under time-varying policy being smaller than 0. This implies that the automatic stabilizers in the tax-benefit system were completely shut down in these two countries in 2009, thereby amplifying income shocks when Ireland's (Estonia's) real GDP fell by more than 5% (14%). Households had to pay more in taxes or received lower benefits even if they were facing a decline in household income.

Starting in 2010, more and more country dots are to the left of the 45 degree line, hinting at contractionary changes in tax-benefit systems. As in Ireland and Estonia in 2009, income stabilization coefficients under time-varying policy are negative in some cases which mirrors the fact that the automatic stabilizers in the tax-benefit system could not play out. This is true for Greece in 2010–2011 and in 2013, for Cyprus in 2012, for Hungary in 2011–2012, for Latvia and Lithuania in 2010, for Ireland and Luxembourg in 2011, for Portugal in 2011 and 2013 and for Slovakia in 2013. The functioning of automatic stabilizers was hampered in several other EU countries, with income stabilization coefficients under time-varying policy being larger than 0, but smaller than the income stabilization coefficient under constant policy. As can be seen in panel (g), the dispersion of country dots around the 45 degree line becomes much smaller in 2014 indicating a more neutral fiscal policy stance. Figure 8 in Appendix shows very similar results for the unemployment shock scenario.

Micro vs. macro estimates of fiscal stabilization.

The previous section has shown how discretionary changes in tax-benefit systems in the EU have affected the workings of automatic stabilizers during and after the Great Recession. This section explores how our micro-based measures of household

Fig. 3 Income Stabilization Coefficients (Income Shock): Constant vs. time-varying policy *Notes:* The figure plots the income stabilization coefficient under time-varying policy (θ) on the x-axis and income stabilization coefficients under constant policy (τ) on the y-axis. Income stabilization coefficients under time-varying policy for year t capture policy changes from $t-1$ to t. Income stabilization coefficients to the right (left) of the dashed 45 degree line imply expansionary (contractionary) changes in the tax-benefit system. *Source:* Own calculations using EUROMOD

income stabilization relate to conventional macro measures of fiscal stabilization. For the latter, we consider year-on-year changes in the cyclical and the cyclically adjusted budget balance which are often used to assess automatic stabilizers and discretionary fiscal policy measures (Alesina et al. 2008; Fatás and Mihov 2009). The cyclically adjusted budget does not only reflect changes in tax-benefit policies, but also other fiscal policy changes including corporate income taxes, indirect taxes or government consumption and investment policies. It is therefore a much broader measure as compared to the income stabilization coefficient under time-varying policy derived in this paper. Nevertheless, such a comparison is informative as it shows if the micro and macro measures share the same pro- or counter-cyclical properties and hence to what extent the micro-based measure of household income stabilization provides complementary information to conventional macro measures.

As shown by Mourre et al. (2014), net borrowing (*NB*), which is defined as the difference between nominal government expenditure and revenue, can be approximated by the sum of cyclically adjusted (*CANB*) and cyclical net borrowing (*CNB*):

$$NB_t = CANB_t + CNB_t \tag{4.1}$$

$$NB_t = CANB_t + \varepsilon \cdot OG_t \tag{4.2}$$

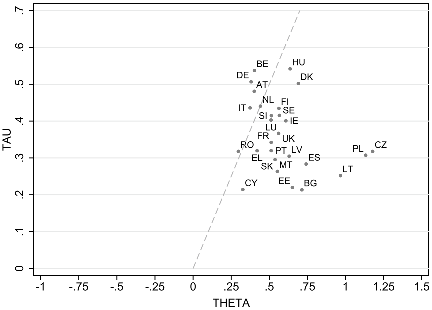
The left-hand side of the equation shows the deficit-to-GDP ratio. The right-hand side of the equation depicts the cyclically adjusted budget balance which corresponds to the deficit-to-GDP ratio that would prevail if the economy was running at potential and an estimated cyclical component. The latter measures the extent to which budgetary revenues and expenditures react to the economic cycle in the absence of policy changes. ε stands for the semi-elasticity of the overall budget with respect to changes in output and $OG = \frac{Y-Y^p}{Y^p}$ denotes the output gap.[16]

As commonly done in the literature, we consider year-on-year changes in order to assess the fiscal policy stance:

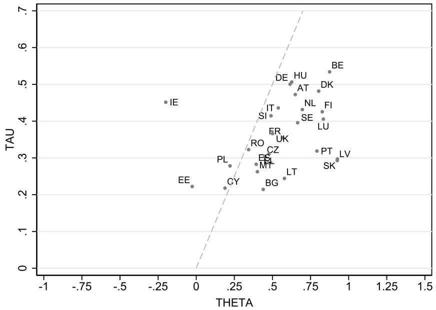
$$\Delta NB_t = \Delta CANB_t + \Delta CNB_t \tag{4.3}$$

This way, the aggregate fiscal impulse which is measured as the year-on-year change in net borrowing (ΔNB) can be decomposed into the effect of automatic stabilizers (the year-on-year change in cyclical net borrowing, ΔCNB) and discretionary fiscal policy (the year-on-year change in cyclically adjusted net borrowing, $\Delta CANB$).

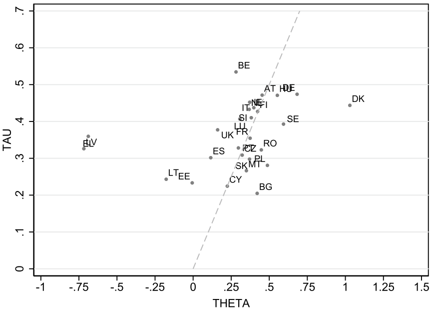
[16] Semi-elasticities are estimated for specific time-periods and are assumed to be time-invariant over this period.



