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Does the EU financing system contribute to shadow economic activity?

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Abstract

Financial contributions to the EU budget depend basically on official GDP. This means that countries with higher shadow economic activity contribute less than they should contribute in a system based on actual GDP and therefore could reduce their incentive to fight against such activities. In this paper we investigate if the EU financing system really has an influence on the intensity with which governments in EU member states fight against shadow economic activity. We find that the EU net contributors significantly fight more intensively against shadow economic activity while EU net receivers significantly fight less. As a result, shadow economic activity is higher in net receiver and lower in net contributor countries than it were in comparison with a scenario of nationally balanced EU funding. Quantitatively and averaged over the time period 2001-2007, the diagnosed effect amounts to a stimulation of hidden economic activity by almost 10% for particular economies.

JEL classification: C31, D63, F33, H21, H26.
Keywords: EU financing system, shadow economy, tax auditing.

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1 Introduction

Shadow or underground economic activity is an often unavoidable consequence of economic activity. The extent of hidden economic activities in a particular country depends on variables that can be influenced by the government as well as on factors that are beyond its control. Among the former one can encounter the tax rate, the auditing policy and the penalty system. Among the latter we have tax moral and the confidence into the agents working in the public sector. Both certainly depend on the level of corruption in the public sector. Since tax rates reflect country specific tax moral, confidence and preferences for public goods and income redistribution, the relative size of the shadow economy is also varying across countries. The intensity at which governments are fighting against underground economic activities depends on the benefits and costs. Among the benefits we have that a reduction of shadow economic activities allows a more just income distribution and a more efficient provision of public goods. The costs of reducing underground economic activity depend on the efficiency of the tax administration with regard to auditing, enforcement of tax debts and the severity of penalties. Owing to this heterogeneity cross-national comparisons of hidden economic activity, though of theoretical and empirical interest, appear to have no overall policy implications. This changes in the presence of a cross-national financing system in which contributions are based on the size of the official economy such as in the European Union (EU).

The main part of a country's contribution to the EU budget is based on official gross national product (GNP). Heterogeneity in the sizes of the member states' shadow economy, therefore, has a clear consequence: countries with a small shadow sector pay too much and countries with relatively large shadow economies pay too few. Additionally, the amounts that member states receive from the EU budget are also negatively correlated with official GNP. In such a scenario countries have lower incentives to fight against shadow economic activities. Reducing their shadow economy means paying higher contributions to the EU budget whose benefits are mainly for the citizens of other EU economies. In this paper we investigate theoretically and empirically the impact that the EU financing system exerts on shadow economic activity in the member states before the 2004 enlargement. In particular, we analyze how the EU financing system influences taxation and the intensity to fight against hidden economic activity. We find that in its current form the EU financing system has a significant influence on all these most likely jointly endogenous variables. Especially, EU receiver countries tolerate higher states of shadow economic activity in comparison with an artificial scenario of nationally balanced EU financing.

To highlight the importance of the extent of the shadow economic activities in different EU member states on their financial contributions to the EU budget, we calculate the difference between actual and shadow economy corrected contributions.[1] The EU budget is raised from three principal sources: traditional own resources, resources based on value added tax (VAT)

[1]Calculations are done for 2004 when the member states coincided with the set of economies on which our empirical analysis is based.

and those based on GNP. Furthermore, it exists a reduction of the financial contribution of the United Kingdom (the so-called UK correction). Traditional own resources consist of custom and agricultural duties and sugar levies and account for approximately 12% of total EU revenue. The VAT own resources is levied on member states' VAT bases that is harmonized in accordance with EU legislation. The contribution of each member state is then based on a uniform percentage of its harmonized VAT revenue. However, the VAT base is capped at 50% of each member states' GNP. This correction pretends to avoid that poorer member states pay too much compared to their contributive capacity since consumption (and VAT) make up a higher percentage of GNP in relatively less prosperous countries.[2] This part accounts for around 15% of total EU revenue. The GNP own resources are used to balance the EU budget and are based on the same percentage rate applied to the member states official GNP. This part is around 73% of the EU budget and, thus, it is its most important financial source.

The UK correction is a specific mechanism introduced in 1985 to correct the budgetary imbalance of the UK. Basically, it reimburses the UK 2/3 of the difference between its share in EU expenditures and its contributions to the EU budget. The reduction of the UK's contribution is financed by the other member states where the contributions of Austria, Germany, the Netherlands and Sweden are restricted to 25% of its value without the correction.

In Table 1 we have recalculated the EU member states' contributions based on estimates

[2] In the 2004 general EU budget the VAT own resources of the following member states were capped: Greece, Ireland, Portugal and Spain.

of inofficial economic activity (Schneider, 2009). When calculating the VAT own resources we have applied the same correction factors to the VAT base and the GNP base. Thus, the member states whose VAT contributions are capped are the same as in the 2004 official EU budget. The GNP own resources have been calculated on the basis of a common percentage such that the total EU budget remains the same as the 2004 official total budget. The UK correction has been calculated based on the same formulae as applied in the EU budget (see EUR-Lex, 2004).

From the results we see that the countries that contributed too much because of heterogeneous shadow economic activities in the EU member states are Austria, Denmark, Finland, France, Germany, Ireland, the Netherlands and the UK. The three countries with highest absolute imbalance are, in this order, the UK, France and the Netherlands. If we consider the imbalance relative to actual contributions, countries with highest negative rates are Austria (-4.73%), the UK (-4.70%), and the Netherlands (-3.00%). In absolute terms actual and adjusted contributions differ for these countries by 102, 587 and 161 million Euro, respectively. The countries that benefitted most from an understated GNP in absolute terms are Italy, Spain and Greece. Also in relative terms Greece (8.55%), Italy (6.15%) and Spain (3.69%) are those with highest positive rates. Though these estimates should be taken with care they give a first and quantitative hint at the implications of shadow economic activity in the EU member states on their financial contributions. Furthermore, the real impact might be even higher for two reasons. First, as mentioned before, the VAT own resources of many of the countries with highest shadow economies are capped. Since shadow economic activity can be expected to affect much more the total GNP than the VAT base, this would imply that the caps applied in these countries are proportionally higher or that even no caps will be applied. This could imply a marked increase in the contributions to the EU budget based on VAT own resources of these countries. Second, we have only analyzed the member states' contributions to the EU budget but not the expenditures of the EU in the member states which is negatively correlated with the official per capita GNP. Thus, a higher GNP usually not only implies an increase in a country's contributions but also a reduction of the transfers from the EU.

Though our empirical results are based on data for EU member states before the 2004 enlargement, most recent budget imbalances in the EU are even larger as can be seen in Table 2. We find that in 2009 in absolute terms some member states pay and receive up to 600 million Euro to much. In relative terms member states could see their contributions to be increased (reduced) up to 17% in comparison with a scenario where actual instead of official economic figures provide the basis for country specific contributions.

To understand how cross-national transfers, as in the EU financing system, can affect a government's incentives to fight against unofficial economic activities we set up a theoretical model of optimal linear income taxation and optimal tax auditing. In this model individuals choose labor supply and their income declaration. Taking into account the individual's behavior, the government decides the optimal tax rate and income auditing probability to maximize social welfare under a budget constraint. The budget is used for income redistribution and to finance public goods. Furthermore, the budget requirement is increased (decreased) by transfers to (from) the EU. From the model we obtain testable predictions of the effects of a transnational financing system on auditing probabilities, tax rates and shadow economic activity. In the empirical part we use a system of simultaneous equations to estimate the impacts of different exogenous variables on tax rates, an index that accounts for the intensity with which governments fight against shadow economic activity and shadow economic activity itself. Our exogenous variables are related to per capita income, unemployment, the social budget, corruption, and the extent of EU transfers. The cross section of countries comprises the EU member states (except Luxembourg) before the 2004 enlargement. Robustness checks are performed for several cross sections over the period 2001-2007.

The main result from our theoretical model is the prediction that countries that are EU net contributors, and therefore have higher revenue requirements, will have higher tax rates, a higher auditing intensity and less shadow economic activity. The same holds for countries that have a higher proportion of non-taxpayers and higher social budgets. On the empirical side, most predictions of the theoretical model are supported by the reduced form model representation qualitatively and significantly. We also compare the actual financing status of the EU with a counterfactual scenario that formalizes zero net budget positions. Quantitatively, it turns out that, on the one hand, single factual EU receivers would face a reduction (an increase) of shadow economic activity (the tax burden) of about 10% (20%). On the other hand, particular factual EU payers would benefit from a reduction of the tax burden of up to 10% in the counterfactual situation.

Though the analysis of the impact of an international financing system on the incentives to fight against shadow economic activities is new, some aspects of our analysis are related to previous work. The theoretical set up in Section 2 builds on established models of income tax evasion and optimal taxation. The first model on income tax evasion is Alligham and Sandmo (1972). Analyzing potential determinants of the income declaration of a risk averse individual they show that the impact of the marginal tax rate on tax evasion is unclear and that both a higher penalty rate and a higher auditing probability decrease tax evasion. However, Yitzhaki (1974) shows that a higher marginal tax rate increases tax compliance if the penalty is proportional to the evaded tax and not only to the evaded income, which is the case in many countries. Providing a baseline for our approach, optimal linear income taxation has been analyzed by Sheshinski (1972) and Dixit and Sandmo (1977) among others. An integration of tax evasion into the analysis of optimal income taxation has been proposed by Sandmo (1981) and Cremer and Gahvari (1994). Closest to the approach followed in this paper is the model introduced in Cremer and Gahvari (1994). They analyze the effect of tax evasion on optimal linear income taxation when individuals can influence the probability of being caught through concealment payments. The main differences to our model setup are, however, that we have no concealment and that the government does not determine the guaranteed income that we assume to be exogenous. Furthermore, in our model framework a part of the population does not pay any taxes.

The empirical analysis of tax evasion is typically based on individual household data that in some studies has been aggregated to analyze the influence of demographic and social factors on tax compliance. Such studies have been mainly concentrated on testing the predicted effects of the explanatory variables encountered in the tax evasion models of Alligham and Sandmo (1972) and Yitzhaki (1974). Summarizing the results of these studies, Andreoni et al. (1998) conclude that the impact of tax rates on evasion has not yet been clarified. Penalties and audit probabilities have some deterrent effects, the magnitude of which remains unclear, however.

The next Section presents a simple model of optimal linear taxation and tax auditing where individuals freely choose declared income and labor supply. Based on this model, Section 3 outlines our empirical estimation strategy to quantify and test core model implications for the case of the EU financing system. It describes the impact of distinct exogenous variables on shadow economic activity, tax auditing and tax rates and analyzes the variation in these variables under a counterfactual scenario where a cross national financing system does not exist. Section 4 concludes.

2 Theoretical model

In this Section we set up a very simple model to analyze possible effects of cross-national transfers on a government's incentives to fight against unofficial economic activities. The economy consists of individuals that are identical except with regard to their wage rate, w. We assume that the utility function of each individual is quasi–linear and that the labor supply elasticity is constant, i.e.

$$U = C - AL^{1+1/\epsilon},$$

where U and C are utility and consumption, respectively, L is labor supply and $\epsilon > 0$.

