European Commission

JRC TECHNICAL REPORTS

# Measuring the fiscal and equity impact of tax evasion: evidence from Denmark and Estonia

*JRC Working Papers on Taxation and Structural Reforms No 05/2017*

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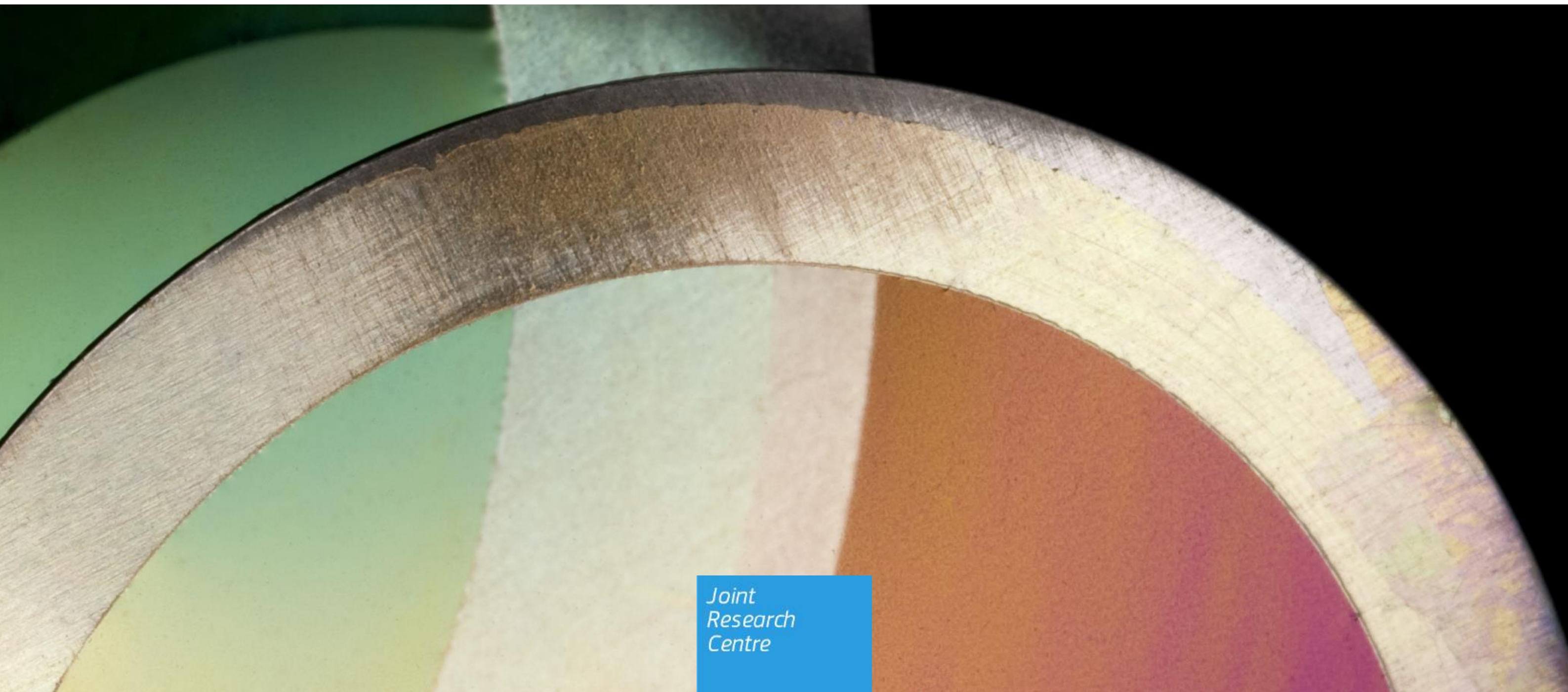
December 2017



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JRC109629

ISSN 1831-9408

Sevilla, Spain: European Commission, 2017

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How to cite: Barrios, S., Greve, B., Hussain, M. A., Paulus, A., Picos, F. and S. Riscado (2017), "Measuring the fiscal and equity impact of tax evasion: evidence from Denmark and Estonia"; JRC Working Papers on Taxation and Structural Reforms No 05/2017, European Commission, Joint Research Centre, Seville, JRC109629

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## Abstract

In the European context where fiscal consolidation is required in many countries, tax non-compliance behaviour becomes a very relevant issue for governments and policy makers. In this paper, we aim at contributing to the assessment of tax non-compliance, by estimating individual measures of tax evasion, focusing on employment earnings for two countries, Denmark and Estonia. Additionally, we simulate two different scenarios – a "true world" where some individuals underreport their income to the tax authorities and a "perfect world" where everyone reports truthfully their incomes – in the European microsimulation model EUROMOD, allowing us to obtain the fiscal and distributional effects of taking into account evaded employment income. Furthermore, the Estonian country case allows us to illustrate the importance of linking survey and administrative data not only to accurately estimate tax evasion, but also to correct survey income amounts for measurement error. Preliminary findings indicate that taking into account non-reported incomes has non-negligible fiscal and distributional effects when these are taken into account to compute tax liabilities and benefits, even in a country where estimated non-reported income represent a low percentage of earnings, such as Denmark.

# 1 Introduction

Tax evasion is a source of major concern in a number of European countries. Tax evasion erodes tax bases, and policy measures to fight it are usually difficult to implement effectively. It has also important implications for the conduct of fiscal policy, especially so in countries with fiscal consolidation needs and where tax capacity is substantially lower than the average. Tax evasion affects directly the fundamental objectives of tax policy with regards to the efficiency and equity of the tax and benefits system. It can impact negatively on economic performance as it is usually correlated with low civic behaviour and makes it harder to deliver public services such as health or education. On the efficiency side, tax evasion generates a shift of the tax burden onto non-evaders which might distort consumption and labour supply decisions. On the equity side, tax evasion undermines the social contract between the state and taxpayers (horizontal equity) and weakens the redistributive nature of the tax and benefit system (vertical equity). The problems of tax evasion and non-compliance might therefore have wide-ranging social and policy consequences. These detrimental effects are likely to be exacerbated and acquire special relevance in times of severe economic crisis to meet fiscal objectives and to soften their social consequences. In this context, it is very important to quantify tax evasion and its effects in terms of revenue loss and distributional impact. However, analytical tools to measure the extent and consequences of tax evasion remain limited and to date, largely unsatisfactory (see Schneider and Buehn, 2016), mainly because existing tools often rely on aggregate national statistics in an attempt to discover the causes of so-called "tax gaps". In this way, the objective of this paper is twofold: firstly we want to estimate non-reported employment income at individual level; secondly we are also interested in investigating the fiscal and distributional impact of taking non-reported employment income into account. We focus on tax non-compliance behaviour of households and individuals, and we present two country cases – Denmark and Estonia. For each of these countries, and using different methodological approaches – which depend directly on the micro-data availability in each country – we quantify tax evasion as the estimated share of employment income of individuals which is not reported to tax authorities. Then we use the tax-benefit microsimulation model EUROMOD to analyse the fiscal and distributional effects of correcting individuals/households incomes to take into account non-declared incomes. In this way, we are able to compute the loss on tax revenues compared to the case of full-compliance and also to understand the real distributional situation of individuals across income deciles. This is fundamental to accurately assess social welfare, since, as Sutherland et al. (2009) put it, "low take up, leakage of benefits to ineligible recipients and misreporting of taxable income will distort the intended impact of changes in social transfers and the tax system, and will limit the validity of projections based on the assumption of full compliance to policy rules".