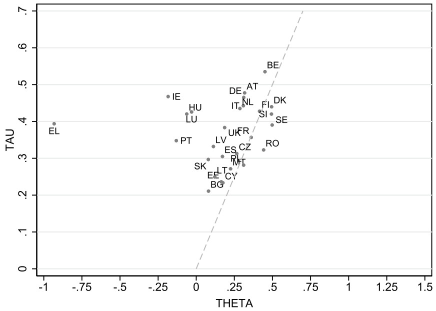
(a) 2008



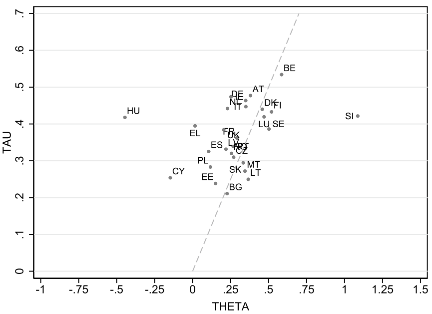
(b) 2009



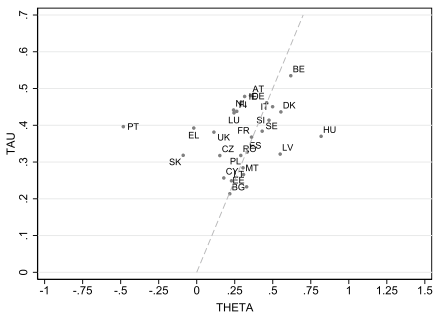
(c) 2010



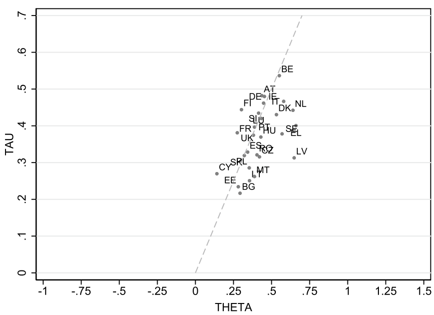
(d) 2011



(e) 2012



(f) 2013



(g) 2014

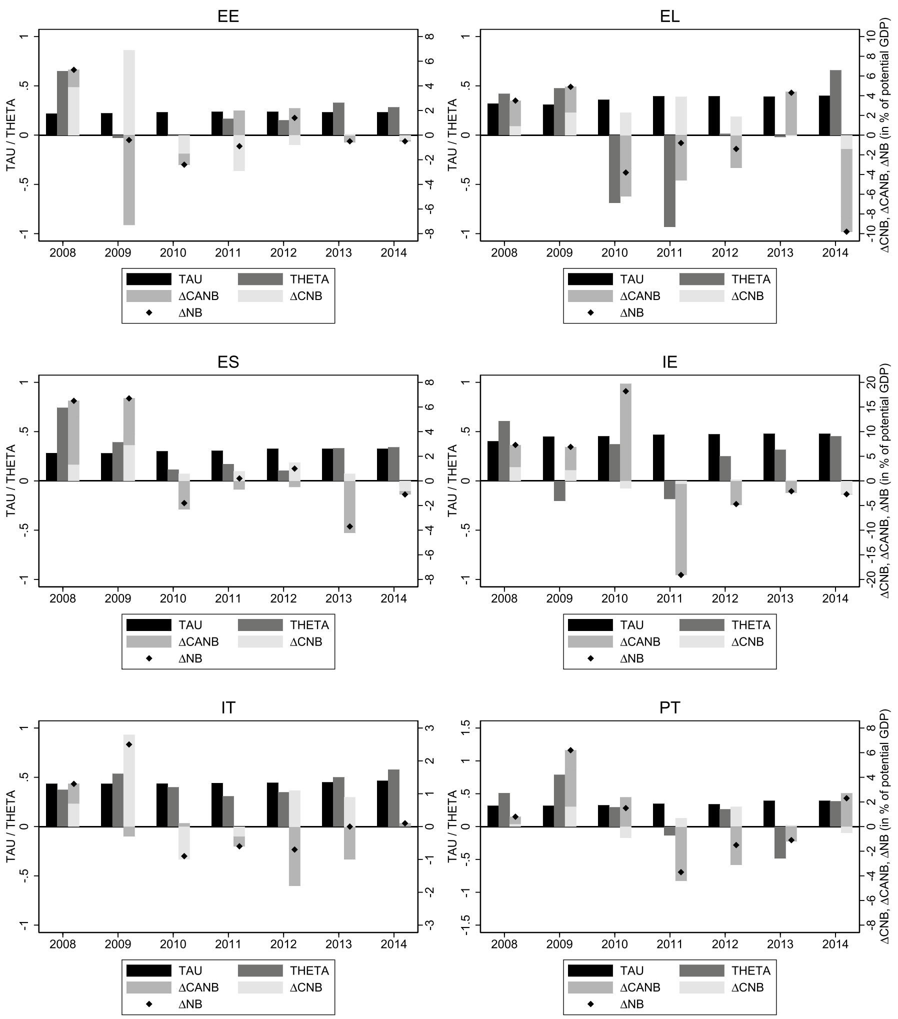


Fig. 4 Micro vs. Macro Estimates of Fiscal Stabilization (Income Shock) *Notes:* The bar chart shows the income stabilization coefficients under constant (τ) and time-varying policy (θ) (left y-axis) and the year-on-year changes in cyclically adjusted ($\Delta CANB$), cyclical (ΔCNB) and overall net borrowing (ΔNB) (right y-axis). *Source:* Own calculations using EUROMOD. Data on cyclical, cyclically adjusted and overall net borrowing are from the AMECO database

Figure 4 compares the micro and macro measures of fiscal stabilization for six countries that were severely hit during the Great Recession and the euro-area debt crisis: Estonia, Greece, Ireland, Italy, Portugal and Spain.[17] It depicts the income stabilization coefficients under constant (τ) and time-varying policy (θ) (the left and the middle bar, left y-axis) and the year-on-year changes in cyclically adjusted

[17] Corresponding bar charts for all other EU member states are available upon request.

($\Delta CANB$), cyclical (ΔCNB) and overall net borrowing (ΔNB) (the right bar, right y-axis) for the period 2008–14, respectively. Focus first on Ireland. As shown in the previous section and also visible in Fig. 4, the income stabilization coefficient under time-varying policy was negative in 2009. This implies that the functioning of the built-in automatic stabilizers was hampered in 2009 because of pro-cyclical adjustments in taxes and benefits. Figure 4 reveals that in contrast to our micro measure, the rise in Ireland's cyclically adjusted budget deficit by 4.6 percentage points of potential GDP in 2009 instead points to a significant counter-cyclical fiscal loosening.

The difference between the micro and the macro measure of fiscal stabilization seems striking at first sight. However, it can be explained by Ireland's recapitalization of its banking system after the burst of the property bubble which accounted for a large part of the increase in budget deficits from 2008–2010. While Ireland's budget was balanced in 2007, the deficit had risen to an unprecedented level of 32% of GDP in 2010. At the same time, Ireland started a process of fiscal consolidation in 2009 which lasted until 2013 and included measures such as hikes in income taxes and social insurance contributions as well as cuts in unemployment benefits (Alesina et al. 2015; Devries et al. 2011; Turrini et al. 2015). These fiscal consolidation measures had an adverse impact on household income stabilization and explain the difference between the micro and macro measures of fiscal stabilization during the financial and economic crisis in Ireland.

Another example where the income stabilization coefficient under time-varying policy and the year-on-year change in cyclically adjusted net borrowing go in opposite directions is Spain in 2013. While Spain reduced its cyclically adjusted budget deficit from 5.7% of potential GDP in 2012 to 1.5% in 2013, the income stabilization coefficient under time-varying policy for 2013 is slightly larger than the income stabilization coefficient under constant policy. That is, the improvement in the budget balance was achieved without hampering the functioning of automatic stabilizers in the tax-benefit system.

Focus next on Estonia. Estonia implemented benefit cuts and tax increases in 2009, reflected in an income stabilization coefficient under time-varying policy being smaller than 0, despite a drop in real GDP of almost 15%. These pro-cyclical adjustments in the tax-benefit system went hand in hand with other fiscal consolidation measures such as cuts made to investments and the government wage bill (Raudla and Kattel 2011) so that both the micro and the macro measure of fiscal stabilization in Fig. 4 point to contractionary fiscal policies in 2009.