The individual faces a flat tax rate t on his reported income and receives a guaranteed income G. A taxpayer's true income is unknown for the government but can be observed by auditing the tax payer. The tax administration decides to audit randomly a proportion p of all taxpayers. Thus, a taxpayers probability of being audited is p. We assume that all income that a taxpayer has not declared is discovered with probability one if he is audited. A taxpayer that is audited and has not declared the amount of income F must pay the penalty $\pi F^2/2$, with the penalty rate $\pi > \underline{\pi}$.[3] The cost of an audit is θp. The consumption of tax evaders is thus a random variable and expected utility is given by

$$V = (1-t)wL + tF + G - p\frac{\pi}{2}F^2 - AL^{1+1/\epsilon}.$$

The individual chooses F and L to maximize expected utility. As solutions we obtain

$$F^* = \frac{t}{p\pi}, \tag{1}$$

$$L^* = \left(\frac{(1-t)w}{(1+1/\epsilon)\,A}\right)^{\epsilon}. \tag{2}$$

[3]We assume $\underline{\pi}$ such that the fine is always higher than the evaded tax.

To guarantee an interior solution we assume that π and A are such that $F^* < wL^*$. The results indicate that non-declared income increases with the tax rate and decreases with the probability of being audited and with the penalty rate.[4] Thus, the individual's indirect utility is

$$V^*(t,p;w,G,A,\pi,\epsilon) = \frac{A}{\epsilon}\left(\frac{(1-t)w}{(1+1/\epsilon)\,A}\right)^{\epsilon+1} + G + \frac{t^2}{2p\pi}.$$

The government chooses the tax rate and the auditing probability to maximize social welfare.[5] There are two groups in the economy: the non-taxpayers that do not work and the taxpayers having wage rate w distributed over the interval $[\underline{w},\overline{w}]$ with density function $f(w)$. The non-taxpayers are γ of the population. The social welfare function is assumed to be weighted utilitarian with weights of $\alpha > 1$ attached to non-taxpayers. The government obtains its expected revenue R from the taxation of declared income and the penalties. So, the expected tax and penalty collected from an individual with wage rate w is $R = \left(t\,(wL - F) + p\frac{\pi}{2}F^2\right)$. With optimal labor supply and income declaration the revenue becomes

$$R^*(t,p;w,G,A,\pi,\epsilon) = tw\left(\frac{(1-t)w}{(1+1/\epsilon)\,A}\right)^{\epsilon} - \frac{t^2}{2p\pi}.$$

The government's revenue is determined by the revenue requirements to finance public goods

[4]When agents are risk averse, the effect of the tax rate on tax evasion is not clearly determined in the Alligham-Sandmo (1972) model. However, in the Yitzhaki (1974) model, where fines are imposed on evaded tax instead of undeclared income, tax evasion also increases with higher tax rates when agents are risk averse.

[5]Instead, the penalty rate is assumed to be exogenous. This is because it cannot be freely chosen by tax authorities but is determined by legal principles such as the proportionality of infraction and punishment

(P), the guaranteed income (G) and the tax audits ($(1-\gamma)\theta p$). Furthermore, it is increased (reduced) by net transfers to (from) other countries (Tr). Denote the government's net revenue requirements by $T = P + G + Tr$. The government's optimization problem can be written as:

$$\begin{aligned} \max_{t,p} \quad & \gamma\alpha G + (1-\gamma)\int_{\underline{w}}^{\overline{w}} V^*(t,p;w,G,A,\pi,\epsilon)f(w)dw \\ \text{s.t.} \quad & (1-\gamma)\int_{\underline{w}}^{\overline{w}} R^*(t,p;w,G,A,\pi,\epsilon)f(w)dw = T + (1-\gamma)\theta p. \end{aligned}$$

Assuming an interior solution, the first-order conditions for this problem are:

$$\frac{\partial\Lambda}{\partial t} = (1-\gamma)\int_{\underline{w}}^{\overline{w}} \frac{\partial V^*}{\partial t} f(w)dw + \lambda(1-\gamma)\int_{\underline{w}}^{\overline{w}} \frac{\partial R^*}{\partial t} f(w)dw = 0 \quad (3)$$

$$\frac{\partial\Lambda}{\partial p} = (1-\gamma)\int_{\underline{w}}^{\overline{w}} \frac{\partial V^*}{\partial p} f(w)dw + \lambda(1-\gamma)\int_{\underline{w}}^{\overline{w}} \frac{\partial R^*}{\partial p} f(w)dw - (1-\gamma)\lambda\theta = 0 \quad (4)$$

$$\frac{\partial\Lambda}{\partial\lambda} = (1-\gamma)\int_{\underline{w}}^{\overline{w}} R^*(t,p;w,G,A,\pi,\epsilon)f(w)dw - T - (1-\gamma)\theta p = 0, \quad (5)$$

where Λ is the Lagrangean and λ the Lagrangean multiplier that measures the shadow cost of public funds. Substitution of the expressions for indirect utility and tax revenue obtains the following result:

Proposition 1. *The optimal tax rate and the optimal auditing probability are determined by the following equations:*

$$\frac{t}{1-t} = \left(\frac{\lambda-1}{\lambda\epsilon}\right)\left(1 - \frac{t}{p\pi}E[wL^*]^{-1}\right) \quad (6)$$

$$p = \left(\left(\frac{\lambda-1}{\lambda}\right)\frac{1}{2\theta\pi}\right)^{\frac{1}{2}} t \quad (7)$$

$$tE[wL^*] = \frac{t^2}{2p\pi} + \frac{T}{(1-\gamma)} + \theta p. \quad (8)$$

Equation (6) shows the trade-off between distributional and efficiency aspects that determine the optimal tax rate. The first term on the right hand side indicates that the tax rate decreases with the elasticity of labor supply and increases with the shadow cost of public funds. The second term on the right hand side shows the net effect of taxation on tax evasion. Its sign is negative. This means that the presence of tax evasion decreases the optimal tax rate. The effect is the lower, the higher are the auditing probability and the punishing rate. Equation (7) gives the optimal auditing probability. We find that it increases with the tax rate and the shadow cost of public funds and decreases with the auditing cost and the punishing rate. Furthermore, we find that $p < \widetilde{p} = (2\theta\pi)^{-\frac{1}{2}}\, t$ which is the auditing probability that maximizes total public revenue minus auditing costs. The optimal auditing probability is smaller than $\tilde{p}$ since the optimal auditing probability takes into account the effect of auditing on taxpayer utility, which is negative ($\partial V^*/\partial p < 0$).

The effects of marginal changes in the exogenous variables on the optimal tax rate and the auditing probability can be obtained from solving the system of equations (6)-(8). We obtain the following result:

Proposition 2. *The optimal tax rate and auditing probability increase with the governments net revenue requirements and with the proportion of non-taxpayers in the population and decrease with the wage rate and the penalty rate. Furthermore, the optimal tax rate increases with the marginal auditing cost. The optimal auditing probability increases (decreases) with the marginal* *auditing cost if labor supply is inelastic (elastic).*

From Proposition 2 we find that increased net revenue requirements increase the tax rate. Furthermore, it is also optimal for the government to increase the auditing probability in this case. For the case of the EU budgetary system this means that countries that are net contributors to (receivers from) the EU should be expected to see their tax rates and penalty rates increased (decreased) by EU membership. An increased proportion of non-taxpayers, for example due to more unemployment, increases the tax rate and the auditing probability. On the contrary, higher expected income due to higher earning abilities allows to reduce the tax rate and the auditing probability. Higher penalty rates allow to reduce both the tax rate and the auditing probability. Concerning the effect of an increase in the auditing cost we find that this increases the tax rate while the effect on the auditing probability depends on the elasticity of labor supply. To explain this result recall that the tax rate and the penalty rate are alternative instruments of the government to raise tax revenue. So, an increase in auditing costs should mean that the auditing probability is decreased and the tax rate is increased. However, from the Laffer curve we know that an increase of the tax rate only increases tax revenues on the ascending part of the Laffer curve. But the more inelastic labor supply is, the closer is the tax rate to the tax revenue maximizing tax rate, because in this case taxation has low social costs. Therefore, with sufficiently inelastic labor supply tax revenue can only be increased by raising also the auditing probability which is lower than the tax revenue maximizing auditing probability. On the other hand, with elastic labor supply we obtain the expected result that an increase in auditing costs increases the tax rate and decreases the auditing probability.

Regarding the marginal effects of the exogenous variables on non-declared income in (1) we see that these exclusively come through the tax rate and the auditing probability (except for the penalty rate that also has a direct impact). If the effects of an exogenous variable on the tax rate and the auditing probability go in the same direction, as is the case for all of the variables when labor supply is inelastic, the impact on non-declared income is not clear on first sight. Furthermore, the total effect is in most cases a rather complicated function of the model parameters. However, for the government's net revenue requirements and the proportion of non-taxpayers we obtain the following result:

Proposition 3. *Non-declared income decreases with the government's net revenue requirements and with the proportion of non-taxpayers.*

Proposition 3 has some interesting implications. First, it means that countries that are net contributors to the EU budget and have therefore higher revenue requirements will be characterized by less shadow economic activity. To understand this result recall from Proposition 2 that higher revenue requirements increase the optimal tax rate and auditing probability. Higher tax rates increase shadow economic activity while higher auditing probabilities decrease shadow economic activity. Proposition 3 states that in our model the second effect dominates, such that shadow economic activity decreases when the revenue requirements increase. Second, Proposition 3 implies that countries with a higher proportion of non-taxpayers, for example due to a higher unemployment rate, will also have less shadow economic activity. The reason for this result is similar to the previous. A higher rate of non-taxpayers requires higher tax rates and a higher auditing probability (Proposition 2) which has conflicting impacts on shadow economic activity. Again, the effect that comes from the higher auditing probability dominates the effect from the tax rate so that non-declared income (shadow economic activity) decreases with the proportion of non-taxpayers.

3 Empirical analysis

In this Section we first sketch our strategy to estimate and test empirically the impacts of EU net positions on the cross sectional pattern of the extent of hidden economic activity, the strength of fiscal institutions, and the tax burden. Secondly, since numerous measures of the theoretical model in Section 2 are latent we discuss in detail the extraction and construction of data from publically available sources. Finally, empirical results from two and three stage least squares modeling (2SLS and 3SLS, respectively) of simultaneous equations are discussed in detail.

