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## The response of labour taxation to changes in government debt

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**NO 1307 / MARCH 2011**

**THE RESPONSE OF  
LABOUR TAXATION  
TO CHANGES IN  
GOVERNMENT DEBT**

by **Fédéric Holm-Hadulla,**  
**Nadine Leiner-Killinger**  
and **Michal Slavík**



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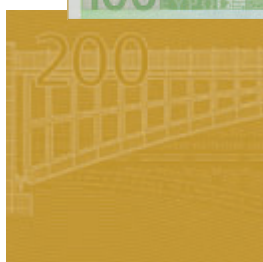
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# THE RESPONSE OF LABOUR TAXATION TO CHANGES IN GOVERNMENT DEBT<sup>1</sup>

by Frédéric Holm-Hadulla, Nadine Leiner-Killinger  
and Michal Slavík<sup>2</sup>



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### **Abstract**

This paper investigates the relationship between government debt and labour taxation for a panel of 18 EU countries over the period 1979-2008. The econometric estimates point to a statistically significant and economically relevant positive response of labour taxation to changes in the general government debt and interest expenditure-to-GDP ratios. The results are robust across a range of econometric specifications and labour tax indicators.

**Keywords:** Debt, labour taxes, fiscal adjustment

**JEL codes:** H2, H24, H63, J22.

## Non-technical summary

The global financial and economic crisis has led to rapidly rising debt ratios in most EU countries. While many governments have already adopted ambitious fiscal consolidation packages in response, these plans would only mark the beginning of a prolonged period of budgetary restraint necessary to bring back debt ratios to pre-crisis levels. Assessing the potential repercussions of such a restrictive fiscal stance is by no means trivial. Besides the expected scale and timing of fiscal contraction, the economic implications depend on its composition. In particular, the feedback effects of fiscal adjustment on economic growth may differ substantially depending on whether it is predominantly revenue- or expenditure-based and which specific spending or revenue items are mainly affected. Hence, in order to assess the potential impact of the expected fiscal consolidation episode on general economic performance it is useful to observe key regularities of fiscal adjustment in the past with regard to individual budgetary items.

Against this background, this paper analyses the response of labour taxation to changes in general government gross debt and interest payments in EU countries. As documented by a large body of literature, labour taxation distorts incentives to work and to accumulate human capital, distortions which intensify with higher tax rates. Thus, the burden of debt on potential growth is higher if governments meet additional financing requirements in a way that exerts negative supply-side effects on labour markets. At the same time, the theoretical literature on budgetary decision making suggests that governments might favour revenue-based fiscal consolidation over expenditure restraint since tapping the ‘common pool’ of public funds is less costly from a political perspective than cutting specific spending programmes. Consequently, governments tend to respond to exogenous shocks to their fiscal position by adjusting tax rates even if this incurs long-run costs from an economic perspective.

The analysis is based on a panel of 18 EU countries over the period 1979-2008. As measures for labour taxation we use the indicators ‘tax burden’ and ‘tax wedge’ as provided by the OECD in their annual *Taxing Wages* study. Given the drawbacks of the commonly used estimators for dynamic panel models with unobserved heterogeneity, the analysis uses a range of econometric procedures, including a least squares dummy variable (LSDV) estimator, a generalised method of moments (GMM) estimator, and a bias-corrected least squares dummy variable (LSDVC) estimator.

Our econometric estimates show that, indeed, rising (falling) debt and interest expenditure ratios go along with increases (decreases) in labour taxes in subsequent years. A one percentage point increase in the debt ratio (interest payments ratio) is estimated to raise the tax burden of an average single earner (as defined in the OECD *Taxing Wages* study) by 0.03%-0.04% (0.16%-0.17%) in the subsequent year and by 0.13% (0.71%-0.94%) in the long-run. The corresponding effects for the debt ratio (interest expenditure ratio) on the tax burden of an average one-earner family amount to 0.02% (0.22%-0.23%) in the subsequent year and to 0.12%-0.18% (1.30%-1.76%) in the long-run. Especially for the interest expenditure ratio, the associated effects on an average household’s net income appear economically relevant. The response of the tax wedges has the same sign and is similar in magnitude.

# 1 Introduction

The global financial and economic crisis has led to rapidly rising debt ratios in most EU countries.<sup>1</sup> While many governments have already adopted ambitious fiscal consolidation packages in response, these plans would only mark the beginning of a prolonged period of budgetary restraint necessary to bring back debt ratios to pre-crisis levels. Assessing the potential repercussions of such a restrictive fiscal stance is by no means trivial. Besides the scale and timing of fiscal contraction, the economic implications depend on its composition. In particular, the feedback effects of fiscal adjustment on economic growth may differ substantially across individual budgetary items. For example, a number of studies find that tax-based fiscal consolidation tends to be more contractionary than expenditure-based fiscal adjustment (see e.g. IMF 2010), with some analyses suggesting that declines in expenditures are even accompanied by an expansion of economic activity (see e.g. Alesina and Perotti, 1995 and Alesina and Ardagna, 2010).<sup>2</sup> Furthermore, this literature documents that both the implications for growth and the prospects of achieving sustainable improvements in fiscal positions depend on which specific tax rate is raised and which type of government spending is cut (see e.g. Hauptmeier *et al.*, 2007 and Uhlig and Trabandt, 2009). Hence, in order to assess the potential impact of the expected fiscal consolidation episode on general economic performance it is useful to observe key regularities of fiscal adjustment in the past with regard to individual budgetary items.

Against this background, this paper analyses the response of labour taxation to changes in general government gross debt for a panel of EU countries. As documented by a large body of literature, labour taxation distorts incentives to work and to accumulate human capital, distortions which intensify with higher tax rates.<sup>3</sup> Thus, the burden of debt on potential growth is higher if governments meet additional financing requirements in a way that exerts negative supply-side effects on labour markets. At the same time, the theoretical literature on budgetary decision making suggests that

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<sup>1</sup>For more details on euro area fiscal policies in the crisis see van Riet *et al.* (2010).

<sup>2</sup>See also, for example, Afonso, Nickel and Rother (2006), Afonso and Alegre (2008), and Coenen, Mohr and Straub (2008).