Approaching the problems of tax evasion and non-compliance is not straightforward because of its hidden nature. From a theoretical point of view, compliance behaviour is difficult to explain, especially if one takes the neoclassical perspective. The traditional approach to taxation and taxpayers' behaviour relies on an expected utility model, as the one introduced by Allingham and Sandmo (1972), where rational, homogeneous and risk adverse taxpayers choose between a safe portfolio – implying full compliance with the tax law – and a risky one – implying income underreporting. However, considering reasonable values for variables such as fine and audit rates, tax rates and risk aversion parameters, the neoclassical set up predicts very high tax evasion, which is not really observed. More recently, behavioural models of taxation try to depart from the rational and risk-averse taxpayer set up. As explained in Weber et al. (2014), it may be more reasonable to assume that taxpayers do not know the distribution of probabilities of the tax audits and that the presence of social determinants, such as peer effects, social norms, fairness values, provision of public goods, and psychological factors, are important to explain tax compliance behaviour.

In this paper we focus on survey and administrative data to understand tax non-compliance behaviour. In this way, a number of caveats should be considered in our analysis. First, surveys imply a time lag between the moment the individuals are interviewed and the moment the incomes were earned/received. This means that recall problems are very likely to arise at the moment when individuals are answering to the survey, meaning that incomes may be reported with measurement error. Practitioners are often concerned with measurement errors problems, especially regarding the reporting of net income and social benefits. The analysis for Estonia relies on an exact respondent matching between survey data and the individual tax records, which were additionally pre-populated by third party (employers) information. Our starting hypothesis in this case is that tax evasion is positively correlated with the difference between the incomes declared in different datasets by each respondent. Moreover, and following Figari et al. (2009), we assume that survey respondents have no incentive to conceal their "true" income to the survey interviewers, because their answers have no impact on their disposable incomes.[1] This allows us to obtain an approximation of the amount of underreported income as the difference between the income reported in the surveys and the income declared to the tax authorities, taking also into account potential survey measurement errors. For that, we apply a novel econometric methodology, proposed by Paulus (2015), which allow us to disentangle intentional misreporting from measurement error. In the case of Denmark, the available micro-data on individual and households is already drawn from tax records. Therefore we are not able to apply the same methodology, and we need complementary information to infer on the tax non-compliance behaviour of the Danish. In this way, we have recurred to cross-section studies on the hidden economy (Hvidtfeldt et al., 2010; Skov, 2014a; Skov 2014b; and Skov et al., 2015) and also on national estimates of tax evasion aggregates (Skov, 2014a).

We estimate that in Estonia there are around of 30% partly non-compliant individuals among the employees' population, while the fully non-compliant share is close to 4%. The monetary extent of evaded earnings is though much more limited, with the share of non-reported income on the total estimated gross true earnings reaching almost 16% for private employees and 12% when considering all employees. In Denmark, considering a sample of individuals aged between 18 and 74, we find that among employees around 23.5% seem to be partially evading (this figure drops for the whole population to 16.7%). The distribution of non-reported incomes of the partially compliant employees as a percentage of true earnings shows a decreasing pattern across deciles, especially in the first half of the distribution, being quite flatter afterwards. On average, this percentage reaches 26% for partially compliant employees and only 7% for the whole population.

[1] However, other authors as Leventi et al. (2013) point out that tax evaders may try to be consistent with their tax evading behaviour and underreport their income also in the surveys.

The EUROMOD simulations show that there are non-negligible fiscal and distributional effects of taking into account evaded employment incomes to compute tax liabilities and benefits. Interestingly, our preliminary findings indicate that although in aggregate terms the fiscal impact of tax evasion is lower in Denmark than in Estonia, on average the disposable income change is relatively higher. This seems to reflect the higher relative weight of the Danish tax-benefit system in the economy compared to the Estonian one.

This paper is organized as follows. Section 2 describes the datasets used to estimate a measure of tax evasion. Section 3 explains the estimation methodology applied in each case study and its main results, while section 4 presents the results of the fiscal and equity impacts of accounting for tax evasion in Estonia and Denmark. Section 5 concludes.

# 2 Data

In the two country cases we use cross-section micro-data from the European Survey on Income and Living Conditions (EU-SILC), which offers data on employment income at the individual level. Our common goal is to estimate non-reported employment income at an individual basis, but the different methodologies for data collection lead to different estimation methodologies in each case, as explained below.

*Estonia*

For Estonia it was possible to access tax records and to have an exact matching performed between the 2008 wave of national SILC and individual tax declarations, so we could compare the survey answers to the incomes declared to the tax authorities. No consent was required from the sample members to link datasets and thus any potential bias arising from consenting (see Sakshaug and Kreuter, 2012) is avoided. The linkage was based on personal IDs and achieved for practically all sample members, ensuring high quality of the combined dataset and effectively no loss of statistical representativeness.[2] From the 14,942 individual observations in SILC, we were able to link 99.5% with tax records, leaving us with a sample of 10,237 observations for which we have complete information on their employment status. From these, more than a half are employed people, i.e. they reported positive earnings in the survey. Both data sources (survey and register) provide income information by type at the individual (and household) level for 2007.

The information from tax records is not limited to what people report in tax returns. If the respondent did not file a tax report, the information provided by the employers was then used instead. This information is also used to pre-populated individual tax reports, as referred before. The tax records distinguish between various types of payment in greater detail, allowing us to construct a measure of earnings from the tax records, which corresponds conceptually to the one in SILC as close as possible.[3] It is worth emphasising that unlike with a comparison of survey and register income information from independent (or non-matched) samples, we can directly contrast incomes from the two sources for the same individuals. It should come as no surprise that the two measures are highly correlated but generally not identical due to income misreporting in one or both data sources, which could have been either intentional or unintentional.

*Denmark*

In the Danish case the EU-SILC data is already drawn from tax records, so we needed complementary data, such as hidden economy surveys, and also national aggregates information on tax evasion, to be able to estimate underreporting employment income. Specifically, we have combined the 2011 wave of national SILC for Denmark with a series of cross-section studies on the hidden economy phenomenon (Hvidtfeldt et al. 2010, Skov 2014a, Skov 2014b Skov et al. 2015), and also on national aggregates on tax evasion estimated by Skov (2014a). The cross-section surveys are a representative sample of the Danish population, aged between 18 and 74 years old, and they cover the period

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[2] Statistics Estonia requested tax records information for sample members from the tax authority and the latter had no access to the linked dataset itself.

[3] Despite our best efforts to reconcile the two measures, it is possible that some conceptual differences may remain, though these are likely to be minor in the case of employment income which we focus on at this stage. Further details on data sources and their linkage, and the construction of comparable income measures from the two sources, can be found in Paulus (2015).

1994-2009, with a final total number of respondents of around 28,000 individuals (23,000 in the final set of analysis). They also include individual and household information on demographic, education, income and labour market characteristics. It is important to notice that the definition of hidden economy in these studies is very broad: it includes "black activities" but also free exchanges of services between individuals.[4] All interviews respected the confidentiality and anonymity of the individuals surveyed. We are also aware that individuals may misreport when asked about their participation in hidden activities, the "reasonable" time spent and monetary amounts gained in such activities. This misreporting can be unintentional, due mainly to recall difficulties[5], and can be considered measurement error, but there can also be intentional underreporting in case of high number of hours in hidden activities since this is not considered socially acceptable.[6] However, it is reasonable to assume that the measurement errors do not consist in systematically over or underreporting, and that on average they will wash out, given also the large sample considered.

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[4] Surveyed individuals faced the following question on the hidden economy: "*The next questions are about what is normally called 'black work'. There is a lot of evidence that a large part of the population accepts 'black work' and 'black transactions', meaning activities circumventing the tax authorities such that all involved gets away cheaper because it all happens without taxes and duties etc. This can include 'black activities', where there is cash payment, but it can also be exchange of services between friends, acquaintances, and family members. Have you during the last 12 months conducted activities of this kind?*"

[5] The recall period is of 12 months recall period in the surveys.