3.1 The empirical model

According to the theoretical outline in Section 2 we set up an empirical model with three endogenous variables (tax noncompliance, auditing probability and the tax rate). Notably, also related microeconometric studies (Witte and Woodbury 1985, Dubin and Wilde 1988, Dubin et al. 1990, Beron et al. 1992) confirm the endogeneity of the auditing rate as it depends on the level of noncompliance. With regard to exogenous determinants we account for per capita income, the proportion of tax payers, the preference for social redistribution and cross-national transfers. To control for the confidence in the public sector we further include a measure of corruption. We consider the following system of simultaneous equations:

$$f_i = p_i\gamma_{12} + t_i\gamma_{13} + \beta_{11} + ci_i\beta_{12} + y_i\beta_{13} + u_i\beta_{14} + e_{1i} \tag{9}$$

$$p_i = f_i\gamma_{21} + \beta_{21} + ci_i\beta_{22} + eu_i\beta_{25} + e_{2i} \tag{10}$$

$$t_i = f_i\gamma_{31} + \beta_{31} + y_i\beta_{33} + eu_i\beta_{35} + s_i\beta_{36} + e_{3i},\ i = 1, \ldots, N. \tag{11}$$

where for country i, f_i is the extent of shadow economic activity, p_i an index of auditing activities and punishment, t_i the tax quote, ci_i a corruption index, y_i per capita income, u_i the unemployment rate, eu_i the EU net budget position and s_i social expenditure.[6] By assumption, $E[\boldsymbol{e}_i] = 0,\ E[\boldsymbol{e}_i\boldsymbol{e}_i'] = \Sigma,\ \forall i,$ and $E[\boldsymbol{e}_i\boldsymbol{e}_j'] = 0, i \neq j$, where $\boldsymbol{e}_i = (e_{1i}, e_{2i}, e_{3i})'$. The number of cross sectional entities is N. Country specific vectors of endogenous and exogenous variables are, respectively, $\boldsymbol{y}_i = (f_i, p_i, t_i)'$ and $\boldsymbol{x}_i = (1, ci_i, y_i, u_i, eu_i, s_i)'$. Compactly, the system (9) to

[6] Table 3 lists the country specific variables and their scales in some more detail.

(11) obeys a standard reduced form representation, i.e.

$$\begin{aligned} [\boldsymbol{y}_1, \boldsymbol{y}_2, \ldots, \boldsymbol{y}_N] &= [\boldsymbol{x}_1, \boldsymbol{x}_2, \ldots, \boldsymbol{x}_N]\Pi + V \\ \doteq Y &= X\Pi + V, \end{aligned} \tag{12}$$

where V is a $3 \times N$ dimensional matrix of model disturbances and the (3×6) parameter matrix Π depends in a nontrivial manner on the structural parameters γ_{ij} and β_{ik}, $i, j = 1, 2, 3$, $k = 1, \ldots, 6$.

3.2 Data

Data are collected for particular years over a cross section of 14 EU member economies. The selection of economies and time periods is determined by the availability of data as, in particular, of (estimated) shadow economic activity (Schneider 2009, see also Schneider 2007) and statistics describing the tax systems and their efficiency in the OECD (OECD 2004, 2007, 2009a). The cross section of economies comprises Austria (AUT), Belgium (BEL), Denmark (DNK), Finland (FIN), France (FRA), Germany (GER), Greece (GRC), Ireland (IRL), Italy (ITA), Netherlands (NLD), Portugal (PRT), Spain (ESP), Sweden (SWE), and the United Kingdom (UK). Thus, the sample covers the European Union members before the 2004 enlargement except Luxembourg which is excluded since time series estimates of shadow economic activity are not available for this country.

Owing to the provision of averaged shadow economic activity for the period 2001 to 2002 and the rather small cross sectional dimension we refrain from adopting panel data estimation techniques for the system in (9) to (11) but rather estimate the model by years and comment on particular estimates and their robustness over time. At the aggregated level we also discuss time mean group estimates as motivated for cross sectional aggregation in Pesaran and Smith (1995). For single years the system of equations is estimated by means of 2SLS and 3SLS.

In measuring the endogenous variables of our model and some statistics presumed exogenous we composed an (almost) complete set of internationally comparable data for the year 2003. With regard to other years coping with missing values becomes an important part of the empirical analysis. Two core variables considered in the theoretical model are either latent (f_i) or difficult to quantify given the scarcity of internationally comparable statistics that describe fiscal institutions (p_i). We comment in detail on data sources, data availability and the treatment of missing values in Appendix B. In the following we describe the gathering of endogenous and exogenous variables in turn.

Regarding the endogenous variables, the data on the extent of shadow economic activity (f_i) are taken from Schneider (2009). He uses the MIMIC (multiple indicator multiple cause) methodology and the currency demand approach to estimate the size of the informal sector in percent of the "official" GDP.[7] Within the former framework shadow economic activity is

[7]Though EU contributions are based on GNP, all our variables of the empirical model are related to GDP because it is the more appropriate measure to address tax evasion in response to fiscal means which refer to

modeled on the one hand as the outcome of its causes like tax rates and the degree of regulation or unemployment. On the other hand, there are variables that indicate the size of the shadow economy, for instance, currency ratios and the labor force participation rate. The MIMIC approach works on basis of a two step procedure. In a first step the relationship between observed indicator variables and underlying causes of shadow economic activity is estimated. In a second step the link between indicator variables and the latent variable is used to estimate the size of the hidden sector. The currency demand approach, initiated by Cagan (1958), is based on the presumption that shadow transactions are undertaken in the form of cash payments. Therefore currency demand is expected to be related to shadow economic activity. Then, the currency demand approach consists in isolating the effect of shadow transactions on currency demand from other needs for holding currency. The estimates in Schneider (2009) are annual and cover the time period from 2003 to 2007 and an estimated average size of the shadow economic activity for 2001 and 2002. As the extent of hidden economic activity is latent, it is clear that any (explicit) measure might be subjected to criticism, and, moreover, is likely affected by measurement errors. For a discussion of the magnitude of shadow economic activity at an international level the reader may consult Dell'Anno et al. (2007) or Schneider (2007). For the purposes of this paper, it is worthwhile pointing out that the time varying international quotes for shadow activity are 'consistent' in the sense that they are derived by means of a unified methodological approach.

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domestic production and services.

Though being a core variable of the theoretical model in Section 2 the intensity of tax auditing and punishment of tax evasion (p_i) is not directly observable. As an approximation of this quantity we first take the number of employees in the tax administration as a fraction of the overall labor force to approximate the probability for an individual agent to be subjected to a tax audit. This measure is then multiplied with the overall revenues collected from tax audits as a fraction of overall taxes. As such, the latter quote, published as 'tax efficiency' in OECD reports (OECD 2004, 2007, 2009a), corresponds to the strength of punishing tax evaders. The number of employees in the fiscal administration is also published by the OECD (OECD 2004, 2007, 2009a). Numerically, it turned out that the p_i measure (being the product of two likely small ratios) is rather small. Therefore p_i statistics are measured in squared percentage points times 10.

The tax rate t_i is determined as the sum of both direct and indirect taxes and legal contributions to social security systems in percent of GDP. Both higher taxation and social contributions equally increase incentives to hide economic activities and thereby the size of the informal sector.

Turning to the exogenous variables, the corruption index as published online by Transparency International (2008) is a reversed measure on the interval $[0, 10]$ such that the institutional framework in an economy is considered the more corrupt the less is ci_i. To have this quote on the same scale as other variables we multiply it by 10. The net EU budget position

(eu_i) is the difference between resource inflows minus outflows for economy i into/from the EU budget as percentage of GDP. Thus, negative (positive) quotes indicate net payer (receiver) economies. The data for GDP are drawn in national currency and then, for the cases of Denmark, Sweden and the United Kingdom, renominated in Euro by means of end of the year monthly exchange rate quotes. Unemployment rates, u_i, are in percent of the labor force. In an attempt to quantify an economies' preference with regard to (social) redistribution of income (s_i) we consider total social expenditures minus legal contributions to social security systems. Again this statistic is scaled in percent of GDP.

The expected impacts of exogenous on endogenous variables in light of the theoretical model are resumed in Table 4. Thereby a lower corruption index (indicating a more corrupt economy) is associated with a higher auditing cost. Consequently, we expect less corrupt countries to have a lower tax rate and auditing intensity. A higher wage rate is positively related to a higher per capita income. Thus, according to Proposition 2, richer countries have lower tax rates and auditing intensities. The proportion of non-taxpayers is related to unemployment which means that countries with more unemployment have a higher tax rate and auditing intensity. Finally, a negative EU budget position and higher social expenditure increases the governments revenue requirements which, according to the theoretical results, goes along with a higher tax rate and more auditing.

The impact of the exogenous variables on shadow economic activity comes through the tax rate and the auditing intensity. The total effect depends on whether the positive effect from the tax rate or the negative effect from the auditing intensity dominates. Notably, the total impact of the exogenous variables on shadow economic activity is likely sensitive to the model specification. Within the framework outlined in Section 2 and regarding unemployment, the EU budget position and social expenditures the negative effect dominates the positive one (see Proposition 3). Therefore, we expect countries with higher unemployment, a negative EU budget position (receiver economies) and higher social expenditure to have a smaller informal sector. For the remaining variables (y_i and ci_i) the total effect is a rather complicated function of the model parameters and, therefore, not provided in Table 4.

3.3 Descriptive characteristics

To get a first impression of the data, Figure 1 illustrates the cross sectional distribution of the endogenous variables in 2003. The ordering of the cross sectional entities accords with their net EU budget position, i.e. EU net payers to receivers are displayed from the left to the right hand side. Further descriptive statistics, including measures for the exogenous variables, are given in Table 5. The cross sectional pattern indicates that the bilateral relationship between tax rates and shadow economic activity or tax auditing and shadow economic activity is not obvious at first sight. Measured against the EU net budget position we observe some positive evolvement of shadow economy quotas and a (mildly) negatively sloped cross sectional pattern of the tax burden which are both in line with the predictions offered by the theoretical model. With regard to the distribution of p_i a general impression is not available from Figure 1 since such quotes are particularly high for Greece and Italy. Notably, the illustration must be taken with some care, since the effect of important explanatory variables, for instance, the degree of corruption, is not explicit in the figure. Overall, it appears that in countries with similar auditing activities higher tax rates coincide with higher shadow economic activity (e.g. Sweden, United Kingdom). Nevertheless, without the inclusion of further explanatory variables it appears rather difficult to diagnose functional linkages between these variables.

Regarding the constructed measure of the strength of the tax auditing system the two quotes for Greece and Italy are remarkably high which effectively goes back to the high shares of contributions to the tax flow stemming from auditing activities (19.68% and 8.69% for Greece and Italy, respectively). On the one hand both outlying quotes might reflect that these economies are characterized by relatively low tax moral in the sense that the government has to enforce more rigidly the collection of tax revenue. On the other hand, however, the diffuse cross sectional pattern of the p_i quotes might reflect the construction of the measure as squared percentage points ($\times$ 10). To address the impact of the two somewhat outlying observations we also estimate the empirical model (9) to (11) from the presumption that the p_i measure for these two countries is 'only' 75% of the quotes initially determined. It turns out that the impact of trimming these two outlying statistics is marginal and does not change the empirical conclusions qualitatively.