Another example for constrained automatic stabilizers due to contractionary fiscal adjustments is Greece. Greece was in a long recessionary period from 2008–2012 with large increases in cyclical deficits in these years. While automatic stabilizers in Greece's tax-benefit system could operate freely in 2008 and 2009 ($\theta_t > \tau_t$), they were shut down or at least heavily constrained during the euro-area debt crisis ($\theta_t < 0$ in 2010 and 2011 and $0 < \theta_t < \tau_t$ in 2012) due to pro-cyclical tax hikes and benefit cuts. These changes in the tax-benefit system and other fiscal consolidation measures led to a reduction of Greece's cyclically adjusted budget deficit from 14.9% in 2009 to 0.8% in 2012. Tax-benefit reforms and other budgetary measures shared the same cyclical properties during this

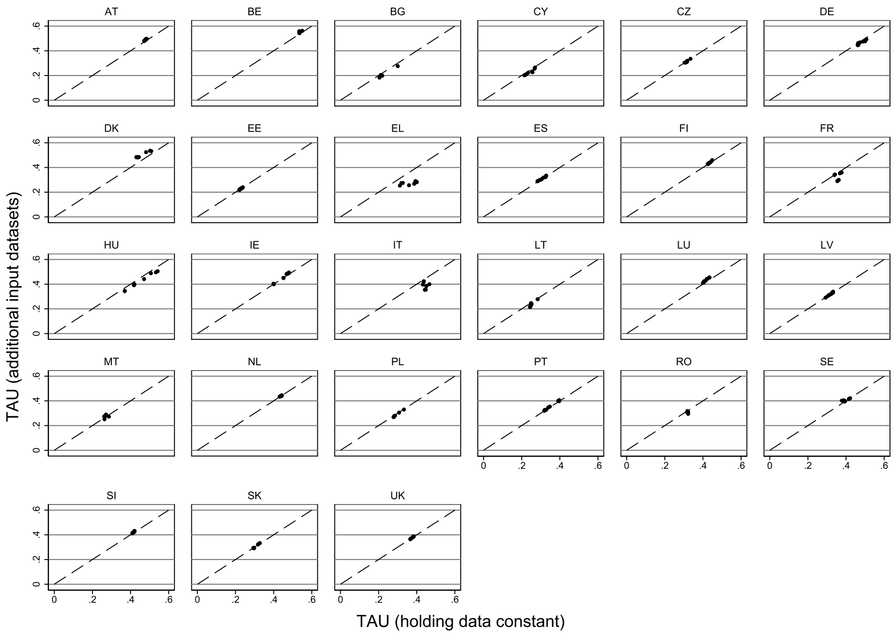


Fig. 5 Robustness check: τ (holding data constant) vs. τ (additional input datasets) (Income Shock Scenario) *Notes:* The figure plots baseline income stabilization coefficients with input data held constant on the x-axis and re-calculated income stabilization coefficients with additional input datasets on the y-axis. *Source:* Own calculations using EUROMOD

episode. Similar patterns of constrained automatic stabilizers after the Great Recession are also visible for Estonia (2010–2012), Ireland (2010–2013), Italy (2010-2012), Portual (2010-2013) and Spain (2010–2012).

Our results suggest that a sole focus on time-invariant semi-elasticities and changes in the budget balance may provide an incomplete picture. The cases of Ireland and Spain exemplify that tax-benefit reforms and other budgetary measures sometimes have opposite cyclical properties and that additional indicators such as the income stabilization coefficients proposed in this paper are needed to assess the extent of household income stabilization. It should be noted, however, that the comparison of micro and macro-based estimates of fiscal stabilization should be taken with a grain of salt given their conceptual differences, in particular with regard to the limited number of revenue and spending categories included in our simulations.

4.3 Robustness Check: Additional EU-SILC Data Years

In our simulations with EUROMOD, we kept market incomes and household demographics constant at their 2007 level (2008 EU-SILC input data with an income reference period of 2007) so that any changes in the income stabilization coefficients over time documented in our main analysis are attributed to changes in the tax-benefit systems. As a robustness check, we recalculate income stabilization coefficients making use of all available EUROMOD input data for the simulation period (2010, 2012, 2014 and 2015 EU-SILC data with the following income reference periods: 2009, 2011, 2013 and 2014). That is, for each simulated policy year, EUROMOD takes the input data that is closest to the simulated policy year. We do so in order to explore to what extent (asymmetric) changes in market incomes and household demographics affect the stabilization capacity of the tax-benefit system.[18]

The results are shown in Fig. 5. For each country, our baseline income stabilization coefficients holding the input data constant are shown on the x-axis, the recalculated income stabilization coefficients based on additional input datasets are shown on the y-axis. Figure 5 reveals that income stabilization coefficients are mainly on or very close to the 45-degree line. The correlation between the two measures is very high and amounts to 0.96. There are a few countries with small deviations from the 45-degree line. For example in Greece and Italy (Denmark), income stabilization coefficients become somewhat smaller (larger) when we make use of additional input datasets. Overall, these results suggest that observed changes in income stabilization coefficients over time are primarily due to changes in the tax-benefit system and only to a small extent affected by changes in market incomes or household demographics. They are in line with previous findings presented by Dolls et al. (2012) who have shown by means of policy swaps that the magnitude of income stabilization coefficients is mainly determined by the rules of the tax-benefit system.[19]

5 Conclusion

This paper derives a new measure of household income stabilization that shows how discretionary changes of the tax-benefit system interact with the automatic cushioning effect of income taxes, social insurance contributions and benefits. In the empirical analysis based on harmonized European micro data and counterfactual simulation techniques, we analyze the automatic stabilizers in the tax-benefit systems of EU member states over the period 2007–2014. We investigate how tax-benefit reforms have affected the effectiveness of automatic stabilizers during the Great Recession and the euro-area debt crisis. The paper also explores how our micro-data based measures of household income stabilization compare to conventional macro measures of automatic stabilizers and discretionary fiscal policy.

We find that the size of automatic stabilizers varies significantly across countries, but that the heterogeneity has become slightly smaller over the period under

[18] As noted in Sect. 3, EUROMOD updates monetary variables if the income reference period of the underlying micro-data and the simulated policy year do not match. This means that our baseline income stabilization coefficients already reflect average changes in market incomes that occurred over the simulation period.

[19] Dolls et al. (2012) have calculated two sets of income stabilization coefficients. The first set of income stabilization coefficients is calculated by holding the dataset of a given country constant and by applying tax and transfer systems of other countries to this input dataset. The second set of income stabilization coefficients is computed based on a fixed tax and transfer system of a certain country, but varying input datasets (and population characteristics) of other countries. They show that there is much more variation within the first set of income stabilization coefficients.

consideration. Income stabilization coefficients range from 20 to 30 percent in some Eastern and Southern European countries to around 60 percent in Belgium, Germany and Denmark. With the exception of Ireland and Estonia, automatic stabilizers played an important role in cushioning household income losses during the Great Recession. Fiscal adjustments in the aftermath of the Great Recession hampered the functioning of automatic stabilizers in several EU member states, in particular, in those countries that were hit hard by the euro-area debt crisis. A comparison of the income stabilization coefficients under time-varying policy with year-on-year changes in the cyclically adjusted budget balance reveals that tax-benefit reforms and other budgetary measures sometimes go in opposite direction, underlining the need to refer to micro-based measures of household income stabilization for an assessment of the automatic stabilizers in the tax-benefit system.