[6] According to Hvidtfeldt et al. (2010), "(…) even if people are willing to admit that they have done undeclared work, it is not certain that they are just as willing to admit how much undeclared work they have done. (…) One can therefore expect that estimates regarding how many hours people work on average to a larger degree underestimate the real extent compared to the "black participation" frequency.".

# 3 Methodology and estimation results

In this analysis we focus only on employment income in both country cases and, as explained before, we aim at correcting this type of income to take into account tax evasion on an individual basis in the EU-SILC micro-data. As we have noted before, the estimation methodologies chosen derive directly from the type of datasets available for analysis in each of the countries. In the Estonian case, since we can compare the employment income amounts reported in two different data sources by the same individuals, we are able to estimate "true" earnings as a latent variable, while disentangling also measurement error from intentional misreporting. As an identification strategy, we have assumed that public sector employees are not able to evade, so their declared incomes to the tax agency coincide with the true ones. However, they may unintentionally misreport their income in the survey. In the Danish case, we will use the cross-section studies on "hidden" economy to estimate non-reported employment income, depending on individual characteristics. Once we find these "hidden" amounts we correct the EU-SILC micro-data for those individuals more likely to be tax evaders.

*Estonia*

We build on the method developed in Paulus (2015) to estimate the distribution of true earnings on the basis of observed multiple employment income measures (from survey and register data sources) at the individual level. The approach allows us to take into account not only tax non-compliance but also possible measurement errors in the survey data. Paulus (2015) proposes a novel econometric model containing a system of three income equations: true income, register (or declared) income and survey income. All three dependent variables are modelled as a function of individual characteristics and – in the latter two cases – true income itself, which is not observed for everyone and is considered a latent variable. The identification strategy is based on the assumption that some workers (namely, public sector employees) are constrained in their choice to comply with the tax rules and, hence, their income is accurately reported to the tax authorities, while other workers (e.g. private sector employees) have no such constraints and may choose to declare only part of their incomes. It is also assumed that there are no systematic differences in the way the two types of workers report their incomes for the survey purposes, conditional on their characteristics and true income, and hence in the conditional distribution of survey measurement errors.

The method distinguishes between (i) full tax evasion where no income is reported for tax purposes, (ii) partial tax compliance where a fraction of earnings (0%<x<100%) is reported, and (iii) full compliance where all income is reported, and allows estimating the individual probabilities associated with each of the three states as well as predicting the (expected) level of true earnings. This provides a more realistic approach compared to methods where compliance is modelled as a binary variable or a given population sub-group assumed to misreport their incomes by the same proportion.

Formally, the econometric model is the following. Let us denote true income for individual $i$ as $y_i^T$, register income $y_i^r$ and survey income $y_i^s$. We observe a sample of employed people ($y_i^s > 0$), who are either truly employed $\left(y_i^T > 0\right)$ or actually non-employed $\left(y_i^T = 0\right)$.[7] We assume a fixed probability $p$ for the former case and $(1-p)$ for the latter. People with positive true earnings are either fully compliant $\left(y_i^r = y_i^T\right)$, partially compliant $\left(0 < y_i^r < y_i^T\right)$ or fully non-compliant $(y_i^r = 0)$. Conditional on truly working, we assume that true earnings are log-normally distributed:

$$\ln y_i^T = x_i \beta^T + \varepsilon_i^T$$
$$\varepsilon_i^T \sim N(0, \sigma_T^2)$$

where $x_i$ denotes (a vector of) person's characteristics. Register earnings, reflecting compliance behaviour, are modelled as a fraction of true earnings what the individual reports to the tax authority:

$$y_i^r = \begin{cases} 0 & \text{if } y_i^T = 0 & \text{(no earnings)} \\ 0 & \text{if } y_i^T > 0 \text{ and } r_i^* \leq 0 & \text{(full non-compliance)} \\ r_i^* \cdot y_i^T & \text{if } y_i^T > 0 \text{ and } 0 < r_i^* < 1 & \text{(partial compliance)} \\ y_i^T & \text{if } y_i^T > 0 \text{ and } r_i^* \geq 1 & \text{(full compliance)} \end{cases}$$

This is a two-limit Tobit model, relying on a latent variable $r_i^*$, which can be interpreted as the "propensity" to comply, and assumed to be a function of true earnings and individual characteristics:

$$r_i^* = \theta^r y_i^T + x_i \beta^r + \varepsilon_i^r$$
$$\varepsilon_i^r \sim N(0, \sigma_r^2)$$

Finally, conditional on our sample of (seemingly) employed people, log survey earnings are modelled as a function of log true earnings and individual characteristics:

$$\ln y_i^s = \theta^s \ln y_i^T \cdot 1\left(y_i^T > 0\right) + \theta_0^s \cdot 1\left(y_i^T = 0\right) + x_i \beta^s + \varepsilon_i^s$$
$$\varepsilon_i^s \sim N(0, \sigma_s^2)$$

We can combine the three earnings equations by writing the overall probability density function for a pair of observed individual earnings $(y_i^r, y_i^s)$, conditional on true earnings. As the latter is (partly) latent, we need to integrate it out over its plausible range, that is any amount equal to or larger than register earnings:

$$f(y_i^r, y_i^s) = f\left(y_i^T = y_i^r | x_i\right) \Pr\left(y_i^r = y_i^T | x_i, y_i^T\right) f\left(y_i^s | x_i, y_i^T = y_i^r\right) + \int_{y_i^r}^{\infty} f(y^T | x_i) f(y_i^r | x_i, y^T) f(y_i^s | x_i, y^T) \mathrm{d}y^T$$

All the components of the probability density function can be directly inferred from the structural equations above (we also assume that various error terms are independent of each other.). Full details can be found in Paulus (2015, Appendix A). Taking logs of individual probability densities and summing across all sample, yields the log likelihood function:

$$\ln L = \sum \ln f(y_i^r, y_i^s)$$

[7] Among possible reasons could be a recall error (e.g. from confusing income reference periods) or intentional misreporting (e.g. due to unwillingness to disclose not having worked).

This allows us to estimate all the parameters simultaneously using the maximum likelihood method.[8] In the case of public sector employees, who are assumed to be fully compliant, the probability density function simplifies considerably: the whole integral on the right-hand side disappears and $\Pr\left(y_i^r = y_i^T | x_i, y_i^T\right)$ is constrained to be 1.

By applying this methodology, we are able to estimate true earnings, measurement error related with the employment income declared in the survey data and the non-reported employment income, at an individual level.[9] With this information we are able to correct the EU-SILC data, at the individual level, for Estonia according to the following identity:

$$\begin{aligned}\text{survey earnings } (y^s) - \text{measurement error} &= \text{true earnings } (y^T) \\ &= \text{reported (register) earnings } (y^r) + \text{non} - \text{reported earnings}\end{aligned}$$

The estimated parameters provided by the econometric model just described are shown in Table A.1 of the Appendix.

Table 1 and Figure 1 below show the main findings regarding the estimation of the share of non-compliant people, and underreported and misreported earnings, respectively. From Table 1 we observe that about two thirds of private employees are estimated to be fully compliant. 29% are partially compliant and nearly 4% entirely non-compliant (i.e. reporting no earnings at all). There is also a marginal share of people (<1%) who report in SILC some positive earnings for the income reference period but who are assessed as likely to have made a reporting error. Once we consider the whole (estimation) sample, i.e. include public employees who are constrained to be compliant by assumption, we see that the share of fully and partially compliant people drops to about 3% and 23%, respectively.