In the following structural and reduced form empirical results are discussed in turn. In light of numerically rather stable results obtained from an evaluation of annual data we mostly discuss time mean group evidence. Time specific estimation results are provided for 2003, 2005 and 2007. As outlined in Appendix B Data for 2003 are most complete. Moreover, while the 2003 sample might be seen to be particularly informative for the pre 2004 EU enlargement state, we note that in 2007 this enlargement has most likely become effective for the EU budgeting. As a consequence of potential structural variations one should, therefore, take estimation results for 2007 with care.

3.4 The structural model

Table 6 documents estimation and diagnostic results for the system of simultaneous equations (9) to (11). Apart from mean group estimates obtained from 2SLS and 3SLS cross sectional regressions by year, more specific results are provided for single years 2003 (2SLS, 3SLS), 2005 (3SLS) and 2007 (3SLS). The implications of applying 2SLS or 3SLS estimation are quantitatively and qualitatively very similar. As the 3SLS estimator exploits more information the discussion of empirical results is concentrated on this method. For all single year regressions the degree of explanation is of medium size about 70% to 80% by equation. Testing the overidentifying restrictions imposed in equations (10) and (11) generally supports the chosen model specification. However, the overidentifying restrictions imposed in (10) are rejected with

10% significance conditional on 2007 data. Similarly, the 2005 model obtains a diagnostic for the tax equation (11) which is significant at the 5% level. Mean group coefficient estimates are almost uniformly significant at common levels and thereby indicate that empirical models estimated separately with annual data obtain rather robust results. Therefore, we first discuss the implications of 3SLS mean group estimation and then briefly consider some robustness issues for more specific evidence based on single cross sectional regressions.

Describing the interaction of the jointly endogenous variables it turns out that, on average, an increase of shadow economic activity goes along with higher tax rates and a weakening of tax auditing. In turn, strengthening the institutional framework of tax audits or reducing tax rates is most likely effective to reduce shadow economic activity. For instance, on average, a reduction of tax rates by one percentage point reduces the extent of hidden economic activity by ≈2.6% of the official GDP. A similar marginal effect (≈-3.5% of GDP) is estimated if the strength of tax auditing activities is increased by one unit. On the other hand, an increase of shadow economic activity by one percentage point increases tax auditing and tax rates, on average, by 0.889 and 0.436 units, respectively. The high significance of all parameters indicates that endogeneity is an important aspect when estimating the impact of exogenous variables on shadow economic activity, tax auditing and the tax burden.

With regard to the empirical impacts of exogenous variables we find that, on average, the degree of shadow economic activity (the tax burden) is increasing (decreasing) in per capita

GDP. These results add to the empirical literature based on household data. For example, Feinstein (1991) finds no significant relationship between tax evasion and income and a significantly negative relationship between tax evasion and the marginal tax rate. Instead, Clotfelter (1983) finds a significant positive relationship in both cases. The estimated structural impact of the unemployment rate on hidden economic activity, on average, is positive. However, for 2003 the effect is negative indicating that the relationship between these two variables is not monotone. Regarding EU budget imbalances we find that EU net receiver economies have both lower auditing and lower tax rates. Finally, as expected, an increase in social expenditure means, on average, higher tax rates.

Because of the diagnosed endogeneity of the estimated model we refrain from interpreting the parameter estimates of the structural form in more detail. Instead, we do this in the following Section for the reduced form where we also test the validity of the models' predictions. Furthermore, we try to assess the overall effect of the EU net budget position by consideration of a counterfactual situation of no EU redistribution in Section 3.6.

3.5 The empirical model in reduced form

Describing the marginal effects of the exogenous variables on the steady state of the endogenous variables, reduced form parameter estimates are provided in Table 7. Similar to structural parameter estimates the empirical model is rather stable in its reduced form. With regard to the impact directions the mean group estimation results are almost uniformly representative for marginal quotes estimated on the basis of year by year data. Notable exceptions resulting in insignificant mean group parameter estimates are the marginal impacts of the per capita income (y_i) and unemployment (u_i) on the strength of the auditing system (p_i). For both exogenous variables we can diagnose significantly positive and negative marginal responses when comparing estimation results for 2003, 2005 and 2007. Moreover, the effect of trimming the p_i measures for ITA and GRC is negligible at the mean group level.

In the light of the theoretical model in Section 2 numerous reduced form results are rather intuitive (see also Table 4). First and most importantly, the net EU position impacts almost uniformly and significantly on all the endogenous variables of the system. Throughout, net receiver countries ($eu_i > 0$) are characterized by higher extents of hidden economic activity which supports the result in Proposition 3. At the mean group level, increasing the net inflow by one percent of GDP increases, on average, the shadow economic sector by ≈1% of GDP. In the same time receiver economies are characterized by less stringent financial auditing institutions. The reduced form response of the tax burden to the net EU position is also negative. Both results are in line with Proposition 2. At the mean group level an increase of the net inflow (a reduction of net outflows) by 1% of GDP decreases (increases) tax revenues on average by ≈ 4% of GDP. Second, the reduced form model uncovers a significantly positive impact of unemployment on hidden economic activity and on the level of taxation. The second result coincides with the predictions from the theoretical model (see Proposition 2 or Table 4). Because the impact on tax auditing is mostly insignificant, the tax effect should dominate the auditing effect on shadow economic activity which explains the first result. Furthermore, our theoretical model only captures the effect of changes in unemployment (the proportion of non-taxpayers) on tax rates and tax auditing. But there also exists a second effect: unemployed persons might have more time and/or incentive to engage in shadow activities in comparison with full-time employed persons. This additional effect can also explain the positive impact of unemployment on hidden economic activity. In absolute terms the mean group marginal response of shadow economic activity is markedly smaller in the reduced form in comparison with the structural form. This result underscores that the often explored triggers of shadow economic activity are best understood in an simultaneous equation setting where tax institutions and hidden economic activity are determined jointly. Third, the strength of tax auditing and tax revenues are positively related with the fraction of resources devoted to social measures (Proposition 2). Opposite to the result in Proposition 3, shadow economic activity also increases with social expenditures. This indicates that empirically the effect of social expenditure on taxation dominates the effect on tax auditing.

Regarding per capita income and the level of corruption we recall that their reduced form impact on shadow economic activity has not clarified in the theoretical outline. For these two impact variables we obtain in analogy to Proposition 2 firstly, that the more a specific country is akin to corruption the weaker are auditing institutions and the lower is the level of taxation. A-priori both marginal effects have opposite impacts on the extent of shadow economic activity.

According to a reduced form overall negative impact on the size of the shadow economy, apparently, the tax level effect dominates the effect of the institutional weakening in more corrupt economies. Secondly, the reduced form uncovers a significantly negative (net) impact of per capita income on shadow economic activity at the mean group level and conditional on 2003 and 2007 data. As predicted by Proposition 2 the marginal impact of income on the tax burden and the strength of tax authorities is negative. While the impact on the former is rather robust we note that p_i shows a positive marginal response to y_i conditional on 2005 data.

3.6 A counterfactual quantification of the effect of the financing system

As argued the current state of EU funding depends mainly on official economic figures. According to theoretical arguments and our empirical evidence a country's net EU position impacts on both hidden economic activity and the setting of fiscal instruments. This indicates that a modification of EU budgeting could improve the allocation of financial resources within the EU. To assess the potential impact of such a reform, we provide a model based counterpart to the quasi EU funding documented in Tables 1 and 2. Specifically, we elaborate on the effects of an artificial scenario of nationally balanced EU financing. This scenario is thought to correspond to any budgetary system that gives no incentives to understate the official economic figures. To isolate the effect of the EU financing system on country specific measures of shadow economy activity, the strength of auditing, and the level of taxation, we estimate the reduced form in (12) and obtain $\widehat{f}_i = \boldsymbol{x}_i \hat{\pi}_1$, $\widehat{p}_i = \boldsymbol{x}_i \hat{\pi}_2$ and $\widehat{t}_i = \boldsymbol{x}_i \hat{\pi}_3$, where parameter vectors comprise $\widehat{\Pi} = [\hat{\pi}_1, \hat{\pi}_2, \hat{\pi}_3]$. In addition, we consider a counterfactual scenario of absent EU financing by means of a collection of observations $\boldsymbol{x}_i^{(0)}$ which are almost identical to $\boldsymbol{x}_i$ except that the fifth element of these vectors is zero throughout. Then, model implied (zero EU balance) counterparts of $\widehat{f}_i$, $\widehat{p}_i$ and $\widehat{t}_i$ are determined as $\widehat{f}_i^{(0)} = \boldsymbol{x}_i^{(0)} \hat{\pi}_1$, $\widehat{p}_i^{(0)} = \boldsymbol{x}_i^{(0)} \hat{\pi}_2$ and $\widehat{t}_i^{(0)} = \boldsymbol{x}_i^{(0)} \hat{\pi}_3$. Finally, the effect of the EU budget position on the endogenous variables is determined as

$$\Delta f_i = 100 \left(\frac{\widehat{f}_i^{(0)} - \widehat{f}_i}{\widehat{f}_i} \right), \ \Delta p_i = 100 \left(\frac{\widehat{p}_i^{(0)} - \widehat{p}_i}{\widehat{p}_i} \right) \text{ and } \Delta t_i = 100 \left(\frac{\widehat{t}_i^{(0)} - \widehat{t}_i}{\widehat{t}_i} \right). \tag{13}$$

Making the effect of cross national financing on the shadow economy, auditing and the tax burden explicit, Table 8 documents the relative impacts defined in (13) and implied by 3SLS estimation. Given the estimation results it is not surprising that mean group results are mostly characterized by relatively small standard errors underpinning numerical robustness of annual relative impacts. We find that in an artificial scenario of zero EU contributions the extent of shadow economic activities would be markedly reduced in Belgium, Greece, Ireland, Portugal and Spain. At the mean group level the estimated reductions vary between 2.63% (BEL) and 9.44% (PRT). On the other hand, some actual net payers to the EU budget as Germany (+2.76%), the Netherlands (+8.1%), Sweden (+2.96%) and the United Kingdom (+1.97%) would face higher shadow economic activities in the counterfactual scenario.

This result may be surprising at first sight. However, in all these countries the increase in shadow economic activity reduces tax revenues by less than the amount they save from having no deficit in EU net contributions. For instance, conditional 2003 GDP figures and 3SLS mean group estimates the total marginal effect of zero EU contributions is an increase in tax revenues of 4485 millon euro in Germany, 1490 million euro in the Netherlands, 503 million euro in Sweden and 2961 million euro in the United Kingdom.[8] Therefore an increase of shadow economic activity in these countries will not necessarily reduce tax income. Instead our result indicates that governments in these countries dedicate too many resources to fight against shadow economic activity than it would be optimal if cross national transfers are excluded.