Our paper has implications for fiscal policy after the COVID-19 crisis with its legacy of high public debt and sustained low interest rates. Fiscal buffers should be built up in good economic times so that automatic stabilizers can operate freely in bad times. Pro-cyclical fiscal adjustments should be avoided in order not to threaten the economic recovery.

Appendix

Income Stabilization Coefficients (Income Shock)

Table 1 Income Stabilization Coefficients–Income Shock. *Source*: Own calculations using EUROMOD

		2007	2008	2009	2010	2011	2012	2013	2014	2015
AT	τ^{TAX}	0.334	0.336	0.326	0.324	0.327	0.330	0.331	0.332	0.332
	τ^{SIC}	0.135	0.139	0.140	0.141	0.142	0.140	0.143	0.143	0.145
	τ^{BEN+UI}	0.007	0.006	0.006	0.007	0.009	0.007	0.007	0.007	0.008
	τ	0.476	0.481	0.472	0.471	0.478	0.477	0.481	0.482	0.485
BE	τ^{TAX}	0.392	0.394	0.386	0.390	0.391	0.391	0.388	0.389	0.408
	τ^{SIC}	0.142	0.142	0.145	0.142	0.142	0.141	0.144	0.143	0.138
	τ^{BEN+UI}	0.002	0.002	0.004	0.002	0.002	0.002	0.003	0.004	0.004
	τ	0.536	0.537	0.534	0.534	0.535	0.534	0.535	0.537	0.550
BG	τ^{TAX}	0.186	0.087	0.087	0.088	0.087	0.087	0.087	0.088	0.087
	τ^{SIC}	0.105	0.116	0.114	0.105	0.112	0.111	0.113	0.116	0.118
	τ^{BEN+UI}	0.009	0.011	0.013	0.011	0.012	0.012	0.013	0.013	0.015
	τ	0.300	0.214	0.214	0.205	0.211	0.211	0.214	0.217	0.219
CY	τ^{TAX}	0.168	0.167	0.166	0.169	0.180	0.196	0.199	0.200	0.197
	τ^{SIC}	0.041	0.041	0.045	0.045	0.045	0.047	0.048	0.056	0.056
	τ^{BEN+UI}	0.008	0.007	0.008	0.010	0.008	0.010	0.009	0.014	0.015
	τ	0.216	0.214	0.218	0.224	0.233	0.254	0.257	0.270	0.268
CZ	τ^{TAX}	0.189	0.164	0.163	0.164	0.168	0.165	0.172	0.170	0.169
	τ^{SIC}	0.128	0.132	0.118	0.121	0.122	0.120	0.121	0.121	0.120
	τ^{BEN+UI}	0.018	0.021	0.023	0.024	0.023	0.025	0.025	0.025	0.026
	τ	0.335	0.318	0.304	0.309	0.313	0.310	0.318	0.315	0.315
DE	τ^{TAX}	0.331	0.343	0.339	0.318	0.312	0.314	0.315	0.316	0.316
	τ^{SIC}	0.128	0.134	0.132	0.134	0.130	0.128	0.126	0.124	0.126
	τ^{BEN+UI}	0.031	0.030	0.030	0.022	0.023	0.021	0.020	0.021	0.022
	τ	0.490	0.507	0.500	0.474	0.465	0.464	0.461	0.462	0.463
DK	τ^{TAX}	0.420	0.414	0.393	0.353	0.349	0.349	0.344	0.338	0.339
	τ^{SIC}	0.074	0.074	0.074	0.074	0.074	0.075	0.075	0.075	0.075
	τ^{BEN+UI}	0.014	0.014	0.014	0.017	0.017	0.017	0.018	0.018	0.018
	τ	0.508	0.502	0.481	0.444	0.440	0.440	0.436	0.430	0.431
EE	τ^{TAX}	0.213	0.202	0.203	0.200	0.200	0.199	0.201	0.201	0.192
	τ^{SIC}	0.017	0.017	0.019	0.033	0.035	0.038	0.031	0.031	0.027
	τ^{BEN+UI}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.005
	τ	0.231	0.220	0.222	0.233	0.236	0.238	0.232	0.234	0.223
EL	τ^{TAX}	0.232	0.226	0.215	0.268	0.299	0.300	0.284	0.283	0.278
	τ^{SIC}	0.093	0.092	0.092	0.091	0.093	0.095	0.103	0.103	0.099
	τ^{BEN+UI}	0.002	0.001	0.004	0.001	0.002	0.001	0.006	0.014	0.009
	τ	0.327	0.320	0.312	0.360	0.394	0.395	0.393	0.401	0.387
ES	τ^{TAX}	0.245	0.236	0.233	0.251	0.257	0.278	0.279	0.280	0.265
	τ^{SIC}	0.046	0.045	0.046	0.046	0.045	0.045	0.046	0.047	0.047
	τ^{BEN+UI}	0.002	0.002	0.004	0.005	0.003	0.002	0.002	0.002	0.003
	τ	0.293	0.283	0.283	0.302	0.305	0.325	0.327	0.329	0.314
FI	τ^{TAX}	0.361	0.363	0.353	0.349	0.348	0.348	0.355	0.356	0.358