**Table 1. Estimated true status of employed individuals (%), Estonia**[10]

| | Private employees | All employees |
|---|---:|---:|
| No earnings | 0.8 | 1.0 |
| Fully non-compliant | 3.9 | 3.1 |
| Partly compliant | 29.0 | 22.8 |
| Fully compliant | 66.3 | 73.2 |

In monetary terms, we observe, from Figure 1, the share of tax non-compliance is less extensive, however. Of total estimated gross true earnings, the share which is not reported to the tax authority is 15.9% for private employees and 12.6% for all sample. There is substantial variation across the distribution of (true) earnings though with much higher prevalence for the bottom decile group (25%); medium high for the second, the third and the top decile (14-15%) and the lowest prevalence

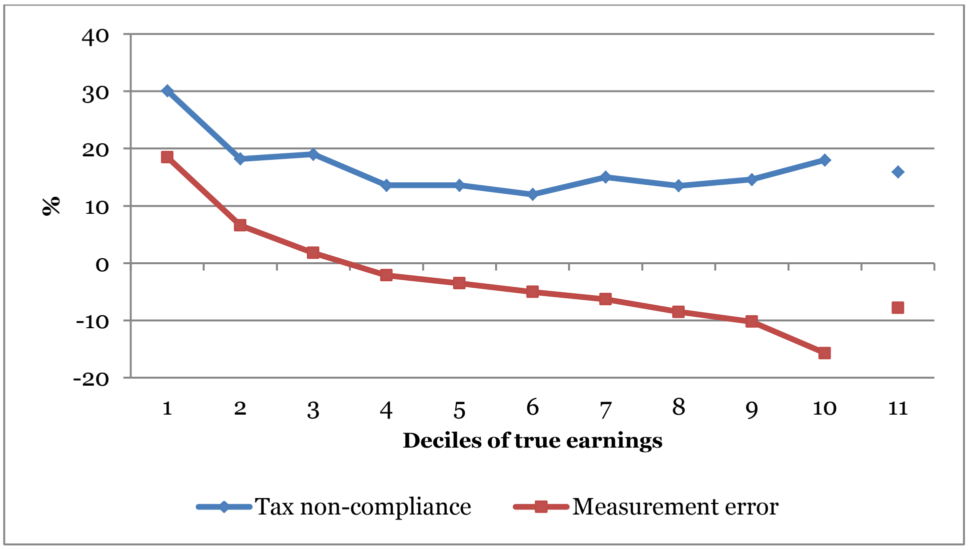
[8] The approach relates to and connects two strands of empirical literature, which have developed in isolation until now: research on partial detection of tax non-compliance using audit data (e.g. Feinstein, 1991) and analysis of survey measurement error using linked datasets (e.g. Kapteyn and Ypma, 2007).

[9] The sample used includes full-time and part-time employees, and the econometric specification used corresponds basically to the multiplicative model #1 in the sensitivity analysis of Paulus (2015).

[10] The estimation sample consists of individuals aged 16 or more declaring positive survey earnings ($y^s > 0$), who also i) answered "yes" to "ever had a regular job", ii) reported part- or full-time employment as the main activity at least for one month in 2007, and iii) whose survey earnings were not imputed and no covariate had a missing value. Survey weights were also not applied in this analysis.

for other deciles (9-12%). Overall, this generates the U-shape profile, illustrated in Figure 1 (blue line). Figure 1 also shows the extent of measurement error in the survey data by decile group. There is notable variation in survey mismeasurement across the true income distribution with large over-reporting at the bottom, modest mismeasurement in the middle and substantial underreporting in the top deciles. This confirms a general tendency of people to present themselves in the survey context more similar to the rest than they actually are. At the aggregate level, survey incomes underreport true earnings by almost 8 per cent.

**Figure 1. Estimated tax non-compliance for employees by decile group (% of true unequivalised earnings), Estonia**




*Denmark*

In order to estimate a measure of tax evasion for Denmark, we have assumed that tax evasion behaviour can be decomposed in three components: participation in "hidden" activities, number of hours per week spent in these activities, and the hourly wage rate earned. Each of these components was estimated by the Danish Economic Council (2011), using as explanatory variables individual characteristics such as gender, age, family status, income levels, education, sector of employment, etc. Dummies for survey years are also included in the regressions. The results of these estimations are shown in Table A.2 in the Appendix.

More specifically, the decision to participate in "hidden" activities is modelled as a logit regression. From this regression we are able to obtain the probability of participating in "hidden" activities for each individual aged between 18 and 74 in the EU-SILC data, according to her characteristics. With this information we are able to rank these individuals from the highest probability to the lowest, and from this ranking we set the percentage of individuals participating in tax evasion activities in our sample to match the estimated Danish national average in 2011, which amounted to 23.9% (Skov, 2014a). We assign probability one to the individuals of this sub-sample and we use the parameters of Table A.2 to estimate the weekly hours spent in "hidden" activities and also the hourly wage rate earned. As for the others we assign them a zero probability of participating in these activities.

In what concerns the weekly hours, and as we can observe from Table A.2, we only know the marginal effects resulting from the Tobit regression. Instead, using Skov (2014a) marginal averages for gender and age computed for those participating in hidden activities, we have assigned an average number of weekly hours devoted to hidden activities to the individuals in our sub-sample, conditional on the combination of these two individual characteristics. These joint averages are shown in Table 2 as well as the marginal averages for gender and age from Skov (2014a).

**Table 2. Estimation of average tax evasion hours, based on marginal gender/age averages for participants in hidden activities, Denmark**

| Age | Male | Female | Total |
|---|---|---|---|
| **18-29** | 4.74 | 3.15 | 4.20 |
| **30-39** | 1.52 | 1.01 | 1.35 |
| **40-49** | 1.90 | 1.26 | 1.68 |
| **50-59** | 1.86 | 1.24 | 1.65 |
| **60-74** | 2.75 | 1.83 | 2.43 |
| **Total** | 2.78 | 1.85 | 2.47 |

Source: Own calculations based on Skov (2014a)

We observe that men dedicate on average 2.78 hours per week to "hidden" activities, while the average for women is lower around 1.85 hours. The youngest seem also to spend more hours on average on these activities, compared with the oldest, with weekly averages of 4.20 and 2.43, respectively. The overall average amounts to 2.47. Each of the joint averages – combination between age and gender – is computed according to the following expression:

$$Average\ Hours\ (age, gender) = Age_{average} * Gender_{average}/Overall_{average}$$

For example, a male in his forties would on average spend 1.90 (=1.68*2.78/2.47) hours per week on "hidden" activities.

In what concerns weekly wages earned on "hidden" activities, these are modelled using an OLS regression and the estimated parameters – Table A.2, column four – are then used to predict the wage rate of individuals participating in tax evasion. These undergo a final correction, so that the average hourly wage rate earned in "hidden" activities matches the national average of DKK 211, estimated by Skov (2014a).[11]

Having estimated all the three components of tax evasion, we can assign to the EU-SILC micro-data the individual yearly employment income derived from participating in "hidden" activities. Also a

[11] This correction consisted of simply comparing the average of the estimated wage rate earned in the "hidden" market to the Danish national average in Skov (2014a) and varying the estimated wage rates according to the difference of those averages, in the same proportion for all the individuals participating in the hidden economy.

final correction is needed in order to match the total of employment income earned in tax evasion activities in our sample with the national average of DKK 42.2 billion (2.3% of the GDP, in 2011), estimated by Skov (2014a).[12]

In this way, the non-reported employment income, for the tax evasion participants is defined, in yearly terms, as follows:

$$
\begin{aligned}
&Non-reported\ income \\
&\qquad = Pr(evader \mid characteristics) * Hours\ per\ week\ (characteristics \mid evader) \\
&\qquad * \ hourly\ wage\ rate\ (characteristics \mid evader) * 52
\end{aligned}
$$

The main results of the estimation are shown below in Table 3 and Figure 2. Table 3 presents the estimated true status of employees and of all the individuals in the sample, while Figure 2 shows the estimated tax non-compliance for employees across the decile distribution. From Table 3, we observe that more than two thirds of the employees are fully compliant, while around 24% seem to be engaged in hidden activities (as expected, given the match between the estimation results and the Danish national averages). When we consider the whole population of individuals, we observe that 6.2% are estimated to be fully non-compliant, while the share of partially compliant individuals is reduced to around 17% and the fully compliant individuals' share remains around 77%.