<sup>3</sup>Theoretically, the effect of higher labour taxes on individual labour supply is a priori ambiguous. On the one hand, higher labour taxes may decrease disposable income, therefore decreasing leisure and increasing the supply of labour (income effect). On the other hand, labour supply may decrease, increasing leisure, which is now cheaper in relative terms (substitution effect). However, if in general equilibrium taxes are used to fund benefits such as unemployment insurance, negative income effects are cancelled out by the positive income effect of benefit recipients, while the substitution effect goes in the same direction - reducing labour supply. Empirically, tax and benefit systems are found to be a major explanatory factor of labour supply developments, particularly for those population groups with a large labour supply elasticity such as, e.g. persons with low incomes or second earners. See for example, Nickell (1997), Nickell and Layard (1999), Nickell *et al.* (2005) and ECB (2008). Furthermore, several studies analyse the impact of the labour tax indicators used in this paper on economic conditions. In one of the seminal contributions to this literature Tullio (1987) finds a negative relationship between these labour tax indicators and economic growth and employment for several OECD countries over the period 1960-83. More recent empirical evidence in this regard is provided by Bertola (2010).



governments might favour revenue-based fiscal consolidation over expenditure restraint since tapping the ‘common pool’ of public funds is less costly from a political perspective than cutting specific spending programmes.<sup>4</sup> Consequently, governments tend to respond to exogenous shocks to their fiscal position by adjusting tax rates even if this incurs long-run costs from an economic perspective.

For a panel of 18 EU countries from 1979-2008, our econometric estimates show that, indeed, rising (falling) debt and interest expenditure ratios go along with increases (decreases) in labour taxes in subsequent years. In particular, a one percentage point increase in the debt ratio (interest payments ratio) is estimated to raise the tax burden of an average single earner (as defined in the OECD *Taxing Wages* study) by 0.03%-0.04% (0.16%-0.17%) in the subsequent year and by 0.13% (0.71%-0.94%) in the long-run. The corresponding effects for the debt ratio (interest expenditure ratio) on the tax burden of an average one-earner family amount to 0.02% (0.22%-0.23%) in the subsequent year and to 0.12%-0.18% (1.30%-1.76%) in the long-run. Especially for the interest expenditure ratio, the associated effects on an average household’s net income appear economically relevant. The response of the tax wedges has the same sign and is similar in magnitude.

Our results are in line with both theoretical and empirical analyses pointing to a positive relation between tax rates and government debt: Barro (1979) suggests that governments, while aiming to minimise the inter-temporal excess burden via uniform taxation, would adjust tax rates in response to changes in permanent government expenditure, e.g. deriving from debt service.<sup>5</sup> This hypothesis received empirical support in studies by Sahasakul (1986) and Kenny and Toma (1997) both of which establish a positive relationship between the marginal tax rates from the federal income and social security tax and the debt ratio in the US. Similarly, Bohn (1998) finds a positive response of the US budget balance to preceding changes in the debt ratio. While previous literature has analysed revenue-based fiscal adjustments in EU countries,<sup>6</sup> this paper is the first one to conduct a separate analysis of the response in various labour tax indicators to changes in government debt.

The paper is organised as follows. Section 2 describes the data underlying this study and reviews some stylised facts concerning developments in labour taxation and debt ratios. Section 3 motivates and describes the econometric model and Section 4 presents the empirical results. Section 5 concludes.

<sup>4</sup>See Weingast *et al.* (1981) and von Hagen and Harden (1995) for the seminal contributions.

<sup>5</sup>Note that in Barro (1979), a positive relation between distortive taxation and permanent changes in funding requirements derives from the government’s optimisation problem. However, since expenditure is exogenous and the distortive tax is the only revenue source, the model does not yield normative implications for the optimal composition of fiscal adjustment.

<sup>6</sup>For a survey of the literature and further empirical evidence see European Commission (2007). For related evidence see Schuknecht and Tanzi (2005). For an in-depth study of the dynamics of both revenue- and expenditure-based fiscal adjustment in the context of US municipalities see Büttner and Wildasin (2006).

## 2 Data and stylised facts

Our dataset consists of a panel of annual observations that cover 18 EU countries over the period 1979-2008.<sup>7</sup> As measures for labour taxation we use the indicators ‘tax burden’ and ‘tax wedge’ as provided by the OECD in their annual *Taxing Wages* study. The tax burden captures personal income tax and employee social security contributions net of cash benefits as a percentage of average gross earnings. The tax wedge captures the difference between total labour costs to the employer and the corresponding net-take home pay of a worker at average earnings as a percentage of total labour costs. Both measures are computed for a representative worker with average income. In this regard, the time series exhibit a methodological change in the year 2000 as the tax indicators have been calculated on the basis of two different definitions of “average income”. Under the old definition, income is measured as the average earnings of a manual full-time worker in the manufacturing sector (‘average production worker’). Under the new concept, this income measure has been extended to capture not only manual workers but also non-manual workers. As a consequence, the OECD provides two series for the labour tax indicators, i.e. (a) one for 1979-2004 under the old definition with a biyearly frequency and (b) one for 2000-2008 under the new definition of average income at an annual frequency (for further methodological explanations see OECD 2006, 2009).

We merge these two datasets, using the information from (a) up to 1999 and from (b) for the rest of the sample period,<sup>8</sup> and interpolate missing observations in every second year in the period 1979-1999. For this interpolation we first derive a broad proxy for average tax rates on labour income by dividing revenues from direct taxes on households by GDP; in a second step we compute the ratios between the labour tax burden (tax wedges) and this average tax rate for the years where both variables are available; finally we replace missing values with the simple average of the ratios in the two adjacent periods multiplied with the average tax rate in the current period. Furthermore, to avoid that the methodological difference between the old and new definition of the average income worker leads to a structural break in the time series, we backcast the data for each labour tax indicator for the period 1979-1999 by applying

<sup>7</sup>The analysis covers those EU countries for which comparable OECD data on labour taxes were available, including Belgium (BEL), Czech Republic (CZE), Denmark (DNK), Germany (DEU), Ireland (IRL), Greece (GRC), Spain (ESP), France (FRA), Hungary (HUN), Italy (ITA), Luxembourg (LUX), the Netherlands (NLD), Austria (AUT), Poland (POL), Portugal (PRT), Finland (FIN), Sweden (SWE) and the United Kingdom (GBR). For the labour tax indicators several observations are missing. In particular, for France tax wedge data start only in 1995 because employers’ social contributions were not reported for the period 1979-1993. Time series on tax wedges for the Czech Republic and Poland start in 1993 and for Hungary in 1995. The interpolation of missing observations (see below) had to be slightly adjusted for Greece, Luxembourg and Portugal where comparable OECD data on direct taxes paid by households were not available. Thus, the interpolation was conducted using all direct taxes instead.