Table 1 (continued)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
	τ^{SIC}	0.063	0.059	0.059	0.065	0.068	0.072	0.071	0.077	0.078
	τ^{BEN+UI}	0.012	0.013	0.014	0.013	0.012	0.013	0.011	0.011	0.011
	τ	0.436	0.434	0.426	0.427	0.428	0.433	0.438	0.444	0.448
FR	τ^{TAX}	0.168	0.169	0.168	0.170	0.173	0.179	0.181	0.183	0.180
	τ^{SIC}	0.133	0.133	0.134	0.134	0.133	0.134	0.136	0.139	0.140
	τ^{BEN+UI}	0.037	0.040	0.053	0.051	0.050	0.049	0.050	0.053	0.056
	τ	0.339	0.342	0.355	0.355	0.357	0.362	0.368	0.374	0.377
HU	τ^{TAX}	0.335	0.339	0.311	0.271	0.225	0.209	0.161	0.161	–
	τ^{SIC}	0.191	0.196	0.190	0.195	0.191	0.204	0.203	0.203	–
	τ^{BEN+UI}	0.007	0.007	0.005	0.005	0.004	0.006	0.006	0.005	–
	τ	0.533	0.542	0.506	0.471	0.420	0.418	0.370	0.369	–
IE	τ^{TAX}	0.316	0.314	0.330	0.327	0.384	0.388	0.388	0.389	–
	τ^{SIC}	0.065	0.065	0.102	0.101	0.067	0.067	0.070	0.071	–
	τ^{BEN+UI}	0.018	0.021	0.019	0.024	0.016	0.019	0.020	0.020	–
	τ	0.399	0.401	0.451	0.452	0.468	0.474	0.478	0.480	–
IT	τ^{TAX}	0.319	0.322	0.322	0.323	0.329	0.331	0.334	0.349	–
	τ^{SIC}	0.105	0.106	0.106	0.106	0.106	0.109	0.110	0.111	–
	τ^{BEN+UI}	0.008	0.008	0.008	0.008	0.007	0.007	0.007	0.007	–
	τ	0.432	0.436	0.436	0.437	0.443	0.447	0.450	0.466	–
LT	τ^{TAX}	0.251	0.226	0.163	0.162	0.161	0.161	0.161	0.163	–
	τ^{SIC}	0.039	0.037	0.087	0.088	0.090	0.090	0.090	0.090	–
	τ^{BEN+UI}	−0.006	−0.011	−0.006	−0.007	−0.001	−0.001	−0.002	−0.003	–
	τ	0.284	0.252	0.244	0.243	0.249	0.250	0.249	0.251	–
LU	τ^{TAX}	0.276	0.280	0.271	0.275	0.297	0.295	0.309	0.309	–
	τ^{SIC}	0.106	0.105	0.108	0.107	0.107	0.105	0.104	0.105	–
	τ^{BEN+UI}	0.019	0.018	0.026	0.025	0.021	0.020	0.021	0.021	–
	τ	0.400	0.403	0.405	0.407	0.426	0.419	0.434	0.435	–
LV	τ^{TAX}	0.227	0.222	0.202	0.235	0.220	0.221	0.212	0.212	–
	τ^{SIC}	0.084	0.081	0.088	0.087	0.108	0.107	0.107	0.098	–
	τ^{BEN+UI}	0.002	0.002	0.003	0.004	0.003	0.004	0.003	0.003	–
	τ	0.312	0.305	0.293	0.326	0.332	0.331	0.322	0.313	–
MT	τ^{TAX}	0.230	0.216	0.213	0.217	0.220	0.222	0.213	0.205	–
	τ^{SIC}	0.038	0.037	0.037	0.036	0.040	0.041	0.045	0.046	–
	τ^{BEN+UI}	0.018	0.011	0.012	0.013	0.012	0.009	0.008	0.011	–
	τ	0.286	0.263	0.262	0.266	0.271	0.272	0.266	0.262	–
NL	τ^{TAX}	0.308	0.313	0.314	0.312	0.314	0.323	0.312	0.313	–
	τ^{SIC}	0.111	0.105	0.089	0.091	0.090	0.089	0.099	0.106	–
	τ^{BEN+UI}	0.017	0.023	0.029	0.029	0.031	0.029	0.031	0.023	–
	τ	0.435	0.440	0.432	0.433	0.435	0.442	0.442	0.442	–
PL	τ^{TAX}	0.179	0.191	0.165	0.166	0.167	0.168	0.169	0.168	–
	τ^{SIC}	0.141	0.105	0.104	0.104	0.104	0.104	0.105	0.106	–

Table 1 (continued)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
	τ^{BEN+UI}	0.013	0.011	0.010	0.011	0.010	0.011	0.011	0.011	–
	τ	0.333	0.307	0.278	0.281	0.281	0.283	0.284	0.286	–
PT	τ^{TAX}	0.211	0.210	0.204	0.211	0.237	0.218	0.277	0.276	0.273
	τ^{SIC}	0.093	0.093	0.094	0.096	0.093	0.108	0.110	0.110	0.109
	τ^{BEN+UI}	0.016	0.017	0.021	0.021	0.018	0.013	0.009	0.010	0.009
	τ	0.321	0.320	0.319	0.328	0.348	0.339	0.396	0.397	0.392
RO	τ^{TAX}	0.207	0.209	0.199	0.201	0.199	0.200	0.201	0.200	–
	τ^{SIC}	0.091	0.088	0.096	0.096	0.106	0.105	0.102	0.103	–
	τ^{BEN+UI}	0.023	0.021	0.027	0.026	0.018	0.015	0.015	0.017	–
	τ	0.322	0.318	0.322	0.323	0.323	0.320	0.318	0.321	–
SE	τ^{TAX}	0.360	0.354	0.332	0.331	0.328	0.321	0.317	0.309	–
	τ^{SIC}	0.054	0.054	0.055	0.055	0.055	0.056	0.057	0.057	–
	τ^{BEN+UI}	0.008	0.008	0.008	0.008	0.008	0.010	0.010	0.012	–
	τ	0.421	0.415	0.396	0.393	0.390	0.386	0.384	0.378	–
SI	τ^{TAX}	0.200	0.206	0.204	0.197	0.207	0.209	0.203	0.201	–
	τ^{SIC}	0.187	0.187	0.188	0.189	0.190	0.186	0.185	0.192	–
	τ^{BEN+UI}	0.021	0.022	0.023	0.024	0.023	0.026	0.026	0.027	–
	τ	0.409	0.415	0.415	0.410	0.420	0.422	0.414	0.420	–
SK	τ^{TAX}	0.147	0.147	0.136	0.136	0.147	0.148	0.143	0.141	0.139
	τ^{SIC}	0.130	0.131	0.130	0.131	0.126	0.127	0.156	0.158	0.171
	τ^{BEN+UI}	0.017	0.017	0.031	0.031	0.023	0.020	0.020	0.021	0.018
	τ	0.293	0.296	0.297	0.298	0.297	0.294	0.318	0.319	0.327
UK	τ^{TAX}	0.259	0.249	0.243	0.255	0.263	0.265	0.266	0.266	0.265
	τ^{SIC}	0.072	0.077	0.080	0.080	0.085	0.085	0.083	0.083	0.084
	τ^{BEN+UI}	0.039	0.041	0.042	0.042	0.036	0.035	0.032	0.032	0.033
	τ	0.370	0.367	0.366	0.377	0.383	0.384	0.381	0.381	0.381
EU	τ^{TAX}	0.264	0.263	0.256	0.256	0.260	0.263	0.264	0.266	0.262
	τ^{SIC}	0.104	0.103	0.104	0.104	0.104	0.104	0.105	0.106	0.107
	τ^{BEN+UI}	0.020	0.021	0.023	0.022	0.021	0.020	0.020	0.020	0.026
	τ	0.388	0.386	0.383	0.383	0.385	0.388	0.389	0.393	0.395
EA	τ^{TAX}	0.259	0.258	0.256	0.262	0.270	0.276	0.278	0.282	0.245
	τ^{SIC}	0.102	0.102	0.103	0.103	0.102	0.103	0.106	0.107	0.108
	τ^{BEN+UI}	0.016	0.017	0.021	0.021	0.020	0.019	0.020	0.020	0.026
	τ	0.377	0.377	0.380	0.386	0.391	0.398	0.403	0.409	0.379

A missing value in the 2015 column indicates that the tax policy is not available in EUROMOD G4.0. EU and EA averages are population weighted

Income Stabilization Coefficients (Unemployment Shock)

Table 2.