**Table 3. Estimated true status of individuals (%), Denmark**

| | **Employees**[a] | **Whole population**[b] |
|---|---:|---:|
| Fully non-compliant | - | 6.2 |
| Partly compliant | 23.5 | 16.7 |
| Fully compliant | 76.5 | 77.1 |

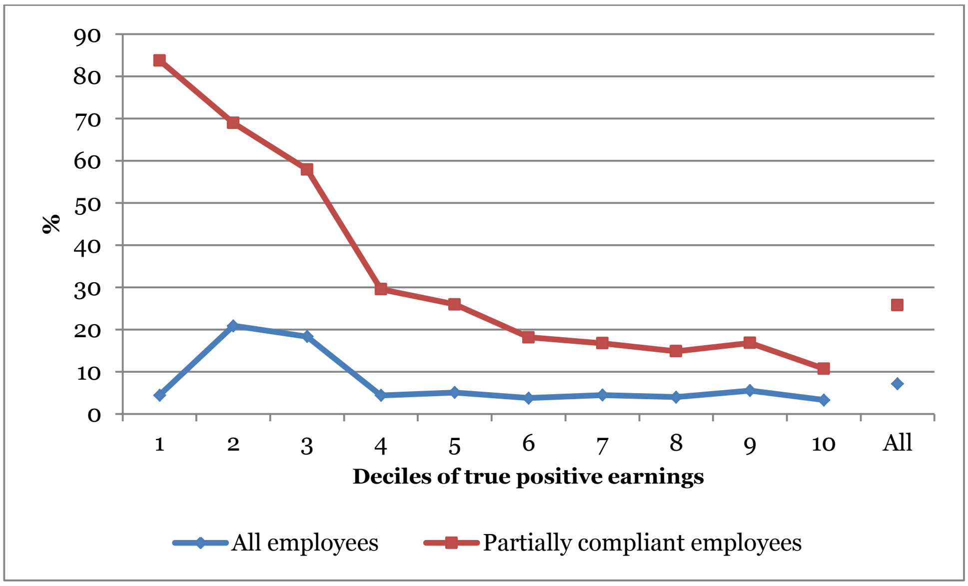
a. Individuals aged between 18 and 74 with positive wages; b. Individuals aged between 18 and 74.

In Figure 2 we quantify the share of unreported income across the deciles of the distribution of true earnings, for partially compliant employees – employees whose earnings were corrected by our estimation procedure – and for all employees – individuals declaring positive earnings. On average, we observe that unreported income accounts for around 26% for "evading" employees while this number falls to around 7% when considering all employees. The distribution of the share of unreported income of partially compliant employees shows in general a decreasing pattern, especially in the first half of the distribution, being flatter in the second half. The main reason for this shape is the fact that undeclared earnings do not vary much across deciles in absolute terms, so the effect for lower deciles is much higher in relative terms. When taking all employees into account, the figures are obviously lower, but the pattern is similar, except for the first decile, which shows much

[12] This correction consisted of simply comparing the average of the estimated non-reported income earned in "hidden" activities to the Danish national average of Skov (2014a) and varying the estimated non-reported income according to the difference of those averages, in the same proportion for all the individuals participating in the hidden economy.

lower values than the second and the third. The reason is that there are very few partially compliant observations in that decile, so the effect of the high share observed (more than 80%) falls to almost 5% when considering all the employees.

**Figure 2. Estimated tax non-compliance for employees by decile group (% of true earnings), Denmark**



# 4 Fiscal and distributional effects of tax compliance

In what follows, we present simulations for the fiscal and distributional effects of tax non-compliance, by comparing two different scenarios – the tax evasion scenario where individuals underreport their earnings, and the no tax evasion scenario, where individuals declare truthfully their earnings.[13]

In order to obtain the fiscal and distributional effects of taking into account non-reported employment income, we use the European microsimulation model EUROMOD.[14] EUROMOD is a microsimulation model that replicates the tax and benefit systems of all EU Member States, applying a set of policy rules to a representative micro-dataset of households and individuals which is based on EU-SILC. In this case we use the original EUROMOD files for Estonia (2007 income data) and Denmark (2009), but we replace the original information on individual employment income by the results obtained in the estimations explained in the previous section. Then EUROMOD applies the corresponding tax-benefit systems to the data and outputs the results of tax liabilities, benefit entitlements and disposable income at the individual and household level. Importantly, EUROMOD captures the interaction of the tax-benefit systems, in the sense that changes in one policy may affect eligibility for others.

Table 4 below describes the two scenarios of analysis, in terms of incomes and tax liabilities/benefits, implemented in EUROMOD, for the two countries under analysis.

**Table 4. Scenarios implemented in EUROMOD**

| Scenario | Employment income | Tax and benefits |
|---|---|---|
| Tax evasion | True | Based on declared income |
| No tax evasion | True | Based on true income |

We first look at the aggregate changes due to the elimination of tax evasion. Table 5 and Table 6 present, respectively for Estonia and Denmark, the effects on the components of disposable income, along with a measure of inequality change.

**Table 5. Aggregate components of disposable income (million EUR), Estonia**

| | Tax evasion | No tax evasion | Difference | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | 95% confidence interval | | |
| | Total | Total | Total | Standard error | Lower bound | Upper bound | % of baseline |
| Original income | 5,854 | 5,854 | 0 | - | - | - | 0.0 |
| Taxes | 874 | 995 | 121 | 6 | 109 | 134 | 13.9 |

[13] All results shown in the figures are statistically significant at 95% confidence level, except otherwise noted.

[14] EUROMOD is currently being developed by the Institute for Social and Economic Research at the University of Essex in collaboration with national experts, and it is financed by DG Employment's European Union Programme for Employment and Social Innovation. See Sutherland (2001) and Sutherland and Figari (2013) for a detailed description of the EUROMOD microsimulation model, which can be accessed on the EUROMOD homepage https://www.euromod.ac.uk/.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Social Insurance Contributions[a] | 105 | 115 | 9 | 1 | 8 | 10 | 8.9 |
| Benefits | 1,209 | 1,200 | -10 | 2 | -13 | -6 | -0.8 |
| Disposable income | 6,084 | 5,944 | -140 | 7 | -154 | -126 | -2.3 |
| Inequality[b] | 0.332773 | 0.330775 | -0.001998 | 0.000564 | -0.003104 | -0.000892 | -0.6 |

a. Employees and self-employed
b. Gini coefficient of equivalised disposable income.