With regard to the counterfactual estimates of the strength of fiscal institutions and the tax burden all results reflect the basic intuition of the theoretical model. Overall, net receiver economies like Spain, Greece, Ireland and Portugal are characterized by a higher tax burden and a strengthening of fiscal institutions in the artificial scenario of a zero EU balance. In the same time, net contributors as Germany (-3.97%), the Netherlands(-7.86%), Sweden (-3.53%) and the United Kingdom (-2.36%) could afford a reduction of the tax burden. Regarding the counterfactual estimates for the strength of tax auditing it is worthwhile to point out that the estimated impacts the trimming of p_i quotes for Greece and Italy does not change the core

[8]The marginal effect takes into account the reduction of tax revenues from additional shadow economic activity. This value is subtracted from the savings of having no EU contribution deficit. The marginal effect does not take into account the effect of lower tax rates on total national income because this effect is unlikely to be constant.

empirical conclusions.

4 Conclusions

In this paper we introduce a model framework addressing the impact of a cross national financing system, as the EU budgetary system, on the extent of shadow economic activity, the strength of tax auditing measures and the level of taxation. As a consequence of relating the common financial funding to official economic data, the theoretical model uncovers an incentive of the fiscal authorities in net receiver economies to tolerate higher levels of shadow economic activity by following weaker policies of tax auditing.

The theoretical model is complemented with cross sectional simultaneous regression models that fully account for the joint endogeneity of hidden economic activity, the auditing intensity and the tax burden. Except for Luxembourg our sample comprises all members of the EU prior to the 2004 enlargement over the time period 2001 to 2007. In its reduced form version we diagnose that EU receiver economies are, on average, characterized by higher states of shadow economic activity, weaker tax auditing institutions and a smaller tax burden.

A major policy implication of this work is immediate. Presumably, the described adverse effects of the EU financing system might be overcome by determining the required payments with reference to actual economic measures comprising both official and hidden economic activity. As such, it is crucial to have efficient econometric methods at hand to gather reliable quotas of the hidden economy that could be accepted by all member states.

With regard to future work is of interest in theory to study and propose EU funding systems that lack incentives to weaken fiscal rigor with respect to the pursue of the shadow economy. From an empirical perspective it is important to monitor the magnitude of budget induced shadow economic activity in the EU24. Moreover, we note that the incentives described in the theoretical model and quantified empirically for the case of the EU are also viable in other federal systems where regional needs and means are subjected to coordination. In such a framework further, eventually microeconometric research should take into account that the preference for similar economic conditions might be stronger as it is for the EU. In the same time, however, policy instruments of the regional fiscal authorities (tax burden, auditing policy) are less diversified.

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Appendix A. Proofs

Proof of Proposition 2

Substitute equation (7) into equation (6) to eliminate λ and define:

$$F_1 \equiv \frac{t}{1-t} - \frac{2\theta\pi}{\epsilon}\left(\frac{p^2}{t^2} - \frac{p}{t\pi}E[wL^*]^{-1}\right) = 0 \tag{14}$$

$$F_2 \equiv tE[wL^*] - \frac{t^2}{2p\pi} - \frac{T}{1-\gamma} - \theta p = 0. \tag{15}$$

Now, the marginal effects of the exogenous variables on the optimal tax rate and auditing probability are given by:

$$\begin{aligned}
\begin{bmatrix} \frac{\partial t}{\partial T} & \frac{\partial t}{\partial \gamma} & \frac{\partial t}{\partial \theta} & \frac{\partial t}{\partial \pi} \\ \frac{\partial p}{\partial T} & \frac{\partial p}{\partial \gamma} & \frac{\partial p}{\partial \theta} & \frac{\partial p}{\partial \pi} \end{bmatrix} &= -\begin{bmatrix} \frac{\partial F_1}{\partial t} & \frac{\partial F_1}{\partial p} \\ \frac{\partial F_2}{\partial t} & \frac{\partial F_2}{\partial p} \end{bmatrix}^{-1} \begin{bmatrix} \frac{\partial F_1}{\partial T} & \frac{\partial F_1}{\partial \gamma} & \frac{\partial F_1}{\partial \theta} & \frac{\partial F_1}{\partial \pi} \\ \frac{\partial F_2}{\partial T} & \frac{\partial F_2}{\partial \gamma} & \frac{\partial F_2}{\partial \theta} & \frac{\partial F_2}{\partial \pi} \end{bmatrix} \\
&= -D^{-1}\begin{bmatrix} \frac{\partial F_2}{\partial p} & -\frac{\partial F_1}{\partial p} \\ -\frac{\partial F_2}{\partial t} & \frac{\partial F_1}{\partial t} \end{bmatrix} \begin{bmatrix} \frac{\partial F_1}{\partial T} & \frac{\partial F_1}{\partial \gamma} & \frac{\partial F_1}{\partial \theta} & \frac{\partial F_1}{\partial \pi} \\ \frac{\partial F_2}{\partial T} & \frac{\partial F_2}{\partial \gamma} & \frac{\partial F_2}{\partial \theta} & \frac{\partial F_2}{\partial \pi} \end{bmatrix}
\end{aligned}$$

where $D \equiv \frac{\partial F_1}{\partial t}\frac{\partial F_2}{\partial p} - \frac{\partial F_1}{\partial p}\frac{\partial F_2}{\partial t}$. Making use of equation (14) we obtain for the partial derivatives respective p and t:

$$\begin{aligned}
\frac{\partial F_1}{\partial t} &= \frac{1}{(1-t)^2} - \frac{2\theta\pi}{\epsilon}\left(\frac{-2p^2}{t^3} + \frac{p}{t^2\pi}E[wL^*]^{-1} + \frac{p}{t\pi}E[wL^*]^{-2}\frac{\partial E[wL^*]}{\partial t}\right) \\
&= \frac{2-t}{(1-t)^2} + \frac{2\theta p}{\epsilon t}\left(\frac{\pi p}{t^2} - \frac{\partial E[wL^*]}{\partial t}E[wL^*]^{-2}\right) > 0 \\
\frac{\partial F_1}{\partial p} &= -\frac{2\theta\pi}{\epsilon}\left(\frac{2p}{t^2} - \frac{1}{t\pi}E[wL^*]^{-1}\right) = -\frac{t}{1-t}p^{-1} - \frac{2\theta\pi}{\epsilon}\frac{p}{t^2} < 0 \\
\frac{\partial F_2}{\partial t} &= E[wL^*] + t\frac{\partial E[wL^*]}{\partial t} - \frac{t}{p\pi} = \left(1 - \frac{p^2}{\widetilde{p}^2}\right)\left(E[wL^*] - \frac{t}{p\pi}\right) > 0 \\
\frac{\partial F_2}{\partial p} &= \frac{t^2}{2p^2\pi} - \theta = \left(\frac{\widetilde{p}^2}{p^2} - 1\right)\theta > 0
\end{aligned}$$

where $\widetilde{p} = (2\theta\pi)^{-\frac{1}{2}}\,t$ is the auditing probability that maximizes total public revenue minus auditing costs and $\partial E[wL^*]/\partial t = -\epsilon(1-t)^{-1}E[wL^*] < 0$. This means that $D > 0$. The remaining partial derivatives are given by:

$$\begin{aligned}
\frac{\partial F_1}{\partial T} &= 0, \quad \frac{\partial F_2}{\partial T} = -\frac{1}{1-\gamma} < 0, \quad \frac{\partial F_1}{\partial \gamma} = 0, \quad \frac{\partial F_2}{\partial \gamma} = -\frac{T}{(1-\gamma)^2} < 0, \\
\frac{\partial F_1}{\partial \theta} &= -\frac{2\pi}{\epsilon}\left(\frac{p^2}{t^2} - \frac{p}{t\pi}E[wL^*]^{-1}\right) = -\frac{t}{(1-t)\,\theta} < 0, \quad \frac{\partial F_2}{\partial \theta} = -p < 0, \quad \frac{\partial F_1}{\partial \pi} = -\frac{2\theta}{\epsilon}\frac{p^2}{t^2} < 0, \\
\frac{\partial F_2}{\partial \pi} &= \frac{t^2}{2p\pi^2} > 0, \; \frac{\partial F_1}{\partial w} = -\frac{2\theta p}{\epsilon t}E[wL^*]^{-2}\frac{\partial E[wL^*]}{\partial w} < 0, \; \frac{\partial F_2}{\partial w} = t\frac{\partial E[wL^*]}{\partial w} > 0,
\end{aligned}$$

where $\frac{\partial E[wL^*]}{\partial w} > 0$. Now we have that

$$\frac{\partial t}{\partial T} = -D^{-1}\left(\underbrace{\frac{\partial F_2}{\partial p}}_{+}\underbrace{\frac{\partial F_1}{\partial T}}_{0} - \underbrace{\frac{\partial F_1}{\partial p}}_{-}\underbrace{\frac{\partial F_2}{\partial T}}_{-}\right) > 0, \qquad \frac{\partial p}{\partial T} = -D^{-1}\left(-\underbrace{\frac{\partial F_2}{\partial t}}_{+}\underbrace{\frac{\partial F_1}{\partial T}}_{0} + \underbrace{\frac{\partial F_1}{\partial t}}_{+}\underbrace{\frac{\partial F_2}{\partial T}}_{-}\right) > 0,$$

$$\frac{\partial t}{\partial \gamma} = -D^{-1}\left(\underbrace{\frac{\partial F_2}{\partial p}}_{+}\underbrace{\frac{\partial F_1}{\partial \gamma}}_{0} - \underbrace{\frac{\partial F_1}{\partial p}}_{-}\underbrace{\frac{\partial F_2}{\partial \gamma}}_{-}\right) > 0, \qquad \frac{\partial p}{\partial \gamma} = -D^{-1}\left(-\underbrace{\frac{\partial F_2}{\partial t}}_{+}\underbrace{\frac{\partial F_1}{\partial \gamma}}_{0} + \underbrace{\frac{\partial F_1}{\partial t}}_{+}\underbrace{\frac{\partial F_2}{\partial \gamma}}_{-}\right) > 0,$$

$$\frac{\partial t}{\partial \theta} = -D^{-1}\left(\underbrace{\frac{\partial F_2}{\partial p}}_{+}\underbrace{\frac{\partial F_1}{\partial \theta}}_{-} - \underbrace{\frac{\partial F_1}{\partial p}}_{-}\underbrace{\frac{\partial F_2}{\partial \theta}}_{-}\right) > 0, \qquad \frac{\partial p}{\partial \theta} = -D^{-1}\left(-\underbrace{\frac{\partial F_2}{\partial t}}_{+}\underbrace{\frac{\partial F_1}{\partial \theta}}_{-} + \underbrace{\frac{\partial F_1}{\partial t}}_{+}\underbrace{\frac{\partial F_2}{\partial \theta}}_{-}\right),$$

$$\frac{\partial t}{\partial \pi} = -D^{-1}\left(\underbrace{\frac{\partial F_2}{\partial p}}_{+}\underbrace{\frac{\partial F_1}{\partial \pi}}_{-} - \underbrace{\frac{\partial F_1}{\partial p}}_{-}\underbrace{\frac{\partial F_2}{\partial \pi}}_{+}\right), \qquad \frac{\partial p}{\partial \pi} = -D^{-1}\left(-\underbrace{\frac{\partial F_2}{\partial t}}_{+}\underbrace{\frac{\partial F_1}{\partial \pi}}_{-} + \underbrace{\frac{\partial F_1}{\partial t}}_{+}\underbrace{\frac{\partial F_2}{\partial \pi}}_{+}\right) < 0,$$

$$\frac{\partial t}{\partial w} = -D^{-1}\left(\underbrace{\frac{\partial F_2}{\partial p}}_{+}\underbrace{\frac{\partial F_1}{\partial w}}_{-} - \underbrace{\frac{\partial F_1}{\partial p}}_{-}\underbrace{\frac{\partial F_2}{\partial w}}_{+}\right), \qquad \frac{\partial p}{\partial w} = -D^{-1}\left(-\underbrace{\frac{\partial F_2}{\partial t}}_{+}\underbrace{\frac{\partial F_1}{\partial w}}_{-} + \underbrace{\frac{\partial F_1}{\partial t}}_{+}\underbrace{\frac{\partial F_2}{\partial w}}_{+}\right) < 0.$$