<sup>8</sup>This change in methodology does not affect the results of our empirical analysis (see section 3).

the growth rates of the respective variable obtained from (a) to the value for 2000 obtained from (b). Of the eight household types provided by the OECD - differing by household income and composition - we look at two basic types of households: a single earner and a one-earner family with two children at income levels amounting to 100% of average income, as only for these household types the OECD provides the long historical time series.

Table 1: Debt ratios and labour tax indicators over the last three decades

Country	Debt in % of GDP		Tax burden				Tax wedges			
			single earner		one-earner family		single earner		one-earner family	
	change 79-08	level 2008	change 79-08	level 2008	change 79-08	level 2008	change 79-08	level 2008	change 79-08	level 2008
AUT	28.8	62.6	7.8	33.9	12.2	20.5	10.3	48.8	13.9	38.4
BEL	24.0	89.8	16.5	42.5	17.0	22.6	7.8	56.0	6.0	40.8
CZE	17.5	30.0	0.9	23.6	-12.2	-7.1	1.0	43.4	-8.8	20.6
DEU	39.3	66.0	9.2	42.7	-0.8	24.1	9.5	52.0	1.9	36.4
DNK	2.6	34.2	0.8	40.9	-1.2	29.1	0.7	41.2	-1.4	29.5
ESP	25.1	39.7	2.2	19.0	-0.8	11.2	0.4	37.8	-1.7	31.8
FIN	23.0	34.2	0.1	30.0	4.2	23.1	1.5	43.5	5.0	38.0
FRA	46.5	67.5	6.0	27.8	10.2	17.6	-1.2	49.3	1.7	42.1
GBR	-1.2	52.0	-6.9	25.6	-6.8	19.1	-6.3	32.8	-5.8	26.9
GRC	76.7	99.2	12.6	26.3	36.5	26.6	15.0	42.4	32.4	42.7
HUN	17.9	72.9	2.6	38.3	4.2	24.6	-0.5	54.1	0.0	43.9
IRL	-23.6	43.9	-13.5	14.6	-18.1	-4.7	-11.0	22.9	-14.9	5.5
ITA	46.8	106.1	9.0	29.3	0.6	15.5	1.0	46.5	-7.7	36.0
LUX	9.6	13.7	1.1	27.2	5.0	1.0	0.1	35.9	-4.6	12.8
NLD	15.3	58.2	3.5	36.1	6.2	28.1	2.7	45.0	5.1	38.0
POL	3.8	47.2	10.6	28.6	11.3	21.5	-6.0	39.7	-6.7	33.7
PRT	31.8	66.3	4.6	22.8	-5.6	9.9	6.3	37.6	-0.8	27.2
SWE	3.5	38.3	-10.8	26.7	-9.3	19.1	-6.7	44.6	-5.3	38.9
<b>Mean</b>	<b>21.5</b>	<b>56.8</b>	<b>3.1</b>	<b>29.8</b>	<b>2.9</b>	<b>16.8</b>	<b>1.4</b>	<b>43.0</b>	<b>0.5</b>	<b>32.4</b>

Note: For countries for which labour tax indicators are available only for a shorter period, the changes refer to the respective start date (see text). The tax burden is defined as personal income tax and employee social security contributions at average earnings as a percentage of gross earnings. The tax wedge is defined as the difference between total labour cost to the employer and the corresponding net take home pay of a worker with average earnings as a percentage of total labour costs. For the definition of country codes see footnote 7.

Table 1 provides information on past developments in labour taxation and general government gross debt ratios. Both government debt ratios and labour taxation as measured by tax burdens and tax wedges rose between 1979 and 2008 at the sample average (by 21.5 percentage points to 56.8% of GDP).<sup>9</sup> Over these 29 years, debt ratios fell only in Ireland (by almost 24 percentage points to 44% of GDP in 2008) and the UK (by slightly more than 1 percentage point to 52% of GDP in 2008). In all other

<sup>9</sup>Since a full set of data for Czech Republic and Poland (Hungary) is only available from 1996 (2000) onwards the respective differences are computed relative to these years. Likewise for Luxembourg labour tax indicators could only be computed from 1990 onwards and for France, tax wedges are only available from 1995 onwards.

countries, debt ratios rose, with the strongest increases observed in Greece (by almost 77 percentage points to about 99% of GDP), Italy (by 47 percentage points to 106% of GDP) and France (by 47 percentage points to 68% of GDP). At the same time, in the majority of countries, labour taxation increased. Only in Ireland, Sweden and the United Kingdom all labour tax indicators considered here were lower in 2008 than at the beginning of the respective sample period.