## Table 6. Aggregate components of disposable income (million DKK), Denmark

| | Tax evasion | No tax evasion | Difference | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | 95% confidence interval | | |
| | Total | Total | Total | Standard error | Lower bound | Upper bound | % of baseline |
| Original income | 1,029,445 | 1,029,445 | 0 | - | - | - | 0.0 |
| Taxes | 351,211 | 372,175 | 20,964 | 791 | 19,412 | 22,515 | 6.0 |
| Social Insurance Contributions[a] | 91,728 | 97,553 | 5,825 | 210 | 5,413 | 6,237 | 6.3 |
| Benefits | 312,050 | 307,677 | -4,373 | 746 | -5,836 | -2,910 | -1.4 |
| Disposable income | 898,555 | 867,393 | -31,162 | 1,188 | -33,491 | -28,833 | -3.5 |
| Inequality[b] | 0.250311 | 0.250480 | 0.000169 | 0.000792 | -0.001384 | 0.00172220 | 0.1 |

a. Employees and self-employed
b. Gini coefficient of equivalised disposable income.

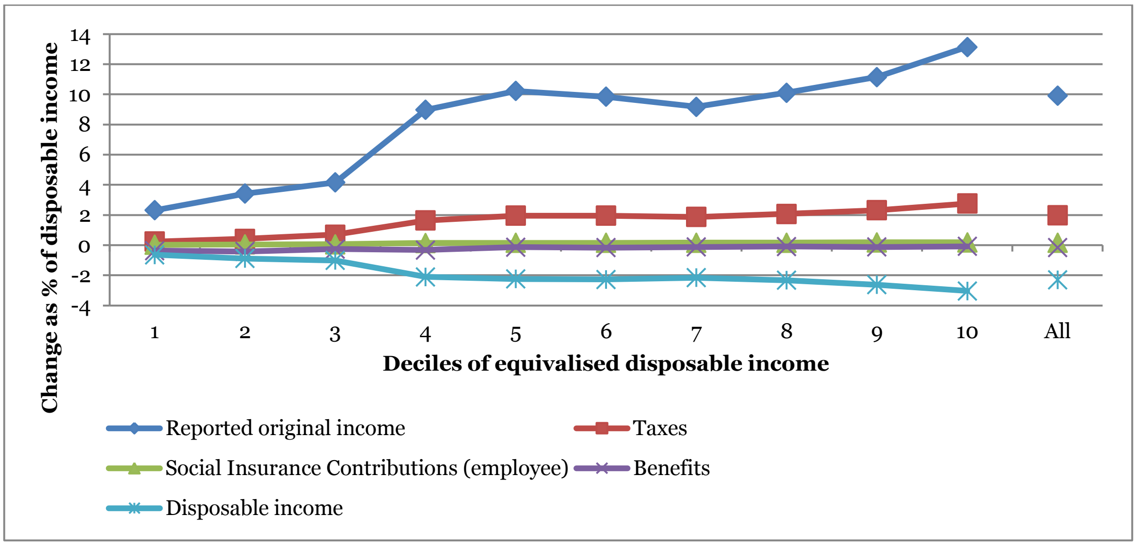
As expected, as declared employment income increases on average on the no tax evasion scenario, taxes and social insurance contributions increase, while benefits go down, because means tested benefits depend on after tax income (declared income minus declared taxes), which now is higher. The combination of these effects impacts the disposable income of households, which is reduced by 2.3% in Estonia and 3.5% in Denmark. The effect is higher in Denmark despite the fact that the relative effect on taxes and social contributions is lower than in Estonia. The reason is that the tax burdens in Denmark are much higher, so even small relative changes in taxes have a significant effect on disposable income. Regarding the distribution of disposable income (in equivalised terms[15]) in terms of the Gini coefficient, the results are different for the two countries: while we observe a slight reduction in Estonia, the value remains approximately constant for Denmark (the point estimates are very similar and the difference between them is not statistically significant).

It is also interesting to investigate the distributional effects by deciles of replacing originally reported employment income with adjusted employment income for tax and benefit purposes. Figure 3 and Figure 4 show the effect of this increase in reported original (market) income on the different components of the tax-benefit system, and consequently on disposable income. In particular it shows the change in each of the components as a percentage of household disposable income, as a way to make them comparable. The calculations are done by deciles of equivalised true disposable

[15] According to Eurostat, the equivalised disposable income is defined as the "total income of a household, after tax and other deductions, that is available for spending or saving, divided by the number of household members converted into equalised adults; household members are equalised or made equivalent by weighting each according to their age, using the so-called modified OECD equivalence scale". This scale assigns a weight of 1 to the household head, 0.5 to other adults (14 year-old or older) and 0.3 to children (younger than 14). The result of the calculation is attributed to every member of the household.

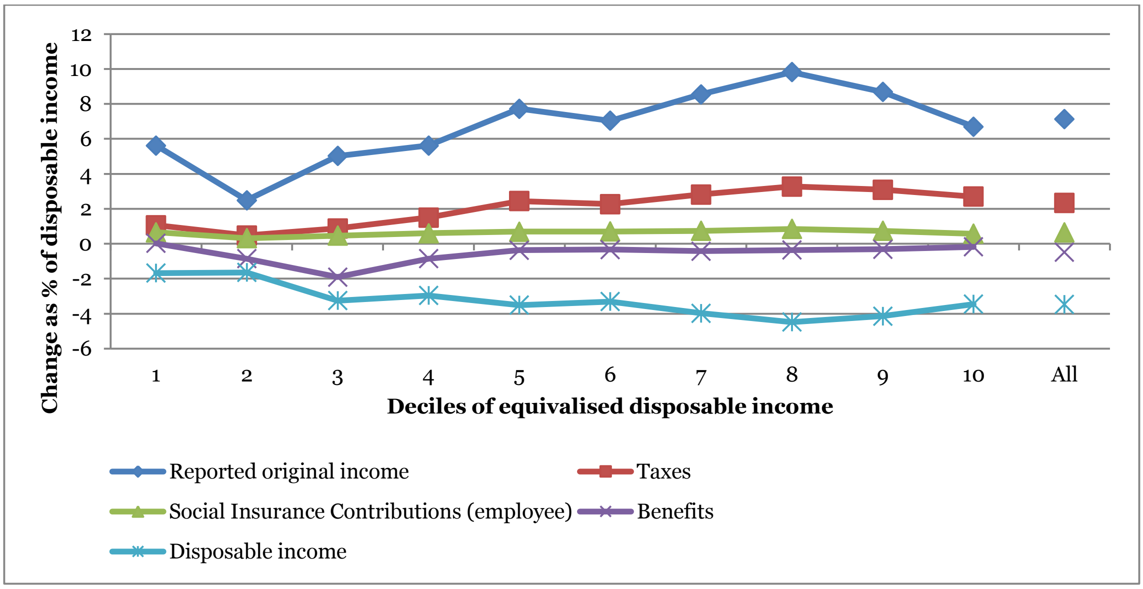
income. Note that these deciles largely differ from those used in Figures 1 and 2, that were based on gross true earnings, which are only one of the several components of disposable income.[16]

**Figure 3. Distributive impact of tax compliance on household disposable income (change as % of household disposable income), Estonia**




Note: reported original income is calculated as the sum of reported employment income plus all other market incomes (which do not change); taxes, social insurance contributions and benefits are based on reported original income; disposable income is calculated as true original income minus taxes, contributions and benefits based on reported original income.

**Figure 4. Distributive impact of tax compliance on household disposable income (change as % of household disposable income), Denmark**




[16] In the case of Denmark, we find a totally different composition of the two types of deciles, which is a reasonable result given the impact of the Danish benefit system on the ranking of households by disposable income.

Note: reported original income is calculated as the sum of reported employment income plus all other market incomes (which do not change); taxes, social insurance contributions and benefits are based on reported original income; disposable income is calculated as true original income minus taxes, contributions and benefits based on reported original income.