The expected marginal impact of the auditing cost on the optimal auditing probability and of the wage rate and the penalty rate on the tax rate shows that the signs are unclear. However, in the latter case a closer look shows that:

$$\begin{aligned} \operatorname{sign}\frac{\partial t}{\partial \pi} &= \operatorname{sign}\left(-\underbrace{\frac{\partial F_2}{\partial p}}_{+}\underbrace{\frac{\partial F_1}{\partial \pi}}_{-} + \underbrace{\frac{\partial F_1}{\partial p}}_{-}\underbrace{\frac{\partial F_2}{\partial \pi}}_{+}\right) \\ &= \operatorname{sign}\left(-\left(\frac{\widetilde{p}^2}{p^2}-1\right)\theta\left(-\frac{2\theta}{\epsilon}\frac{p^2}{t^2}\right) + \left(-\frac{t}{1-t}p^{-1} - \frac{2\theta\pi}{\epsilon}\frac{p}{t^2}\right)\frac{t^2}{2p\pi^2}\right) \\ &= \operatorname{sign}\left(-\frac{t^3}{2p^2\pi^2(1-t)} - \frac{2p^2\theta^2}{\epsilon t^2}\right) \text{ (using the definition of } \widetilde{p}) \end{aligned}$$

The expression in brackets is negative. Thus, $\frac{\partial t}{\partial \pi} < 0$. Regarding the marginal effect of changes in the wage rate on tax rates we get:

$$\begin{aligned}
\text{sign}\frac{\partial t}{\partial w} &= \text{sign}\left(-\underbrace{\frac{\partial F_2}{\partial p}}_{+}\underbrace{\frac{\partial F_1}{\partial w}}_{-} + \underbrace{\frac{\partial F_1}{\partial p}}_{-}\underbrace{\frac{\partial F_2}{\partial w}}_{+} \right) \\
&= \text{sign}\left(\left(\frac{t^2}{2p^2\pi} - \theta \right) \frac{2\theta p}{\epsilon t} E[wL^*]^{-2} - \left(\frac{t^2}{1-t} p^{-1} + \frac{2\theta\pi}{\epsilon}\frac{p}{t} \right) \right) \\
&= \text{sign}\left(\left(\frac{t^2}{2p^2\pi} - \theta \right) \left(\frac{\pi p}{t} - \frac{\epsilon t^2}{2\theta p\,(1-t)} \right)^2 - \left(\frac{\epsilon t^3}{2\theta p^2\,(1-t)} + \pi \right) \right) \quad \text{using (14)} \\
&= \text{sign}\left(-1 - \frac{p^2}{\widetilde{p}^2} - \frac{\widetilde{p}^2}{p^2}\frac{2\epsilon t}{1-t} - \left(\frac{\widetilde{p}^2}{p^2}\frac{\epsilon}{1-t} + \frac{2}{\pi p} E[wL^*]^{-1} \right) \frac{\epsilon t^2}{1-t} \left(\frac{\widetilde{p}^2}{p^2} - 1 \right) \right)
\end{aligned}$$

Again, the expression in brackets is negative. Thus, $\frac{\partial t}{\partial w} < 0$. Regarding the expected marginal impact of the marginal auditing cost on the optimal auditing probability, using that $\frac{\partial F_1}{\partial t}$ can also be written as $\frac{\partial F_1}{\partial t} = \frac{1}{(1-t)} + \frac{1-\epsilon t}{(1-t)^2} + \frac{p^2}{\widetilde{p}^2}\left(\frac{1}{t\epsilon} + \frac{1}{(1-t)}\right)$, we find that

$$\begin{aligned}
\text{sign}\frac{\partial p}{\partial \theta} &= \text{sign}\left(\underbrace{\frac{\partial F_2}{\partial t}}_{+}\underbrace{\frac{\partial F_1}{\partial \theta}}_{-} - \underbrace{\frac{\partial F_1}{\partial t}}_{+}\underbrace{\frac{\partial F_2}{\partial \theta}}_{-} \right) \\
&= \text{sign}\begin{pmatrix} -\left(1 - \frac{p^2}{\widetilde{p}^2}\right)\left(E[wL^*] - \frac{t}{p\pi}\right)\frac{t}{1-t}\frac{1}{\theta} \\ +\left(\frac{1}{(1-t)} + \frac{1-\epsilon t}{(1-t)^2} + \frac{p^2}{\widetilde{p}^2}\left(\frac{1}{t\epsilon} + \frac{1}{1-t}\right)\right) p \end{pmatrix} \\
&= \text{sign}\begin{pmatrix} -\left(1 - \frac{p^2}{\widetilde{p}^2}\right)\frac{t}{1-t}\epsilon E[wL^*]\frac{\widetilde{p}^2}{p^2}\frac{t}{1-t}\frac{1}{\theta} \\ +\left(\frac{1}{(1-t)} + \frac{1-\epsilon t}{(1-t)^2} + \frac{p^2}{\widetilde{p}^2}\left(\frac{1}{t\epsilon} + \frac{1}{1-t}\right)\right) p \end{pmatrix} \quad \text{using (14)} \\
&= \text{sign}\begin{pmatrix} -\left(1 - \frac{p^2}{\widetilde{p}^2}\right)\frac{t}{1-t}\epsilon\frac{\widetilde{p}^2}{p^2}\left(\frac{T}{(1+\gamma)\theta p} + 1 + \frac{\widetilde{p}^2}{p^2}\right) \\ +\left(1 + \frac{1-\epsilon t}{(1-t)} + \frac{p^2}{\widetilde{p}^2}\left(\frac{1-t}{t\epsilon} + 1\right)\right) \end{pmatrix} \quad \text{using (15)}
\end{aligned}$$

The function in brackets is convex in ϵ with positive sign for $\epsilon \rightarrow 0$ and negative sign for $\epsilon \rightarrow \infty$.

Thus, $\exists \widetilde{\epsilon}$ such that $\frac{\partial p}{\partial \theta} > 0$ for $\epsilon < \widetilde{\epsilon}$ and $\frac{\partial p}{\partial \theta} < 0$ for $\epsilon > \widetilde{\epsilon}$.

Proof of Proposition 3

First, notice that

$$\frac{\partial F_1}{\partial p} + \frac{t}{p}\frac{\partial F_1}{\partial t} = \frac{t}{p}\frac{1}{(1-t)^2} + 2\theta(1-t)^{-1}E[wL^*]^{-1} > 0.$$

Using this, from equation (1) we get

$$\begin{aligned}\frac{\partial F}{\partial T} &= \frac{1}{p\pi}\left(\frac{\partial t}{\partial T} - \frac{t}{p}\frac{\partial p}{\partial T}\right) \\ &= -D^{-1}\frac{1}{p\pi}\left(-\frac{\partial F_1}{\partial p} - \frac{t}{p}\frac{\partial F_1}{\partial t}\right)\frac{\partial F_2}{\partial T} < 0\end{aligned}$$

and

$$\begin{aligned}\frac{\partial F}{\partial \gamma} &= \frac{1}{p\pi}\left(\frac{\partial t}{\partial \gamma} - \frac{1}{p}\frac{\partial p}{\partial \gamma}\right) \\ &= -D^{-1}\frac{1}{p\pi}\left(-\frac{\partial F_1}{\partial p} - \frac{t}{p}\frac{\partial F_1}{\partial t}\right)\frac{\partial F_2}{\partial \gamma} < 0.\end{aligned}$$

Appendix B. Data sources and treatment of missing values

The data for labor force and unemployment are drawn from OECD Statistics-online (OECD, 2009b). Measures of total social expenditures, and direct and indirect taxes as well as population data are taken from OECD Statistics-online (OECD, 2009b). GDP quotes are obtained from the World Development Indicators (The World Bank, 2006). Revenues and expenditures of the countries from and to EU are from the Financial Report of EU (EU, 2007).

Required for the construction of the p_i measures, the number of employees in the financial administration system is not documented by the OECD on an annual basis. As one might expect, the time variation of this count variable is moderate and so we replace for each country the counts missing for 2001, 2003, 2005 and 2006 by the quantities reported for 2002, 2004 and 2007, respectively. On top of that, however, data on tax efficiency are missing for Belgium (for all years), Denmark, Italy, Netherlands (for 2007). Moreover, this statistic has not been published by the OECD for 2001 and 2002. We replace the 2007 missing values for Denmark, Italy and the Netherlands by 2004 quotes. Thus, for these countries the tax efficiency measure is effectively constant over the time period 2004 to 2007. For the periods 2001 and 2002 tax efficiency estimates are imputed by country as backcasts implied by a linear trend estimate conditional on the available country specific information.

As tax efficiency statistics for Belgium are unavailable we set it to 3.5 which is between the average estimates for France and Germany and somewhat closer to the former. Varying the tax efficiency constant for Belgium between the boundaries spanned by statistics for Germany and France does not change the empirical results documented in Section 3 in a qualitative manner.

Measures of total social expenditures have not been reported for the years 2006 and 2007. Noting that this variable evolves are rather smoothly in developed economies, we replace missing values in 2006 and 2007 by quotas reported for 2005. A further missing value for PRT in 2005 is replaced by the observation in 2004.