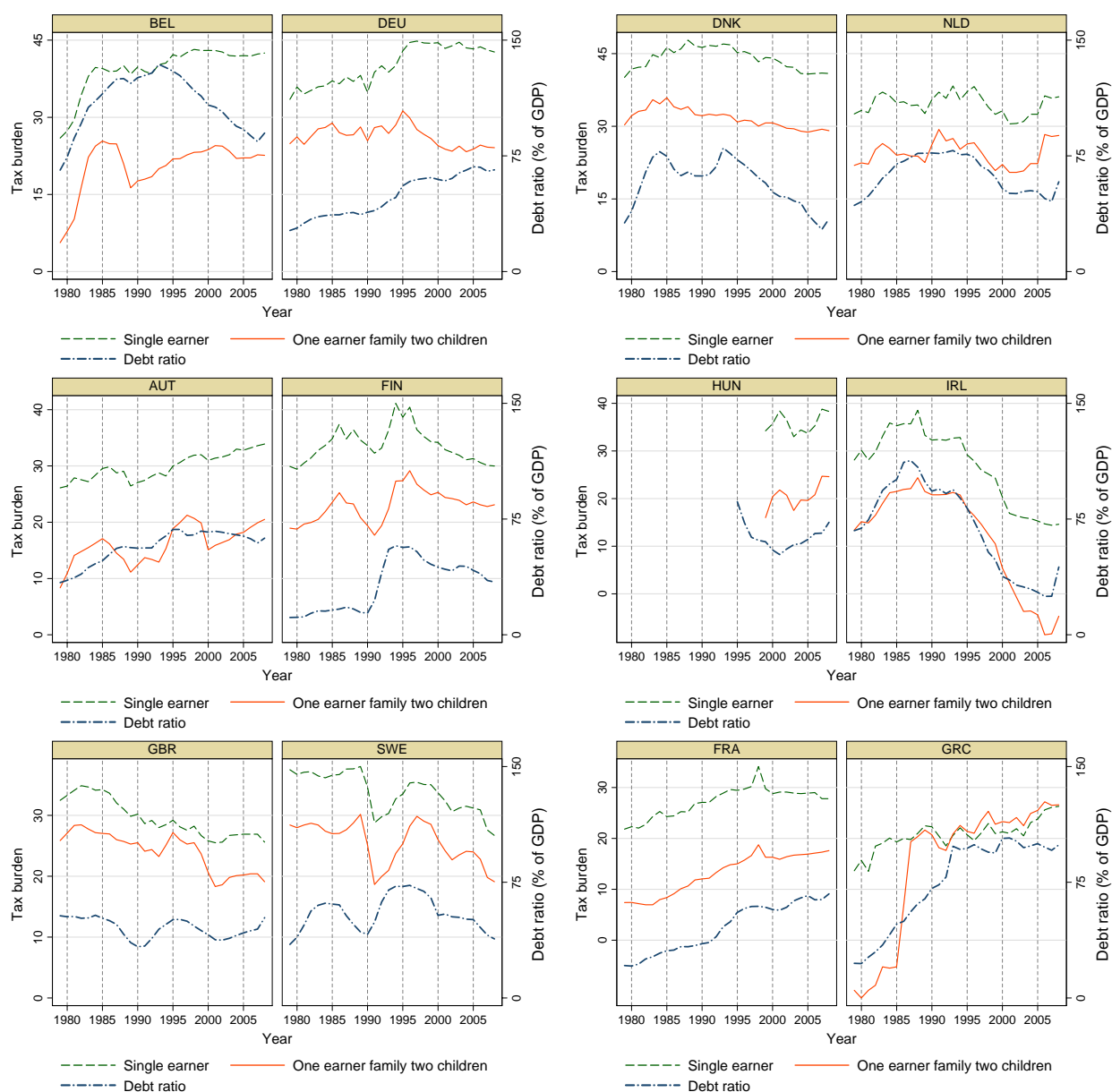
The ensuing empirical analysis tests the relationship between debt and labour taxation. To allow for a first illustrative assessment of this relationship, Figure 1 plots tax burdens and debt ratios against time for each country.<sup>10</sup> Upon inspection, in some countries debt ratios and labour tax burdens seem to have evolved in a strikingly similar manner over time. For example, the marked increase in Finland's debt ratio from 1991 onwards was followed by a distinct switch from declining to rising labour tax burdens a year later. Five years later, the variables simultaneously reach their peaks and then decline at a roughly similar pace. While episodes of similar patterns between labour taxation and debt developments may be observed in further countries (such as Sweden where the labour tax indicators and the debt ratio moved almost in parallel), the charts only in a few cases point to clearly divergent developments (e.g. in Belgium a decrease in the debt ratio since the mid-1990's coincided with a secular increase in labour taxation).

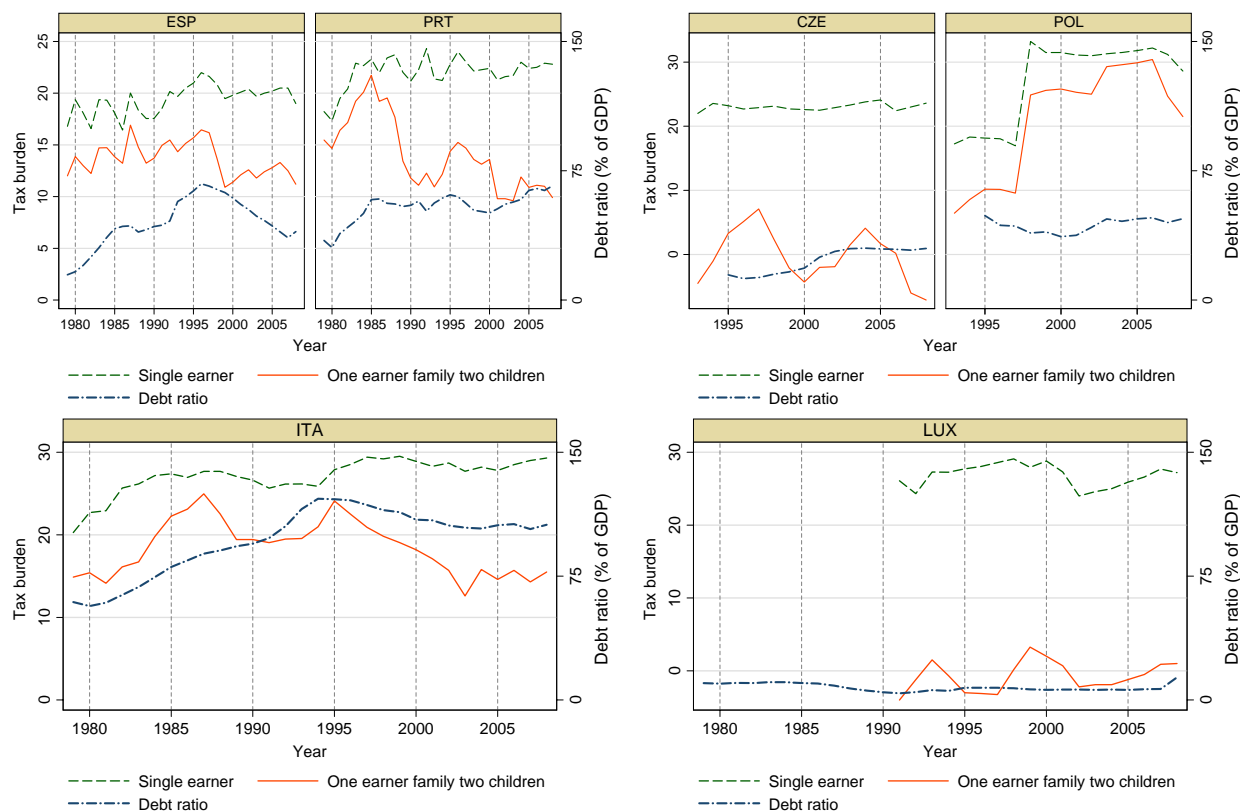
As a further illustrative exercise, Figure 2 plots tax burdens in 2008 against debt ratios. It shows that the cross-country variation in both tax rates and debt ratios is relatively large. For example, in 2008, the debt ratio ranged from around 15% of GDP in Luxembourg to 106% in Italy. At the same time, the labour tax burden for a single earner without children ranged from 15% in Ireland to 43% in Belgium and Denmark. Overall, labour taxes for one-earner families with two children tend to be lower than for single earners. The labour tax rate for a one-earner family with two children was lowest in the Czech Republic (-7%, indicating a labour subsidy from the government) and highest in Denmark and the Netherlands (29%). The chart points to a small positive correlation between the two variables, indicating that across this sample of 18 EU countries high debt ratios also tend to go along with relatively high tax rates on labour. Qualitatively similar results obtain when looking at tax wedges. While the causal interpretation of this observation should not be over-emphasised, Section 3 provides an in-depth analysis of the relation between labour taxation and general government debt.