For the whole population of Estonia we observe that an increase around 10% of reported original income causes an increase in taxes (2%), while the effect on social contributions and (means-tested) benefits is negligible in relation to disposable income[17]. The overall effect of these changes is a 2.3% reduction in disposable income, as seen in Table 5. For Denmark the increase in disposable income is lower (around 7%), but the effect on disposable income is higher (3.5%), due to the combined effect of the more significant effect on taxes, social contributions and benefits.

By deciles, Estonia shows an increasing pattern for original income, except between deciles 5 and 7 where it is slightly decreasing. The negligible effect of social contributions and benefits observed for the whole population is also true for each decile, being taxes the only relevant source of change. The pattern is similar to original income, but much flatter, and since social contributions and benefits do not change, this pattern is mirrored on disposable income. The pattern for Denmark is different: we see that the highest increases in reported original income are around the 8th decile, and the lowest around the 2nd. We also see that the effect on taxes is correlated to the changes in original income. On the contrary, changes in benefits are larger in the lower deciles (except the first one), because the households in these deciles have incomes close to the limit for receiving benefits, so increases in reported income may make them lose entitlement. The first three deciles illustrate well the combined effect of taxes and benefits on the disposable income. If we compare the first and the second decile we see that the former has a much higher increase in reported income than the latter, because even small corrections to reported incomes represent a large share of income. Nevertheless the reduction in disposable income is similar, because households in the second decile lose means-tested benefits (around 1% decrease), while households in the first decile do not (because even with the increase they are still entitled to receive them). The third decile has a similar increase in original income to the first decile, but the reduction in disposable income doubles the reduction of the first two. This happens because of the joint effect of the increase in taxes (which almost doubles the one of the second decile) and the reduction in benefits (also more than double the one of the second decile).

[17] Besides being small, the changes in benefits are statistically insignificant for most deciles.

# 5 Conclusions

In this paper we present two country case studies on tax evasion, and we describe two different methodologies that allow us to estimate non-reported employment income on an individual basis. In this analysis the type of data and its availability to study the tax evasion phenomenon crucially determinates the estimation methodologies applied to obtain the individual measures of tax evasion.

In the Estonian case we apply a novel econometric technique that allows us to disentangle tax non-compliance behaviour from measurement error. This example illustrates well the importance of linking survey with administrative data for assessing accurately tax evasion behaviour. We find that, in Estonia, full non-compliance is limited in relative terms; however, partial non-compliance amounts to around 23% of employees, while estimated non-reported employment income represents around 12.6% of employment earnings, on average. Moreover, estimated non-reported earnings distributes unevenly across the deciles of the true earnings distribution, having more incidence on the bottom and top deciles. Measurement error shows a decreasing pattern across those deciles, with individuals in the bottom deciles overstating employment income, and the ones in the top understating it to the survey interviewers. Due to the different characteristics of the micro-data, in the Danish case we estimate non-reported income by complementing the SILC microdata using cross-section studies on the hidden economy. These studies focus on a broader concept of non-compliance, which includes also exchanges of services between individuals. However, the monetary extension of the hidden earnings (around 7%) is estimated to be much lower than the Estonian. The simulations for Denmark show how a full tax-compliance scenario would change the main fiscal and distributional outputs of the tax-benefit system: taxes and contributions would increase by 6%, means-tested benefits would decrease by 1.4%, being household disposable income 3.5% lower.

We found also that the fiscal and distributional impacts in each of the countries are of different relative magnitudes, but in both cases they are non-negligible, showing that more attention should be paid to the analysis of tax evasion at the individual level. Interestingly, we observe that, in Denmark, although the increase in reported original income is lower than in Estonia, the effect on disposable income is higher due to the combined effect of the more significant impact on taxes, social contributions and benefits.

Nevertheless, notice that the results of the two methodologies are not directly comparable because the non-compliance concept used is different. Nevertheless, in terms of policy implications, both may be relevant depending on the policy issues one wants to investigate.

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# Appendix

### Table A.1. Estimates of the econometric model for Estonia, based on Paulus (2015)

| | Dependent variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | True earnings | | | Register earnings | | | Survey earnings | | |
| | coef. | | se | coef. | | se | coef. | | se |
| Age[(a)] | -0.019 | ** | 0.009 | 0.082 | *** | 0.021 | -0.034 | *** | 0.005 |
| Age[(a)] squared | -0.036 | *** | 0.005 | -0.002 | | 0.013 | -0.017 | *** | 0.003 |
| Male | 0.316 | *** | 0.018 | -0.162 | *** | 0.053 | 0.108 | *** | 0.014 |
| Estonian nationality | 0.172 | *** | 0.023 | 0.195 | *** | 0.051 | 0.035 | *** | 0.011 |
| Education (ref=basic or less) | | | | | | | | | |
| - secondary | 0.072 | *** | 0.025 | 0.122 | ** | 0.053 | 0.040 | ** | 0.016 |
| - tertiary | 0.216 | *** | 0.031 | 0.250 | *** | 0.076 | 0.131 | *** | 0.020 |
| Marital status (ref=married) | | | | | | | | | |
| - single | -0.031 | | 0.024 | -0.094 | | 0.060 | | | |
| - cohabiting | -0.004 | | 0.020 | -0.189 | *** | 0.051 | | | |
| - divorced/widow/separated | -0.017 | | 0.024 | -0.253 | *** | 0.066 | | | |
| Region (ref=north) | | | | | | | | | |
| - central | -0.155 | *** | 0.024 | 0.152 | ** | 0.060 | | | |
| - north-east | -0.263 | *** | 0.030 | -0.094 | | 0.065 | | | |
| - west | -0.175 | *** | 0.023 | 0.147 | ** | 0.059 | | | |
| - south | -0.196 | *** | 0.021 | 0.097 | * | 0.052 | | | |
| Rural area | -0.009 | | 0.016 | -0.050 | | 0.041 | | | |
| Studying | -0.029 | | 0.036 | 0.208 | ** | 0.104 | | | |
| Industry (ref=edu/health/pub.adm) | | | | | | | | | |
| - agriculture/forestry | -0.001 | | 0.041 | 0.075 | | 0.125 | | | |
| - manufacturing/mining/utilities | 0.042 | | 0.030 | 0.180 | * | 0.096 | | | |
| - construction | 0.307 | *** | 0.039 | -0.241 | ** | 0.094 | | | |
| - wholesale trade | 0.181 | *** | 0.042 | 0.233 | ** | 0.113 | | | |
| - retail trade | 0.028 | | 0.034 | 0.025 | | 0.109 | | | |
| - transportation/storage/courier | 0.192 | *** | 0.036 | -0.156 | | 0.101 | | | |
| - hotels/restaurants | 0.018 | | 0.045 | -0.084 | | 0.125 | | | |
| - prof. services/inform./commun. | 0.134 | *** | 0.044 | 0.079 | | 0.116 | | | |
| - finance/real estate/admin-support | 0.088 | ** | 0.040 | -0.168 | * | 0.102 | | | |
| Occupation (ref=clerks) | | | | | | | | | |
| - senior managers | 0.408 | *** | 0.042 | -0.083 | | 0.139 | | | |
| - professionals | 0.375 | *** | 0.042 | -0.151 | | 0.151 | | | |
| - technicians/associate prof. | 0.209 | *** | 0.040 | -0.205 | | 0.136 | | | |
| - service/sales workers | -0.034 | | 0.040 | -0.172 | | 0.150 | | | |
| - skilled agricultural workers | 0.114 | | 0.075 | -0.580 | *** | 0.193 | | | |
| - craft/trade workers | 0.112 | *** | 0.043 | -0.318 | ** | 0.134 | | | |
| - plant/machine operators | 0.044 | | 0.038 | -0.310 | ** | 0.134 | | | |
| - elementary | -0.218 | *** | 0.039 | -0.379 | *** | 0.139 | | | |