Member State	Size of the shadow economy	1) Trad. own res.	2) VAT own res.	3) GNP own res.	4) UK cor.	5) Total own resources: 1)+2)+3)+4)	6) Total own resources (off. data)	7) Total change: 5)-6)	8) Relative change: 7)/6)
Austria	11,0%	177	324	1531	31	2063	2165	-102	-4,73%
Belgium	20,7%	1064	370	2090	251	3776	3700	76	2,04%
Denmark	17,1%	215	244	1398	168	2024	2028	-4	-0,19%
Finland	17,2%	80	193	1062	128	1463	1464	-1	-0,09%
France	14,3%	1090	2345	11328	1364	16127	16511	-384	-2,32%
Germany	16,1%	2323	3094	15506	315	21239	21398	-159	-0,74%
Greece	28,1%	145	283	1273	153	1855	1709	146	8,55%
Ireland	15,2%	107	185	833	100	1226	1245	-19	-1,53%
Italy	25,2%	1060	1729	10251	1234	14275	13448	827	6,15%
Netherlands	12,5%	1189	694	3244	66	5193	5354	-161	-3,00%
Portugal	21,7%	109	225	1011	122	1466	1415	51	3,58%
Spain	21,9%	714	1267	5694	686	8360	8062	297	3,69%
Sweden	18,1%	281	367	1959	40	2647	2627	20	0,74%
United Kingdom	12,3%	2483	2521	11541	-4660	11886	12473	-587	-4,70%
Total		11036	13842	68721	0	93599	93599	0	

Table 1: Shadow economy (SE) adjusted 2004 EU budget. 1) are traditional own resources (Official data, EUR-Lex, 2004), 2) VAT own resources (SE adjusted), 3) GNP own resources (SE adjusted), and 4) is the UK correction (SE adjusted). Values in million euros. Luxembourg is not included. Columns 4-6 are calculated with the formulas used by the EU (EUR-Lex, 2004) where the VAT and GNP values of each country are adjusted for shadow economic activity according to the 2004 estimates in Schneider (2009).

Member State	Size of the shadow economy	1) Trad. own res.	2) VAT own res.	3) GNP own res.	4) UK cor.	5) Total own resources: 1)+2)+3)+4)	6) Total own resources (off. data)	7) Total change: 5)-6)	8) Relative change: 7)/6)
Austria	8,5%	246	495	1492	39	2271	2414	-143	-5,89%
Belgium	17,8%	1990	641	1995	285	4912	4879	33	0,67%
Bulgaria*)	35,4%	86	88	234	33	441	389	52	13,34%
Cyprus**)	25,0%	50	38	102	15	205	193	12	6,02%
Czech Republic*)	18,0%	247	313	834	119	1513	1488	25	1,71%
Denmark	14,3%	386	425	1341	192	2343	2382	-39	-1,62%
Estonia*)	38,1%	37	44	117	17	214	185	29	15,57%
Finland	14,2%	168	338	1070	153	1729	1761	-32	-1,84%
France	11,6%	1457	3878	10661	1525	17520	18125	-605	-3,34%
Germany	14,6%	3583	4476	13940	360	22359	22639	-279	-1,23%
Greece	25,0%	269	562	1499	214	2545	2374	171	7,19%
Hungary*)	24,3%	139	207	615	88	1049	990	59	5,97%
Ireland	13,1%	259	341	909	130	1639	1670	-31	-1,85%
Italy	22,0%	1915	2880	9267	1326	15387	14796	591	3,99%
Latvia*)	39,2%	34	62	166	24	286	243	43	17,52%
Lithuania*)	30,5%	54	79	211	30	373	337	36	10,80%
Luxembourg*)	9,4%	23	61	166	23	268	282	-14	-4,95%
Malta*)	26,9%	10	13	35	5	63	58	5	8,05%
Netherlands	10,2%	2116	1168	3167	82	6533	6745	-212	-3,15%
Poland*)	26,7%	476	849	2263	324	3912	3611	301	8,32%
Portugal	19,5%	161	352	937	134	1583	1537	46	3,00%
Romania*)	37,5%	246	294	934	134	1607	1400	207	14,79%
Slovenia*)	27,2%	107	85	227	33	452	421	31	7,47%
Slovakia*)	18,3%	118	114	368	53	653	645	8	1,14%
Spain	19,5%	1446	2343	6242	893	10924	10617	307	2,89%
Sweden	15,4%	496	620	1962	51	3129	3152	-23	-0,72%
United Kingdom	10,9%	3107	3777	10240	-6280	10844	11421	-577	-5,05%
Total						114754	114754	0	0

Table 2: Shadow economy (SE) adjusted 2009 EU budget. 1) are traditional own resources (Official data, EUR-Lex, 2009), 2) VAT own resources (SE adjusted), 3) GNP own resources (SE adjusted), and 4) is the UK correction (SE adjusted). Values in million euros. Columns 4-6 are calculated with the formulas used by the EU (EUR-Lex, 2009) where the VAT and GNP values of each country are adjusted for shadow economic activity according to the 2009 estimates in Schneider (2009). *) the values are 2006 estimates from Schneider 2007. **) the value for Cyprus is set equal to Greece.

f_i	extent of shadow economic activities in % of GDP
p_i	index of auditing activities and punishment in $10(\%)^2$
t_i	tax quote (sum of direct and indirect taxes and obligatory contributions to social security systems) in % of GDP
1	constant
ci_i	corruption index as published by Transparency International ($\times 10$)
y_i	per capita nominal income in 1000 Euro
u_i	unemployment in % of labor force
eu_i	net EU budget position in % of GDP
s_i	social expenditure minus obligatory contributions to social security systems in % of GDP

Table 3: Definition and scale of endogenous and exogenous variables. The cross section of economies comprises Austria (AUT, $i = 1$), Belgium (BEL, 2), Denmark (DNK, 3), Finland (FIN, 4), France (FRA, 5), Germany (GER, 6), Greece (GRC, 7), Ireland (IRL, 8), Italy (ITA, 9), Netherlands (NLD, 10), Portugal (PRT, 11), Spain (ESP, 12), Sweden (SWE, 13), United Kingdom (UK, 14).

emp.		ci_i	y_i	u_i	eu_i	s_i
	theo.	θ	w	γ	T	T
f_i	F			-	+	-
p_i	p	-	-	+	-	+
t_i	t	-	-	+	-	+

Table 4: Reduced form implied marginal impacts according to Propositions 2 and 3. Empirical variables (emp.) with counterparts from the theoretical model (theo.). Notably, c_i and eu_i are inversely related to θ and T, respectively. For the impact of c_i (θ) on p_i (p) labor supply is assumed inelastic.

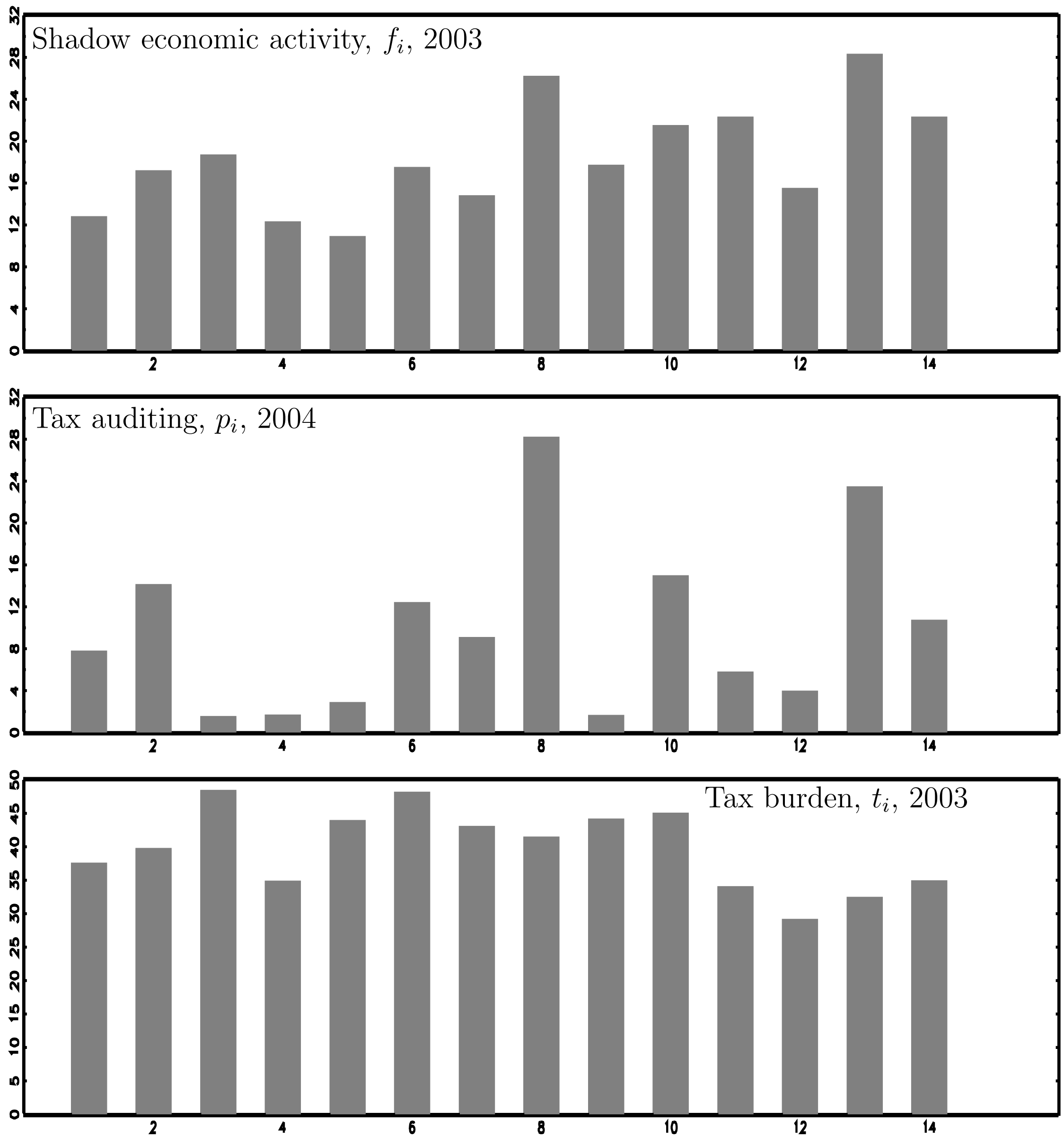

Figure 1 Endogenous variables in 2003/2004. Arabic numbers along the x-axis indicate an ordinal ordering according to the countries 2003 EU net budget position. The ordering of cross sectional entities (from net payers to net receivers) is NLD(1), GER(2), SWE(3), UK(4), AUT(5), DNK(6), FRA(7), ITA(8), FIN(9), BEL(10), ESP(11), IRL(12) GRC(13), PRT(14)).