Table 2 Income Stabilization Coefficients–Unemployment Shock. *Source*: Own calculations using EUROMOD

		2007	2008	2009	2010	2011	2012	2013	2014	2015
AT	τ^{TAX}	0.188	0.192	0.185	0.182	0.186	0.190	0.192	0.194	0.194
	τ^{SIC}	0.164	0.165	0.166	0.166	0.167	0.166	0.169	0.169	0.170
	τ^{BEN+UI}	0.159	0.155	0.156	0.154	0.159	0.157	0.157	0.156	0.156
	τ	0.511	0.511	0.506	0.502	0.512	0.513	0.518	0.519	0.521
BE	τ^{TAX}	0.224	0.227	0.218	0.227	0.229	0.228	0.226	0.226	0.239
	τ^{SIC}	0.132	0.135	0.135	0.135	0.135	0.135	0.134	0.135	0.129
	τ^{BEN+UI}	0.293	0.299	0.307	0.305	0.301	0.322	0.321	0.321	0.318
	τ	0.649	0.660	0.659	0.667	0.665	0.685	0.682	0.681	0.686
BG	τ^{TAX}	0.131	0.091	0.091	0.092	0.091	0.091	0.091	0.091	0.091
	τ^{SIC}	0.125	0.133	0.130	0.120	0.128	0.128	0.129	0.131	0.132
	τ^{BEN+UI}	0.011	0.006	0.005	0.007	0.009	0.009	0.009	0.009	0.009
	τ	0.268	0.230	0.226	0.220	0.228	0.228	0.229	0.230	0.231
CY	τ^{TAX}	0.073	0.071	0.070	0.074	0.077	0.093	0.092	0.094	0.092
	τ^{SIC}	0.057	0.057	0.063	0.063	0.063	0.068	0.069	0.079	0.080
	τ^{BEN+UI}	0.041	0.041	0.047	0.049	0.048	0.054	0.054	0.070	0.070
	τ	0.171	0.169	0.179	0.186	0.188	0.215	0.215	0.243	0.242
CZ	τ^{TAX}	0.111	0.089	0.089	0.089	0.094	0.092	0.099	0.095	0.095
	τ^{SIC}	0.147	0.149	0.135	0.136	0.137	0.136	0.136	0.136	0.136
	τ^{BEN+UI}	0.082	0.086	0.084	0.083	0.080	0.082	0.082	0.081	0.079
	τ	0.340	0.324	0.307	0.307	0.311	0.310	0.316	0.313	0.311
DE	τ^{TAX}	0.224	0.228	0.223	0.206	0.208	0.211	0.212	0.212	0.211
	τ^{SIC}	0.165	0.164	0.162	0.163	0.165	0.164	0.161	0.161	0.161
	τ^{BEN+UI}	0.227	0.225	0.223	0.210	0.209	0.210	0.211	0.212	0.213
	τ	0.616	0.617	0.608	0.578	0.582	0.585	0.583	0.584	0.585
DK	τ^{TAX}	0.247	0.240	0.229	0.210	0.207	0.207	0.201	0.197	0.196
	τ^{SIC}	0.092	0.093	0.093	0.094	0.094	0.095	0.095	0.095	0.095
	τ^{BEN+UI}	0.256	0.259	0.263	0.268	0.270	0.272	0.276	0.275	0.280
	τ	0.596	0.592	0.585	0.571	0.571	0.574	0.571	0.567	0.572
EE	τ^{TAX}	0.173	0.158	0.165	0.163	0.164	0.165	0.168	0.167	0.158
	τ^{SIC}	0.023	0.023	0.023	0.037	0.040	0.044	0.037	0.037	0.033
	τ^{BEN+UI}	−0.015	−0.017	−0.016	−0.017	−0.016	−0.017	−0.017	−0.015	−0.020
	τ	0.180	0.164	0.172	0.183	0.189	0.192	0.188	0.189	0.171
EL	τ^{TAX}	0.128	0.125	0.119	0.152	0.196	0.198	0.198	0.197	0.191
	τ^{SIC}	0.130	0.131	0.132	0.131	0.135	0.138	0.144	0.144	0.141
	τ^{BEN+UI}	0.024	0.024	0.026	0.024	0.023	0.024	0.023	0.070	0.072
	τ	0.281	0.280	0.277	0.307	0.354	0.360	0.365	0.411	0.404

Table 2 (continued)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
ES	τ^{TAX}	0.143	0.132	0.129	0.144	0.148	0.163	0.166	0.165	0.153
	τ^{SIC}	0.074	0.073	0.074	0.074	0.074	0.071	0.071	0.072	0.073
	τ^{BEN+UI}	0.187	0.186	0.197	0.192	0.188	0.183	0.180	0.180	0.181
	τ	0.403	0.391	0.401	0.410	0.410	0.417	0.417	0.417	0.406
FI	τ^{TAX}	0.230	0.232	0.218	0.215	0.214	0.208	0.213	0.214	0.216
	τ^{SIC}	0.065	0.061	0.062	0.068	0.071	0.075	0.075	0.080	0.081
	τ^{BEN+UI}	0.233	0.230	0.237	0.232	0.227	0.261	0.265	0.263	0.264
	τ	0.528	0.523	0.517	0.515	0.511	0.545	0.553	0.557	0.561
FR	τ^{TAX}	0.103	0.103	0.103	0.103	0.105	0.108	0.109	0.109	0.107
	τ^{SIC}	0.156	0.156	0.157	0.157	0.157	0.157	0.160	0.162	0.162
	τ^{BEN+UI}	0.207	0.207	0.218	0.217	0.217	0.216	0.216	0.217	0.218
	τ	0.466	0.466	0.478	0.477	0.479	0.481	0.485	0.488	0.487
HU	τ^{TAX}	0.229	0.233	0.218	0.194	0.177	0.187	0.160	0.160	–
	τ^{SIC}	0.201	0.205	0.196	0.202	0.197	0.212	0.211	0.211	–
	τ^{BEN+UI}	0.056	0.056	0.059	0.056	0.057	−0.008	−0.008	−0.008	–
	τ	0.485	0.494	0.473	0.452	0.431	0.390	0.363	0.362	–
IE	τ^{TAX}	0.192	0.191	0.206	0.203	0.255	0.259	0.259	0.259	–
	τ^{SIC}	0.061	0.062	0.091	0.090	0.061	0.062	0.066	0.066	–
	τ^{BEN+UI}	0.134	0.141	0.118	0.122	0.117	0.117	0.118	0.117	–
	τ	0.388	0.394	0.415	0.416	0.433	0.437	0.442	0.443	–
IT	τ^{TAX}	0.232	0.235	0.236	0.238	0.244	0.247	0.247	0.242	–
	τ^{SIC}	0.120	0.121	0.121	0.121	0.121	0.124	0.125	0.126	–
	τ^{BEN+UI}	−0.042	−0.037	−0.037	−0.037	−0.038	−0.038	−0.033	−0.033	–
	τ	0.310	0.319	0.319	0.321	0.328	0.333	0.339	0.335	–
LT	τ^{TAX}	0.230	0.211	0.146	0.147	0.147	0.148	0.148	0.145	–
	τ^{SIC}	0.044	0.045	0.092	0.091	0.094	0.094	0.094	0.094	–
	τ^{BEN+UI}	−0.019	−0.027	−0.019	−0.002	−0.002	−0.001	−0.002	−0.001	–
	τ	0.255	0.228	0.219	0.235	0.240	0.241	0.240	0.238	–
LU	τ^{TAX}	0.162	0.168	0.159	0.163	0.178	0.177	0.188	0.188	–
	τ^{SIC}	0.114	0.114	0.115	0.115	0.115	0.114	0.113	0.113	–
	τ^{BEN+UI}	0.092	0.087	0.090	0.090	0.096	0.096	0.096	0.097	–
	τ	0.368	0.368	0.364	0.367	0.389	0.387	0.397	0.398	–
LV	τ^{TAX}	0.213	0.200	0.182	0.225	0.209	0.210	0.202	0.195	–
	τ^{SIC}	0.086	0.086	0.088	0.087	0.107	0.107	0.107	0.101	–
	τ^{BEN+UI}	−0.035	−0.055	−0.047	−0.029	−0.029	−0.037	−0.035	−0.036	–
	τ	0.264	0.231	0.223	0.283	0.287	0.280	0.273	0.260	–
MT	τ^{TAX}	0.117	0.109	0.107	0.110	0.112	0.113	0.111	0.107	–
	τ^{SIC}	0.087	0.085	0.085	0.085	0.086	0.087	0.089	0.090	–
	τ^{BEN+UI}	0.033	0.030	0.031	0.031	0.031	0.029	0.028	0.029	–
	τ	0.237	0.225	0.223	0.226	0.230	0.230	0.228	0.225	–
NL	τ^{TAX}	0.086	0.090	0.090	0.088	0.090	0.096	0.085	0.085	–