Notes: [(a)] constructed as $(age - 43)/10$, where 43is (unweighted) sample mean. Robust standard errors shown. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

(Table continues on next page)

(Table continues)

| | Dependent variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | True earnings | | | Register earnings | | | Survey earnings | | |
| | coef. | | se | coef. | | se | coef. | | se |
| Public sector[b] | -0.008 | | 0.025 | | | | 0.186 | *** | 0.066 |
| No of employees (ref=1 to 10) | | | | | | | | | |
| - 11 to 19 | 0.121 | *** | 0.024 | 0.130 | *** | 0.049 | | | |
| - 20 to 49 | 0.170 | *** | 0.023 | 0.342 | *** | 0.056 | | | |
| - 50 or more | 0.287 | *** | 0.022 | 0.460 | *** | 0.055 | | | |
| - uncertain (more than 10) | 0.225 | *** | 0.045 | 0.203 | ** | 0.081 | | | |
| Hours in main job | 0.023 | *** | 0.002 | 0.001 | | 0.003 | | | |
| Second job | 0.118 | * | 0.062 | 0.084 | | 0.147 | | | |
| Hours in second job | 0.003 | | 0.003 | 0.002 | | 0.009 | | | |
| Health status (ref=neutral) | | | | | | | | | |
| - very good | 0.162 | *** | 0.031 | | | | | | |
| - good | 0.064 | *** | 0.018 | | | | | | |
| - poor/very poor | -0.085 | ** | 0.042 | | | | | | |
| Health affected work/studying | -0.052 | ** | 0.022 | | | | | | |
| HH has a mortgage | | | | 0.082 | * | 0.042 | | | |
| HH has a lease | | | | 0.129 | *** | 0.040 | | | |
| Number of waves | | | | | | | -0.020 | *** | 0.004 |
| Month of interview (since Feb) | | | | | | | 0.011 | *** | 0.004 |
| Interview rating (ref=very well) | | | | | | | | | |
| - well | | | | | | | -0.013 | | 0.010 |
| - ok | | | | | | | -0.048 | ** | 0.022 |
| Interview responded (ref=alone) | | | | | | | | | |
| - with someone's help | | | | | | | -0.051 | * | 0.029 |
| - by other HH member | | | | | | | 0.036 | ** | 0.016 |
| At interview: young child | | | | | | | 0.049 | * | 0.027 |
| At interview: older child | | | | | | | -0.010 | | 0.014 |
| At interview: spouse | | | | | | | 0.013 | | 0.010 |
| At interview: other relative | | | | | | | 0.003 | | 0.018 |
| Intercept | 0.513 | *** | 0.083 | 1.221 | *** | 0.197 | 0.482 | *** | 0.035 |
| p | 0.990 | *** | 0.002 | | | | | | |
| $\theta$ (private sector) | | | | -0.020 | *** | 0.003 | 0.687 | *** | 0.016 |
| $\theta$ (public sector) | | | | | | | 0.584 | *** | 0.034 |
| $\theta_0$ | | | | | | | 1.039 | *** | 0.078 |
| $\sigma$ (private sector) | 0.482 | *** | 0.013 | 0.630 | *** | 0.037 | 0.273 | *** | 0.007 |
| $\sigma$ (public sector) | 0.427 | *** | 0.023 | | | | 0.269 | *** | 0.012 |
| | | | | | | | | | |
| Sample size | 4,853 | | | | | | | | |
| AIC | 47,594 | | | | | | | | |
| BIC | 48,340 | | | | | | | | |

Notes: [b] *public sector* includes public sector employees, except those who changed jobs or have a second job. Robust standard errors shown. *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

**Table A.2. Regression estimates regarding participation, weekly hours and hourly wage rate in tax evasion activities in Denmark (1994-2009)**

| Model | Participation [ Logit ] | Hours, weekly [ Tobit (marg.eff.) ] | Wage, hourly [ OLS (ln wage) ] |
|---|---|---|---|
| Single man | 0.176 *** | 0.022 *** | 0.037 * |
| Married woman | -0.868 *** | -0.106 *** | -0.154 *** |
| Single woman | -0.220 *** | -0.031 *** | -0.111 *** |
| Age | 0.005 | 0.001 | 0.016 *** |
| Age squared | 0.000 *** | 0.000 *** | 0.000 *** |
| Have child aged 0-6 years | -0.066 | -0.015 * | 0.000 |
| 20,000-99,999 inhabitants | 0.183 *** | 0.016 * | -0.048 ** |
| 10,000-19,999 inhabitants | 0.200 *** | 0.020 ** | -0.028 |
| Up till 9,999 inhabitants | 0.485 *** | 0.050 *** | -0.062 *** |
| Fyn area | 0.032 | -0.002 | -0.100 *** |
| Jylland area | 0.057 | 0.004 | -0.065 *** |
| Secondary education | -0.242 *** | -0.041 *** | 0.060 * |
| Vocational training | 0.130 *** | 0.016 ** | 0.048 *** |
| Further education | -0.207 *** | -0.032 *** | 0.042 * |
| Agriculture etc. | 0.252 ** | 0.007 | -0.054 |
| Mining etc. | 0.090 | 0.037 | 0.012 |
| Manufacturing | 0.166 ** | 0.012 | -0.036 |
| Utilities supply | 0.360 | -0.005 | 0.003 |
| Water and waste | 0.512 ** | 0.048 | -0.096 ** |
| Construction | 0.735 *** | 0.090 *** | 0.114 *** |
| Repair business etc. | 0.084 | -0.004 | -0.019 |
| Transportation | 0.068 | 0.002 | -0.134 *** |
| Hotels etc. | 0.416 *** | 0.066 *** | -0.024 |
| Information and comm. | -0.101 | -0.007 | -0.110 *** |
| Financial institutions | -0.451 *** | -0.066 ** | -0.044 |
| Real estate | 0.044 | -0.010 | 0.124 |
| Liberal trades etc. | -0.230 | -0.023 | -0.123 * |
| Admin. services etc. | 0.135 | 0.006 | -0.016 |
| Public admininistration etc. | -0.103 | -0.018 | -0.041 |
| Health and social serv. | 0.020 | 0.006 | -0.080 ** |
| Culture etc. | 0.507 *** | 0.046 * | 0.038 |
| Other services | 0.194 | 0.009 | 0.025 |
| Private services | 1.380 * | 0.179 ** | -0.104 |
| International org. | -1.290 | -0.138 | -0.444 *** |
| Wage earner, middle | -0.207 *** | -0.024 ** | 0.049 ** |
| Wage earner, highest | -0.423 *** | -0.036 *** | 0.132 *** |
| Self employed | -0.112 | -0.020 | 0.245 *** |
| Unemployed | -0.202 ** | -0.013 | -0.008 |
| Pensioner etc. | -0.145 | -0.022 | -0.039 |
| Student | -0.114 | -0.007 | -0.119 *** |
| Second quartile, income | -0.108 | -0.016 | 0.056 ** |
| Third quartile, income | 0.040 | -0.015 | 0.112 *** |
| Fourth quartile, income | 0.051 | -0.019 | 0.116 *** |
| Constant | -0.905 *** | -1.565 | 4.537 *** |
| Sample size | 23532 | 23532 | 4669 |

Significance: * 5 %, ** 1 % and *** 0.1 %

Note: The left out category is; married male, living in cities with at least 100,000 inhabitants, living in the Zealand area, with basic education, no information on industry employment, wage earner at the lowest level, and belonging to the lowest income quartile. Year dummies included, but not showed here.

Source: Economic Council (2011).

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