2003	f_i	p_i	t_i	1	ci_i	y_i	u_i	eu_i	s_i
av	18.33	9.775	39.64	1.000	76.36	26.02	7.200	0.330	33.55
std	5.173	8.240	6.052	-	15.72	6.139	2.413	0.919	7.673
min	10.8	1.42	29.0	-	43.0	13.3	4.30	-0.614	25.1
	AUT	SWE	IRL		GRC	PRT	NLD	NLD	GRC
max	28.2	28.1	48.3	-	97.0	34.9	11.5	2.51	53.5
	GRC	ITA	SWE		FIN	DNK	ESP	PRT	DNK
av $\bar{x}$	17.54	9.829	40.01	1.000	75.87	27.39	6.932	0.234	35.51
std $\bar{x}$	1.187	1.049	0.332	-	0.8964	2.227	0.424	0.082	0.286

Table 5: Descriptive statistics for endogenous and exogenous variables (see also Table 3 for the definition and scaling of the variables). Cross sectional average quotes and standard deviations are given for 2003 (for p_i missing 2003 quotes are filled by 2004 statistics). Minimum and maximum realizations in 2003 (2004 for p_i) are also listed. Time averages of cross sectional means are denoted $\bar{x}$ and characterized in terms of their mean (av $\bar{x}$) and standard deviation (std $\bar{x}$).

	f_i	p_i	t_i	1	ci_i	y_i	u_i	eu_i	s_i	R^2	ov
dep	2 SLS, year 2003										
f_i		−13.06 (−2.04)	10.51 (2.09)	300.1 (2.22)	−8.058 (−2.09)	2.306 (1.87)	−2.134 (−1.59)			.764	-
p_i	0.919 (1.63)			18.95 (0.94)	−0.322 (−2.11)			−4.303 (−2.12)		.705	2.35
t_i	0.329 (1.16)			24.01 (2.69)		−0.324 (−1.35)		−4.671 (−3.64)	0.583 (4.31)	.832	0.04
	3 SLS, year 2003										
f_i		−11.81 (−2.53)	9.453 (2.59)	272.6 (2.77)	−7.271 (−2.60)	2.060 (2.34)	−1.656 (−1.73)			.775	-
p_i	0.920 (1.93)			18.89 (1.11)	−0.322 (−2.50)			−4.302 (−2.51)		.705	2.35
t_i	0.333 (1.47)			23.52 (3.30)		−0.317 (−1.66)		−4.633 (−4.50)	0.590 (5.44)	.843	0.05
	3 SLS, year 2005										
f_i		−0.760 (−2.99)	0.686 (4.21)	28.70 (6.13)	−0.539 (−5.60)	0.134 (0.98)	0.790 (2.21)			.853	-
p_i	0.708 (1.85)			15.79 (1.18)	−0.230 (−2.26)			−6.832 (−3.98)		.697	1.01
t_i	0.337 (1.45)			20.43 (3.25)		−0.260 (−1.72)		−4.544 (−3.28)	0.651 (6.08)	.840	4.46
	3 SLS, year 2007										
f_i		2.504 (2.69)	−1.041 (−2.01)	−33.12 (−1.45)	0.645 (1.88)	0.101 (0.72)	2.920 (2.55)			.780	-
p_i	0.858 (1.82)			3.991 (0.28)	−0.119 (−1.09)			−2.515 (−1.51)		.596	5.43
t_i	0.495 (1.59)			23.92 (3.40)		−0.293 (−1.96)		−5.764 (−4.34)	0.560 (4.71)	.792	0.84
	2 SLS mean group 2001-2007										
f_i		−3.839 (−2.03)	2.930 (2.12)	95.21 (2.41)	−2.393 (−2.29)	0.633 (1.72)	1.399 (1.28)			.785	-
p_i	0.917 (12.8)			18.80 (5.23)	−0.317 (−5.48)			−5.025 (−6.51)		.673	-
t_i	0.434 (8.33)			20.85 (13.9)		−0.205 (−4.39)		−4.960 (−29.1)	0.549 (21.6)	.820	-
	3 SLS mean group 2001-2007										
f_i		−3.510 (−1.98)	2.619 (2.10)	88.02 (2.42)	−2.171 (−2.27)	0.575 (1.64)	1.526 (1.47)			.793	-
p_i	0.889 (11.2)			20.15 (5.63)	−0.328 (−5.74)			−5.057 (−6.49)		.683	-
t_i	0.436 (7.36)			20.50 (10.9)		−0.200 (−3.48)		−4.918 (−28.8)	0.556 (21.5)	.831	-
	3 SLS, mean group 2001-2007, after trimming p_i for ITA and GRC										
f_i		−2.496 (−0.41)	1.746 (0.47)	77.40 (0.68)	−1.395 (−0.51)	−0.304 (−0.61)	1.228 (1.55)			.790	-
p_i	0.692 (11.6)			14.85 (4.30)	−0.228 (−4.66)			−3.804 (−6.38)		.574	-
t_i	0.433 (7.76)			20.74 (11.8)		−0.206 (−3.91)		−4.935 (−29.4)	0.554 (21.7)	.827	-

Table 6: 2SLS and 3SLS estimation and diagnostic results ($t-$ratios in parentheses). Single year cross sectional regressions (2003,2005 and 2007, upper panels) and time mean group estimates are distinguished (lower panels). 'dep' is the dependent variable, 'ov' refers to χ^2 statistics testing the overidentifying restrictions in (10) and (11) (having under the null hypothesis of valid restrictions 2 and 1 degrees of freedom, respectively, equation (9) is just identified). R^2 is the single equation or average degree of explanation.

	1	ci_i	y_i	u_i	eu_i	s_i	1	ci_i	y_i	u_i	eu_i	s_i
	2003						2005					
f_i	21.02	−0.222	−0.103	0.717	1.186	0.340	22.53	−0.259	−0.070	0.676	1.623	0.340
	(13.2)	(−14.9)	(−2.60)	(9.77)	(5.27)	(13.4)	(13.3)	(−16.3)	(−1.87)	(7.81)	(5.39)	(12.4)
p_i	45.26	−0.651	−0.096	0.021	−3.467	0.527	23.28	−0.395	0.117	0.911	−4.931	0.212
	(46.2)	(−70.9)	(−3.91)	(0.47)	(−25.0)	(33.6)	(21.7)	(−39.4)	(4.97)	(16.7)	(−26.0)	(12.2)
t_i	29.69	−0.063	−0.348	0.298	−4.195	0.688	14.61	−0.022	−0.134	0.960	−2.910	0.724
	(22.4)	(−5.09)	(−10.5)	(4.87)	(−22.4)	(32.4)	(9.05)	(−1.44)	(−3.80)	(11.7)	(−10.2)	(27.7)
	2007						Mean group					
f_i	23.02	−0.232	−0.108	0.488	0.667	0.313	21.55	−0.215	−0.147	0.646	1.179	0.340
	(14.5)	(−13.9)	(−3.41)	(4.68)	(2.55)	(11.4)	(46.2)	(−13.6)	(−3.69)	(18.9)	(10.4)	(36.5)
p_i	35.89	−0.395	−0.217	−0.805	−1.941	0.429	40.00	−0.579	−0.071	0.302	−3.784	0.425
	(23.6)	(−24.7)	(−7.15)	(−8.05)	(−7.74)	(16.3)	(7.19)	(−7.99)	(−0.93)	(1.22)	(−5.85)	(6.15)
t_i	29.54	−0.091	−0.293	0.661	−5.288	0.705	25.65	−0.068	−0.234	0.555	−4.190	0.686
	(19.1)	(−5.63)	(−9.47)	(6.50)	(−20.7)	(26.3)	(11.3)	(−4.94)	(−6.30)	(5.34)	(−15.2)	(49.4)
							Mean group after trimming p_i for GRC and ITA.					
p_i							29.55	−0.412	−0.062	0.314	−2.810	0.315
							(5.77)	(−6.78)	(−0.93)	(1.42)	(−5.54)	(5.29)

Table 7: Reduced form estimates (see (12)) for single years and time mean group results. Results in the lower right are given for trimmed p_i statistics. Mean group $t$ratios are in parentheses.

	Δf_i				Δp_i					Δt_i			
	2003	2005	2007	mg	2003	2005	2007	mg	mg*	2003	2005	2007	mg
AUT	1.28	1.91	1.23	1.53 (9.71)	-6.14	-14.9	-6.30	−9.60 (−4.97)	−7.30 (−4.64)	-1.66	-1.12	-3.13	−2.01 (−5.55)
BEL	-2.20	-4.36	-1.49	−2.63 (−5.87)	11.5	27.1	8.85	13.9 (4.20)	11.1 (4.41)	3.70	3.76	5.14	4.18 (9.41)
DEN	0.99	2.04	1.55	1.48 (7.59)	-5.88	-14.2	-7.00	−10.2 (−5.70)	−8.13 (−4.77)	-1.26	-1.17	-3.61	−1.88 (−5.13)
FIN	-0.05	0.80	0.60	0.55 (2.75)	3.02	-6.79	-8.83	−4.85 (−0.51)	17.8 (0.93)	0.07	-0.46	-1.41	−0.75 (−2.55)
FRA	0.64	1.61	0.64	0.99 (7.63)	-2.54	-6.64	-3.74	−3.90 (−6.52)	−3.34 (−6.66)	-1.14	-1.26	-1.98	−1.58 (−12.0)
GER	2.84	3.73	1.84	2.76 (11.9)	-16.1	-15.1	-20.2	−16.1 (−6.71)	−12.1 (−6.98)	-4.30	-2.56	-5.05	−3.97 (−10.6)
GRC	-7.45	-9.92	-6.50	−8.58 (−19.1)	25.3	57.6	32.4	36.9 (6.26)	34.4 (5.68)	21.0	14.9	39.5	26.7 (7.84)
IRL	-8.83	-7.21	-1.57	−6.99 (−5.92)	85.0	58.2	10.2	94.2 (2.95)	62.0 (3.04)	16.1	6.02	4.87	11.2 (5.81)
ITA	0.43	1.40	0.57	1.01 (6.59)	-1.16	-4.73	-1.89	−2.94 (−5.07)	−2.79 (−4.96)	-0.84	-1.44	-2.14	−1.88 (−8.68)
NLD	6.91	11.4	6.11	8.10 (12.9)	-96.8	-47.2	-35.3	−144. (−2.13)	−55.5 (−3.63)	-6.81	-5.81	-10.8	−7.86 (−10.7)
PRT	-12.9	-11.4	-4.88	−9.44 (−7.62)	97.9	166.	28.2	75.9 (4.05)	59.6 (4.24)	31.3	12.9	21.1	21.0 (9.24)
ESP	-5.79	-5.07	-1.09	−4.52 (−5.45)	43.0	32.4	6.75	40.8 (3.18)	32.2 (3.06)	12.8	4.76	3.85	9.00 (4.94)
SWE	2.93	3.91	1.93	2.96 (12.2)	-22.0	-21.5	-15.0	−24.2 (−5.31)	−17.3 (−4.79)	-3.49	-2.31	-4.44	−3.53 (−11.5)
UK	2.13	2.47	1.58	1.97 (7.87)	-18.8	-18.2	-8.98	−17.0 (−4.49)	−11.5 (−5.11)	-2.51	-1.45	-3.93	−2.36 (−7.23)

Table 8: Effect of zero EU budget balance ($eu_i = 0$) on the shadow economy, tax auditing and the tax burden over countries. Entries are measured as difference in percent of the estimates obtained under the status quo of an existing EU financing system. Average estimates over the sample period 2001 to 2007 are given with mean group $t-$ratios in parentheses. mg* indicates mean group results after trimming the p_i quotes for GRC and ITA. See also Figure 4 for an illustration of outlying quotes. Since comparison with the counterfactual scenario depends merely on the reduced form of the model (see (12)) Δf_i and Δt_i do not change when trimming the p_i data.