Table 2 (continued)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
	τ^{SIC}	0.121	0.117	0.100	0.102	0.101	0.102	0.108	0.105	–
	τ^{BEN+UI}	0.346	0.352	0.358	0.361	0.359	0.357	0.359	0.356	–
	τ	0.553	0.560	0.548	0.550	0.550	0.554	0.551	0.546	–
PL	τ^{TAX}	0.149	0.161	0.147	0.146	0.147	0.151	0.152	0.151	–
	τ^{SIC}	0.165	0.124	0.125	0.124	0.125	0.126	0.127	0.127	–
	τ^{BEN+UI}	−0.006	−0.002	−0.004	0.000	−0.001	−0.001	0.002	0.000	–
	τ	0.308	0.283	0.268	0.270	0.272	0.276	0.280	0.278	–
PT	τ^{TAX}	0.144	0.143	0.138	0.143	0.161	0.145	0.195	0.194	0.189
	τ^{SIC}	0.108	0.108	0.108	0.108	0.110	0.112	0.113	0.113	0.112
	τ^{BEN+UI}	0.106	0.105	0.106	0.109	0.098	0.088	0.078	0.079	0.078
	τ	0.358	0.355	0.352	0.360	0.369	0.346	0.386	0.386	0.379
RO	τ^{TAX}	0.155	0.158	0.148	0.151	0.161	0.163	0.164	0.164	–
	τ^{SIC}	0.113	0.110	0.122	0.122	0.107	0.107	0.107	0.107	–
	τ^{BEN+UI}	0.143	0.142	0.141	0.145	0.132	0.125	0.126	0.131	–
	τ	0.411	0.411	0.410	0.418	0.400	0.396	0.397	0.402	–
SE	τ^{TAX}	0.251	0.243	0.227	0.222	0.221	0.217	0.216	0.207	–
	τ^{SIC}	0.064	0.064	0.064	0.064	0.064	0.064	0.065	0.065	–
	τ^{BEN+UI}	0.152	0.151	0.151	0.150	0.150	0.152	0.152	0.153	–
	τ	0.467	0.458	0.443	0.436	0.435	0.433	0.433	0.425	–
SI	τ^{TAX}	0.124	0.126	0.123	0.122	0.123	0.123	0.120	0.120	–
	τ^{SIC}	0.205	0.206	0.206	0.207	0.207	0.207	0.207	0.207	–
	τ^{BEN+UI}	0.052	0.052	0.052	0.057	0.058	0.043	0.043	0.042	–
	τ	0.382	0.383	0.381	0.386	0.388	0.373	0.370	0.369	–
SK	τ^{TAX}	0.076	0.076	0.061	0.061	0.074	0.075	0.073	0.071	0.071
	τ^{SIC}	0.150	0.152	0.151	0.152	0.149	0.149	0.174	0.176	0.175
	τ^{BEN+UI}	0.097	0.094	0.099	0.102	0.098	0.094	0.092	0.091	0.091
	τ	0.323	0.322	0.312	0.316	0.321	0.318	0.339	0.338	0.336
UK	τ^{TAX}	0.205	0.198	0.193	0.200	0.200	0.198	0.193	0.191	0.187
	τ^{SIC}	0.085	0.088	0.089	0.090	0.093	0.093	0.093	0.093	0.093
	τ^{BEN+UI}	0.123	0.123	0.125	0.124	0.116	0.116	0.104	0.104	0.104
	τ	0.413	0.408	0.408	0.415	0.409	0.408	0.390	0.388	0.383
EU	τ^{TAX}	0.177	0.176	0.170	0.170	0.175	0.178	0.177	0.176	0.168
	τ^{SIC}	0.125	0.122	0.123	0.123	0.123	0.123	0.124	0.125	0.129
	τ^{BEN+UI}	0.134	0.135	0.137	0.135	0.133	0.132	0.131	0.132	0.174
	τ	0.436	0.432	0.430	0.429	0.431	0.433	0.433	0.433	0.471
EA	τ^{TAX}	0.157	0.157	0.155	0.160	0.167	0.172	0.173	0.172	0.146
	τ^{SIC}	0.121	0.121	0.121	0.121	0.121	0.121	0.123	0.124	0.128
	τ^{BEN+UI}	0.137	0.138	0.143	0.142	0.141	0.141	0.141	0.143	0.192
	τ	0.415	0.415	0.419	0.424	0.429	0.434	0.438	0.439	0.466

A missing value in the 2015 column indicates that the tax policy is not available in EUROMOD G4.0. EU and EA averages are population weighted

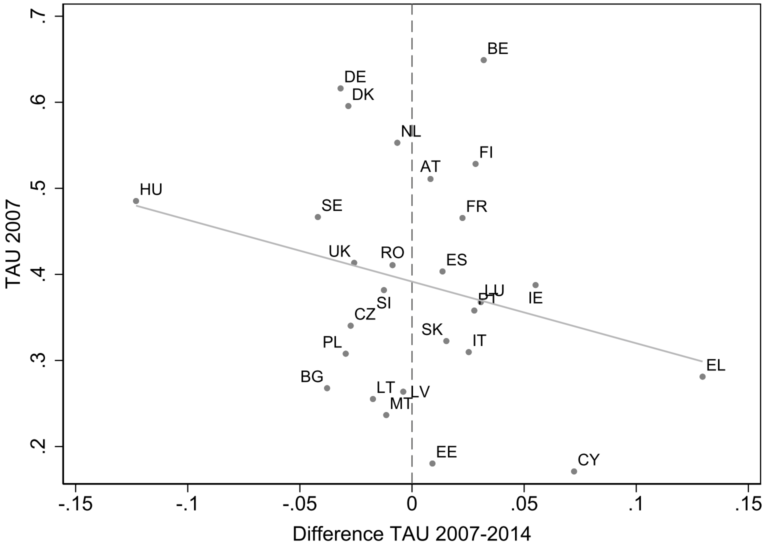


Fig. 6 Change in τ (Unemployment Shock): 2014 vs. 2007 *Notes:* The graph shows the level of the stabilization coefficient after an unemployment shock on the vertical axis and the change from 2007 to 2014 on the horizontal axis. The solid line indicates fitted values of a linear regression of the variable on the vertical axis on the variable on the horizontal axis. The slope is not statistically different from zero. Correlation coefficient: −0.25. *Source:* Own calculations using EUROMOD