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<sup>10</sup>Corresponding charts for labour tax wedges are available upon request.

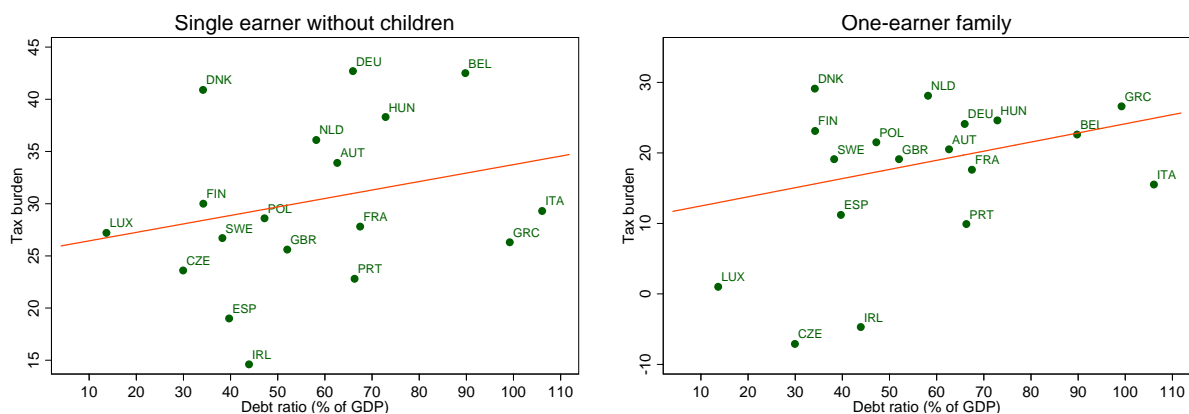
Figure 1: Evolution of debt ratios and labour tax indicators over the last three decades





Note: For the definitions of tax burden and tax wedge see footnote for Table 1. For the definition of country codes see footnote 7.

Figure 2: Relationship between debt ratios and labour tax rates



Note: The regression line is based on a simple regression of tax burdens on debt ratios over the entire sample period. The slope parameter of the debt ratio in both charts is around 0.1 with (cluster-robust) standard errors of around 0.05. For the definitions of tax burden and tax wedge see footnote for Table 1. For the definition of country codes see footnote 7.



### 3 Empirical Model

To analyse the impact of changes in the government debt burden on labour taxation we estimate the equation:

$$\tau_{i,t}^k = c_i^k + \beta^k \tau_{i,t-1}^k + \gamma^k d_{i,t} + \delta^k y_{i,t-1} + \theta^k w_{i,t-1} + v^k b_{i,t} + \varphi^k p_{i,t-1} + u_{i,t}^k$$

where  $\tau_{i,t}^k$  refers to the respective indicator of labour taxation  $k$  (*i.e.* tax burden for single earners, tax burden for a one-earner family with children, and tax wedges for both categories) for country  $i$  in period  $t$ ;  $c_i^k$  is a country-specific intercept to account for unobserved, time-invariant country characteristics that may be correlated with both the dependent and the explanatory variables;  $\tau_{i,t-1}^k$  is the lagged dependent variable, included to allow for the possibility of tax smoothing, which suggests that governments seek to keep distortive tax rates constant over time to minimise the inter-temporal excess burden. While the “strict” tax smoothing hypothesis, *i.e.* that the lagged tax rate fully explains the current tax rate up to a white noise error term, has been challenged empirically,<sup>11</sup> it is generally found to exert a statistically significant and economically relevant impact. Since past taxing decisions and debt developments in turn are likely to be interrelated, omitting  $\tau_{i,t-1}^k$  thus could bias the results.<sup>12</sup>

The coefficient of main interest is  $\gamma^k$  which captures the response of labour taxation to changes in the “debt burden”  $d_{i,t}$ . The definition of the debt burden differs across the subsets of specifications presented below. In the first group (Tables 2 and 3) it is measured as the debt-to-GDP ratio at the end of the previous year. In the second group of specifications (Tables 4 and 5),  $d_{i,t}$  is defined as the interest expenditure-to-GDP ratio. This measure may indeed capture the constraining effect of higher debt burdens on the budgetary room for manoeuvre more closely than debt-to-GDP ratios as the debt servicing cost immediately enters the budget constraint.<sup>13</sup> Moreover, governments’ refinancing costs as captured by the interest expenditure-to-GDP ratio account for variations in interest rates which affect the budgetary position even when the debt ratio is unchanged.

As a control variable, we include the primary fiscal balance net of labour tax revenue as a percentage of GDP,  $b_{i,t}$ , to control for the possibility that governments react to changes in the debt ratio also via budgetary items other than labour taxes (*e.g.* on the expenditure side). Furthermore, we include the lagged dependency ratio,  $p_{i,t-1}$ , defined as the number of persons older than 64 or younger than 15 as a percentage of

<sup>11</sup>See for example, Sahasakul (1986), Trehan and Walsh (1988), Roubini and Sachs (1989), Bizer and Durlauf (1990, 1991), and Kenny and Toma (1997).

<sup>12</sup>To control for unobserved developments common to all countries that could affect both dependent and explanatory variables, we included a linear time trend in several regressions. Furthermore, to correct for the methodological difference for computing labour tax indicators for the period before and after 2000, we added a time dummy that is one from 2000 onwards and zero before 2000. Since neither of these variables had a statistically significant effect, they were not included in the final specifications.

<sup>13</sup>See *e.g.* Bernoth *et al.* (2004) and Bertola (2010).

the working age population. A lower share of working-age persons implies that a given level of labour tax revenue has to be generated from higher tax rates. At the same time, the age structure is a commonly used proxy to capture voters' preferences on fiscal policies and in our analysis serves to complement the fixed effects which only account for time-invariant preference heterogeneity.<sup>14</sup> In addition, the first lag of nominal GDP growth is included since it might influence the government's stance towards distortionary taxation and at the same time affect developments in the debt and the interest expenditure-to-GDP ratio. As another control variable, we include the first lag of nominal wage growth,  $w_{i,t-1}$ , to account for the fact that in a progressive tax system, changes in nominal wages may affect marginal labour tax rates and thus average taxation "mechanically" when households switch income brackets.

Given the drawbacks of the commonly used estimators for dynamic panel models with unobserved heterogeneity, the below analysis uses a range of econometric procedures, including a least squares dummy variable (LSDV) estimator where the explanatory fiscal variables ( $b_{i,t}$  and  $d_{i,t}$ ) are instrumented with several lags of their own levels,<sup>15</sup> a generalised method of moments (GMM) estimator (again treating all fiscal variables as endogenous), and a bias-corrected least squares dummy variable (LSDVC) estimator. Since each of these is subject to specific shortcomings, using a variety of estimators may reduce the risk that the choice of econometric procedure unduly influences the main conclusions from the analysis.

<sup>14</sup> See Bergstrom and Goodman (1973) for the seminal contribution to this literature and Overesch and Rincke (2009) as well as Furceri and Karras (2010) for a similar choice of explanatory variables in empirical analyses of tax policy in OECD countries.

<sup>15</sup> As regards the primary fiscal balance net of labour tax revenue, instrumentation appears warranted since this variable is determined in parallel with labour tax policies in the budgetary process, thus giving rise to immediate simultaneity concerns. Similar concerns apply to the lagged debt ratio since governments are likely to bear in mind some type of inter-temporal budget constraint so that future taxing decisions affect current policies and vice versa. Hence, also lagged fiscal variables might be determined simultaneously with current tax rates and therefore should be instrumented, as well. Instrumenting the fiscal variables with their own lags is a common response to this concern in the related literature (see e.g. Galí and Perotti, 2003). The strategy is based on the identifying assumption that beyond a certain time horizon the interrelation between past and current policies becomes negligible. In our specifications, overidentification tests suggested a 2-lag structure for both the debt and the primary balance less direct taxes variable, except for the tax burden for one-earner families specification where two additional lags of the debt variable had to be included. Intuitively, the instrumentation of the fiscal variables with two lags of their own levels may not appear sufficient to fully exclude that the coefficients still capture some simultaneity between explanatory and dependent variables arising from the inter-temporal nature of budgetary decisions. However, coefficients did not display a strong sensitivity to the inclusion of further lags in the instrument set.

## 4 Results and discussion

Table 2 reports the estimation results obtained from the LSDV estimator with the debt ratio as the main explanatory variable.<sup>16</sup> For each of the four labour tax indicators the results point to a significant positive response of labour taxation to rising debt ratios. To be specific, an increase in the debt ratio by one percentage point on average raises labour tax burdens by 0.04 percentage point for single earners and by 0.02 percentage point for one-earner families in the subsequent year. Similar responses to changes in the debt ratio are found for the labour tax wedges. As expected, labour taxation is highly persistent with coefficients of the lagged dependent variables ranging from 0.68 to 0.84. As a consequence, the long-run effect of an increase in the debt ratio is substantially stronger than the short-run impact, with coefficients amounting to between 0.12 and 0.14.<sup>17</sup> Based on the OECD estimates for annual gross earnings these coefficients can be translated into the reduction in net income that is caused by the typical labour tax response to a change in debt. For example, a one percentage point rise in the debt-to-GDP ratio goes along with an increase in the labour tax burden of a single earner (one-earner family) by around €14 (€7) in the subsequent year at the euro area average; over the long run, the associated cumulative increase in the tax burden would go to €44 (€41).

As Table 2 shows, the coefficients of the primary balance net of direct taxes display a significant negative impact across all labour tax indicators, indicating that an improvement in a country's budgetary position tends to reduce the level of distortionary labour taxation. Moreover, the dependency ratio displays a statistically significant positive effect across all labour tax indicators (except for the tax burden for single earners where the p-value is just above 0.10). This suggests that the higher the share of non-working age people in the economy the stronger the tendency for governments to increase labour taxation. The additional control variables do not display statistically significant coefficients.

The relevant specification tests support the identification strategy. The instrumental variables pass the overidentification test; the null hypothesis of weak instruments is clearly rejected; and in several specifications we reject the null hypothesis that the instrumented variables are exogenous or the p-values of the corresponding test statistic are only slightly above 10% thus suggesting the use of instrumental variable estimation.

As pointed out by Nickell (1981), the LSDV estimator is not consistent in autoregressive dynamic panel data specifications. The resulting bias tends to decrease with the time dimension of the panel (which is relatively large in our dataset) and

<sup>16</sup>The econometric analysis was performed using Stata.

<sup>17</sup>The long-term coefficient is defined as the short-term coefficient of the debt variable divided by one minus the coefficient of the lagged dependent variable. It measures the cumulated long-term response of the respective labour tax indicator to a change in the debt variable that is not reversed in subsequent years.

Table 2: **Regression results based on least squares dummy variables estimator**  
(debt ratio as main explanatory variable)

	Tax burden		Tax wedges	
	<i>single earner</i>	<i>one-earner family</i>	<i>single earner</i>	<i>one-earner family</i>
<i>Lagged dependent variable</i>	0.69*** (0.09)	0.84*** (0.02)	0.68*** (0.08)	0.83*** (0.04)
<i>Debt ratio (first lag)</i>	0.04** (0.02)	0.02* (0.01)	0.04** (0.02)	0.03* (0.01)
<i>Primary balance ratio net of direct taxes</i>	-0.15*** (0.05)	-0.23*** (0.05)	-0.13** (0.06)	-0.19*** (0.05)
<i>Dependency ratio (first lag)</i>	0.12 (0.08)	0.13** (0.06)	0.12* (0.07)	0.11* (0.07)
<i>Growth rate (first lag)</i>	0.02 (0.04)	-0.01 (0.05)	0.06 (0.04)	0.05 (0.05)
<i>Wage rate (first lag)</i>	0.05 (0.04)	0.04 (0.04)	-0.00 (0.05)	-0.00 (0.04)
<i>Debt ratio (long-run coefficient)</i>	0.13*** (0.03)	0.12** (0.05)	0.12*** (0.03)	0.14** (0.06)
<i>Observations</i>	399	371	385	383
<i>Sargan/Hansen test of overidentifying restrictions (p-value)</i>	0.81	0.29	0.87	0.23
<i>Difference in Sargan/Hansen test for endogenous regressor (p-value)</i>	0.05	0.33	0.05	0.19
<i>Kleibergen-Paap rk Wald F-Statistic</i>	204.3	103.0	210.3	247.5