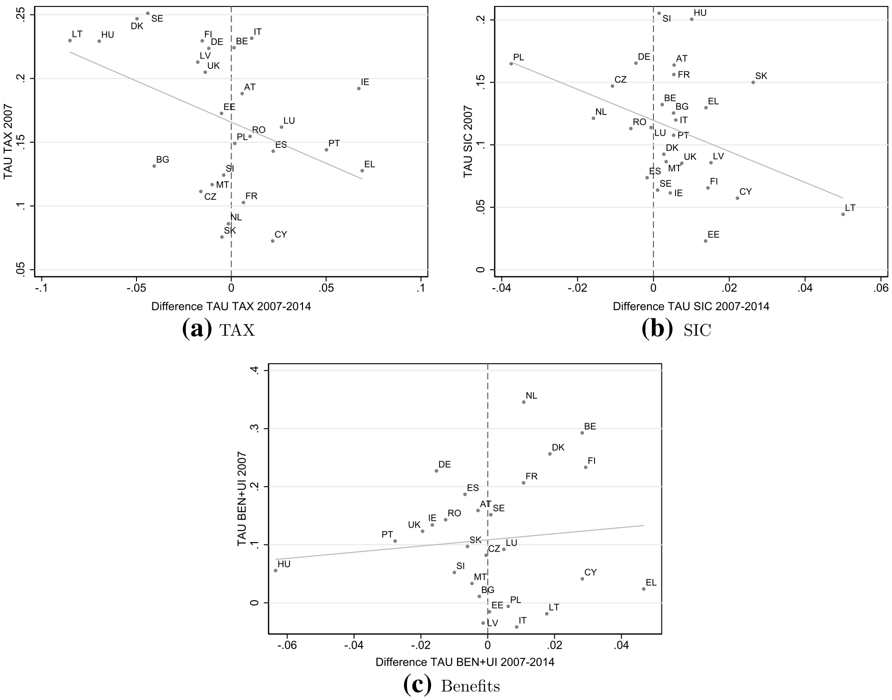
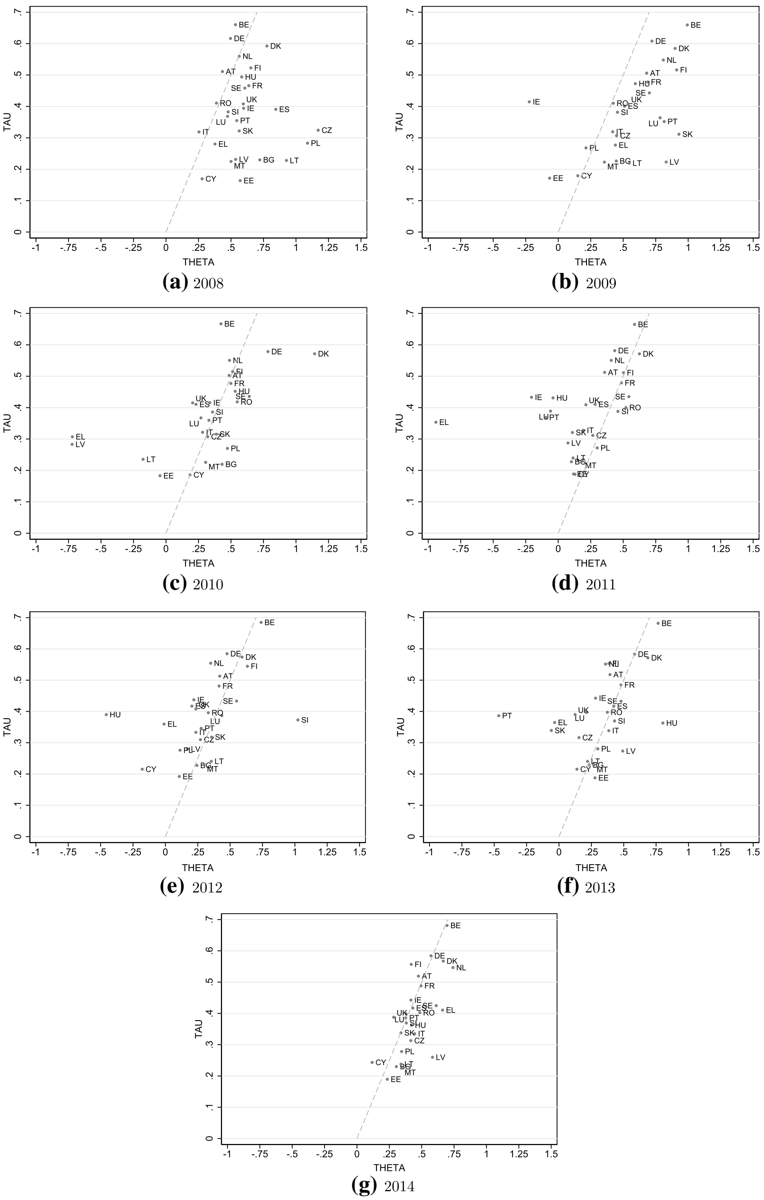


Fig. 7 Change in τ by Component (Unemployment Shock): 2014 vs. 2007 *Notes:* The graph shows the level of the income stabilization coefficient by component in 2007 following an unemployment shock on the vertical axis and the change from 2007 to 2014 on the horizontal axis. The solid lines indicate fitted values of a linear regression of the variable on the vertical axis on the variable on the horizontal axis. The slopes in panel **a** TAX and **b** SIC are statistically different from zero at the 5% level. The slope in panel **c** Benefits is not statistically different from zero. Correlation coefficients: −0.41 (TAX), −0.40 (SIC), 0.11 (Benefits). *Source:* Own calculations using EUROMOD



(a) 2008 **(b)** 2009 **(c)** 2010 **(d)** 2011 **(e)** 2012 **(f)** 2013 **(g)** 2014

Fig. 8 Income Stabilization Coefficients (Unemployment Shock): Constant vs. time-varying policy Income Stabilization Coefficients (Unemployment Shock): Constant vs. time-varying policy *Notes:* The figure plots the income stabilization coefficient under time-varying policy (θ) on the x-axis and income stabilization coefficients under constant policy (τ) on the y-axis. Income stabilization coefficients under time-varying policy for year t capture policy changes from $t-1$ to t. Income stabilization coefficients to the right (left) of the dashed 45 degree line imply expansionary (contractionary) changes in the tax-benefit system. *Source:* Own calculations using EUROMOD

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