Note: All estimates are obtained from two-stage least squares estimation including country- and time-fixed effects. Excluded instruments for the lagged debt ratio and the primary balance less direct taxes are the first two lags of these variables. In the estimation of the tax burden for one-earner families four lags of the debt ratio variable are included to pass the overidentification test. Cluster-robust standard errors in parentheses. \*\*\* significant at 1% level, \*\* significant at 5% level, \* significant at 10% level. For the definitions of tax burden and tax wedge see footnote for Table 1.

primarily affects the coefficient of the lagged dependent variable whereas the other coefficients (which are of main interest for our analysis) are less affected. Hence, the results reported in Table 2 may serve as an interesting starting point for gauging the effect of changes in the debt ratio on labour taxation. However, Monte Carlo simulations suggest that even for relatively long panels the Nickell bias may still be sizeable.<sup>18</sup>

To address these robustness concerns, we test alternative estimators. Given the high persistence in the dependent variable, the Anderson and Hsiao (1981) estimator (which would be a natural starting point for this analysis) only produces very weak instruments in our sample. While we tested GMM estimation techniques as an alternative option, this approach carries the risk of proliferation and weakness of instruments due to the large time dimension of our panel relative to its cross section. This in turn would reinforce the dynamic panel bias affecting the LSDV estimates.<sup>19</sup> This problem

<sup>18</sup>For example, Judson and Owen (1999) show that for a sample size and structure comparable to ours the relative bias may still amount up to 20% of the true coefficient for the explanatory variables.

<sup>19</sup>See Holtz-Eakin, Newey and Rosen (1988) and Arellano and Bond (1991) for the seminal contributions to the literature on GMM estimation. See Roodman (2009) for a discussion of the common

is likely to remain relevant even when strongly restricting the number of instrumental variables. For illustrative purposes, Table A.1 in the Annex presents the Arellano-Bond (1991) difference GMM estimator limiting the instrument set to the first lags of the variables to be instrumented. For all labour tax indicators the coefficient for the lagged dependent variable is substantially below the one obtained from the LSDV specification. The coefficients for the lagged debt ratio, ranging between 0.05 and 0.07, in turn are markedly above the LSDV estimates. Since we would theoretically expect the Nickell bias to be negative for the lagged dependent variable and positive for the debt ratio,<sup>20</sup> these results indicate that GMM estimation indeed may not be suitable to eliminate the bias suspected for the LSDV estimates.

As an alternative way to address the Nickell bias while avoiding the above pitfalls of GMM estimation, we re-estimate the model using the bias-corrected LSDV estimator for unbalanced panels (LSDVC) developed and implemented in Stata by Bruno (2005), which explicitly corrects coefficient estimates for an approximation of the bias term.<sup>21</sup> As shown in Table 3, results are qualitatively similar to those obtained from LSDV estimation, with the coefficient of the lagged debt ratio again ranging from 0.02 to 0.04. The estimated coefficients for the lagged dependent variables are somewhat above the ones estimated in the LSDV specification, which is consistent with the conjecture that the latter may be biased. The long-run coefficients of the debt ratio also exceed those found in the LSDV specification, except for the regression on the tax burden for single earners where it has the same value. The coefficients for the control variables are of the same sign and of a broadly similar magnitude.

These results also merit discussion. In particular, the advantage of the corrected LSDV estimator has to be traded-off against the drawback that it does not allow for endogenous regressors apart from the lagged dependent variable. Hence, we need to assume that governments' decisions are not subject to an inter-temporal budget constraint, thus taking past fiscal policy as independent of today's taxing decision which might contrast with intuition. Yet, given that the coefficients of main interest only differ little between the two specifications we suspect that ignoring potential interdependencies of policy choices across time does not severely affect results in the context of the present analysis.

As discussed in section 3, interest payments are an additional relevant factor in determining the need for governments to respond to deteriorating fiscal positions. Therefore, Tables 4 and 5 present estimates for the LSDV and bias-corrected LSDV specifications in which now the debt-to-GDP ratio has been replaced by the interest payments-to-GDP ratio as the main explanatory variable. While overall the results are qualitatively unchanged, the coefficients of the interest payments are markedly higher

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pitfalls of GMM estimation for panels with a large time dimension relative to its cross section.

<sup>20</sup>See Nickell (1981) for derivations of the direction of the dynamic panel bias.

<sup>21</sup>This estimator provides an extension of methods developed by Kiviet (1995, 1999), Judson and Owen (1999), and Bun and Kiviet (2003) to unbalanced panels.

Table 3: **Regression results based on bias-corrected least squares dummy variables estimator (debt ratio as main explanatory variable)**

	Tax burden		Tax wedges	
	<i>single earner</i>	<i>one-earner family</i>	<i>single earner</i>	<i>one-earner family</i>
<i>Lagged dependent variable</i>	0.79*** (0.03)	0.89*** (0.02)	0.75*** (0.05)	0.89*** (0.04)
<i>Debt ratio (first lag)</i>	0.03*** (0.01)	0.02** (0.01)	0.04*** (0.01)	0.02** (0.01)
<i>Primary balance ratio net of direct taxes</i>	-0.10*** (0.02)	-0.17*** (0.03)	-0.09*** (0.04)	-0.13*** (0.04)
<i>Dependency ratio (first lag)</i>	0.06* (0.03)	0.07* (0.04)	0.05 (0.04)	0.05 (0.04)
<i>Growth rate (first lag)</i>	0.01 (0.03)	-0.01 (0.05)	0.04 (0.05)	0.01 (0.05)
<i>Wage rate (first lag)</i>	0.04 (0.03)	0.05 (0.04)	0.02 (0.05)	0.02 (0.05)
<i>Debt ratio (long-run coefficient)</i>	0.13*** (0.03)	0.18*** (0.07)	0.15*** (0.03)	0.19*** (0.06)
<i>Observations</i>	413	413	398	398

Note: Bias correction is initialised by Arrelano Bond estimator. Bootstrapped standard errors in parentheses. Bias correction up to order  $O(1/NT^2)$ . \*\*\* significant at 1% level, \*\* significant at 5% level, \* significant at 10% level. For the definitions of tax burden and tax wedge see footnote for Table 1.

than for the debt ratio. In the LSDV specification a one percentage point increase in the interest expenditure-to-GDP ratio is associated with an increase in the labour tax indicators between 0.17 (for the tax burden of single earners) and 0.24 (for the tax wedge of one-earner families). In the bias corrected LSDV estimates the coefficients are similar ranging from 0.16 to 0.22. The long-run coefficients are also clearly above those for the debt ratio, reaching a maximum of 1.76 in the regression for the tax burden for one-earner families. Again translating this into the impact on an average household, the associated cumulative increase in the tax burden would amount to almost €600.



Table 4: **Regression results based on least squares dummy variables estimator**  
(interest expenditure ratio as main explanatory variable)

	Tax burden		Tax wedges	
	<i>single earner</i>	<i>one-earner family</i>	<i>single earner</i>	<i>one-earner family</i>
<i>Lagged dependent variable</i>	0.77*** (0.05)	0.82*** (0.02)	0.72*** (0.07)	0.81*** (0.03)
<i>Interest expenditure ratio (first lag)</i>	0.17** (0.08)	0.23* (0.09)	0.22** (0.09)	0.24*** (0.09)
<i>Primary balance ratio net of direct taxes</i>	-0.15*** (0.04)	-0.22*** (0.04)	-0.12** (0.06)	-0.18*** (0.05)
<i>Dependency ratio (first lag)</i>	0.13* (0.07)	0.19*** (0.06)	0.16** (0.07)	0.19*** (0.07)
<i>Growth rate (first lag)</i>	-0.00 (0.04)	-0.03 (0.05)	0.03 (0.03)	0.02 (0.04)
<i>Wage rate (first lag)</i>	-0.03 (0.04)	-0.01 (0.05)	-0.07*** (0.03)	-0.08** (0.04)
<i>Interest expenditure ratio (long-run coefficient)</i>	0.71*** (0.30)	1.30*** (0.44)	0.79*** (0.23)	1.26*** (0.45)
<i>Observations</i>	400	370	386	344
<i>Sargan/Hansen test of overidentifying restrictions (p-value)</i>	0.34	0.33	0.23	0.23
<i>Difference in Sargan/Hansen test for endogenous regressor (p-value)</i>	0.13	0.43	0.19	0.47
<i>Kleibergen-Paap rk Wald F-Statistic</i>	208.2	100.9	271.4	215.8

Note: All estimates are obtained from two-stage least squares estimation including country- and time-fixed effects. Excluded instruments for the lagged interest expenditure ratio and the primary balance less direct taxes are the first two lags of these variables. Cluster-robust standard errors in parentheses. \*\*\* significant at 1% level, \*\* significant at 5% level, \* significant at 10% level. For the definitions of tax burden and tax wedge see footnote for Table 1.

Table 5: **Regression results based on bias-corrected least squares dummy variables estimator** (interest expenditure ratio as main explanatory variable)

	Tax burden		Tax wedges	
	<i>single earner</i>	<i>one-earner family</i>	<i>single earner</i>	<i>one-earner family</i>
<i>Lagged dependent variable</i>	0.83*** (0.03)	0.88*** (0.03)	0.79*** (0.04)	0.88*** (0.03)
<i>Interest expenditure ratio (first lag)</i>	0.16*** (0.05)	0.22*** (0.07)	0.22*** (0.06)	0.18** (0.07)
<i>Primary balance ratio net of direct taxes</i>	-0.09*** (0.02)	-0.16*** (0.03)	-0.07** (0.04)	-0.12*** (0.04)
<i>Dependency ratio (first lag)</i>	0.08** (0.04)	0.12** (0.05)	0.09** (0.04)	0.09** (0.04)
<i>Growth rate (first lag)</i>	-0.03 (0.03)	-0.03 (0.04)	0.00 (0.05)	-0.01 (0.05)
<i>Wage rate (first lag)</i>	0.01 (0.03)	0.01 (0.05)	-0.03 (0.05)	-0.01 (0.05)
<i>Interest expenditure ratio (long-run coefficient)</i>	0.94*** (0.24)	1.76*** (0.44)	1.03*** (0.26)	1.56*** (0.48)
<i>Observations</i>	413	413	398	398

Note: Bias correction is initialised by Arrelano Bond estimator. Bootstrapped standard errors in parentheses. Bias correction up to order  $O(1/NT^2)$ . \*\*\* significant at 1% level, \*\* significant at 5% level, \* significant at 10% level. For the definitions of tax burden and tax wedge see footnote for Table 1.

## 5 Conclusions

This paper investigates the relationship between general government gross debt and labour taxation for a panel of 18 EU countries over the period 1979-2008. The degree of distortionary labour taxation is proxied by the composite OECD indicators of the tax burden and the tax wedge, both for single earners and one earner families with two children at average income levels. Our econometric estimates show a systematic positive response of labour taxation to changes in debt ratios and to changes in the interest expenditure governments have to pay on their debt.

Available information on the EU countries' exit strategy to the crisis seems to suggest that several countries target higher consumption taxes to consolidate their public finances. Against this background, an extension of the analysis presented in this paper would be to more specifically model the overall composition of budgetary adjustment in response to sustainability shocks in a dynamic framework.

## Appendix

Table A.1: **Regression results based on difference GMM estimator**

	Tax burden		Tax wedges	
	<i>single earner</i>	<i>one-earner family</i>	<i>single earner</i>	<i>one-earner family</i>
<i>Lagged dependent variable</i>	0.54*** (0.15)	0.71*** (0.09)	0.31 (0.23)	0.68*** (0.09)
<i>Debt ratio (first lag)</i>	0.05** (0.02)	0.04** (0.02)	0.07** (0.03)	0.04* (0.02)
<i>Primary balance ratio net of direct taxes</i>	-0.18*** (0.05)	-0.22*** (0.08)	-0.10 (0.09)	-0.25*** (0.07)
<i>Dependency ratio (first lag)</i>	0.06 (0.09)	0.14 (0.12)	0.13 (0.11)	0.07 (0.12)
<i>Growth rate (first lag)</i>	0.10** (0.05)	0.10* (0.06)	0.14** (0.06)	0.12* (0.06)
<i>Wage rate (first lag)</i>	-0.04 (0.06)	0.02 (0.07)	-0.02 (0.06)	-0.01 (0.06)
<i>Observations</i>	395	395	380	380
<i>AR test (<math>H_0</math>=no autocorrelation)</i>				
<i>AR(1) p-value</i>	0.01	0.01	0.01	0.00
<i>AR(2) p-value</i>	0.17	0.31	0.14	0.15

Note: Instrument set is limited to the first lag of the instrumented variables. Robust standard errors in parentheses.  
 \*\* significant at 1% level, \* significant at 5% level, \* significant at 10% level. For the definitions of tax burden and tax wedge see footnote for Table 1.

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