INSTITUTE
OF ECONOMIC STUDIES
Faculty of Social Sciences
Charles University

INCOME TAX NONCOMPLIANCE IN GERMANY, 2001-2014

Hannes Fauser
Sarah Godar

IES Working Paper 36/2021

Institute of Economic Studies,
Faculty of Social Sciences,
Charles University in Prague

[UK FSV – IES]

Opletalova 26
CZ-110 00, Prague
E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Institut ekonomických studií
Fakulta sociálních věd
Univerzita Karlova v Praze

Opletalova 26
110 00 Praha 1

E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Bibliographic information:
Fauser H., Godar S. (2021): "Income tax noncompliance in Germany, 2001-2014" IES Working Papers 36/2021. IES FSV. Charles University.

Income tax noncompliance in Germany, 2001-2014

Hannes Fauser[a]
Sarah Godar[b]

[a]Freie Universitat Berlin, hannes.fauser@fu-berlin.de
[b]Charles University Prague and HWR Berlin, sarah.godar@hwr-berlin.de

December 2021

Abstract:
This paper estimates income tax underreporting for the case of Germany, by income category and along the income distribution. Comparing weighted samples of survey and tax data, we find patterns that are in line with the literature: Average income from self-employment and from rent and lease in the survey is higher than in the tax data, increasing in upper quintiles. Income underreporting to the tax authorities may be one of several possible explanations for these descriptive findings. We therefore expand our analysis with the Pissarides & Weber (1989) approach that has been applied to a range of countries and data sources before. We use the German Socioeconomic Panel and the Taxpayer Panel, estimating food, housing cost and donation regressions. Results indicate that self-employment is associated with higher housing cost but not with higher food expenditure in the SOEP. In the TPP we find more robust indication of underreporting as self-employment and business incomes are significantly associated with higher donations and even more so for the top-income decile. We use our results to derive tentative estimates of aggregate tax revenue losses due to underreporting of self-employment and other non-wage incomes.

JEL: D12, D31, H24, H26
Keywords: tax evasion, income misreporting, personal income tax, self-employment, distributional effects

Acknowledgements: The authors thank Stefan Bach, Giacomo Corneo and participants at the 2021 ECINEQ and VfS conferences for comments and suggestions, Markus Grabka for his support with the SOEP and Maurice Brandt, Melanie Scheller, Stefanie Setzer and Stefanie Uhrich for their support concerning the TPP. All remaining errors and omissions are our own. Sarah Godar acknowledges funding from the Berlin Equal Opportunity Program (BCP) and HWR Berlin.

1 Introduction

Following the Financial Crisis of 2008, tax noncompliance has become a growing concern of policymakers and researchers alike. International public scandals like the Offshore Leaks, LuxLeaks, Panama Papers or Paradise Papers have contributed to rising awareness. In Germany, particularly the cases of celebrities have received substantial media attention (Garz & Pagels 2018), as well as widespread "Cum Ex" fraud perpetrated by banks on behalf of wealthy investors (Spengel 2017).

Accordingly, tax evasion is perceived as a more serious offence than previously: During the 1995-98 wave, only 46.3% of German respondends in the World Values Survey deemed cheating on taxes "never justifiable" (extreme value on a 1 to 10 scale). In the 2017-2020 wave, this number has risen to 75.2%. Dörrenberg & Peichl (2018) equally document a relatively high tax morale of German respondents in the 2014 German Internet Panel.

To some extent, also policy action in the field of personal income taxation[1] has been a result of the aformentioned growing concerns: In particular, the Financial Crisis of 2008 was followed by G20 measures in 2009 that increased the number of international tax information exchange agreements (for analyses of these TIEAs, see Johannesen & Zucman 2014 and Menkhoff & Miethe 2019). More importantly, in 2013 agreement was reached to introduce automatic information exchange of financial account information, which became effective in the beginning of 2017 (for early evaluations, see Menkhoff & Miethe 2019 and Casi et al. 2020).

A growing literature documents the extent of income tax avoidance and evasion, increasingly shedding light on the link with income and wealth inequalities. Most notably, Alstadsæter et al. (2019) have exploited the richness of Scandinavian administrative data by linking it with cases of caught or self-reported evaders, for instance from some of the leaks mentioned earlier. A similar analysis has been conducted with Dutch (Lejour et al. 2020) as well as US tax data (Guyton et al. 2021), likely with more to follow in upcoming years. Unfortunately, a likewise approach cannot be followed for the German case, due to legal restraints on the use of tax micro data.

Fortunately though, different strands of the literature have long established indirect approaches to measure tax avoidance and evasion. Firstly, some authors have tried to exploit differences between responses in survey and tax data. This may be

[1] Furthermore, measures were taken to fight base erosion and profit shifting (BEPS) in the corporate income tax.

called the direct discrepancy method, which seeks to compare samples of populations made comparable through weighting and is based on the debatable assumption that taxpayers report their incomes more honestly in an anonymous survey than in their tax declaration. Recent research by Cabral et al. (2021) supports this assumption. The discrepancy method has been applied to a range of European countries, e.g. by Fiorio & D'Amuri (2005), Matsaganis et al. (2010), Benedek & Lelkes (2011) and Leventi et al. (2013), but not yet to Germany.

Secondly, following the seminal paper of Pissarides & Weber (1989, henceforth PW), researchers have relied on differences in reported income compared to certain expenditures to detect underreporting of income. Typically, food is used for survey data and donations in case of tax data. This approach has proven valuable to study the underreporting behaviour of self-employed individuals in particular. As different income sources can be observed in tax data in more detail, studies following the paper of Feldman & Slemrod (2007, henceforth FS) are typically able to also estimate underreporting for other income types. For a literature review, see Albarea et al. (2020, Section 2.2). Estimates in this literature suggest that the self-employed underreport on average 15-40% of their income.

Recently, Albarea et al. (2020) have combined the two major methodologies, by enhancing a micro-simulation based discrepancy estimate with underreporting figures obtained from survey data with the PW methodology. Bazzoli et al. (2020) are moreover able to directly link tax data with household budget survey data at the micro level for seven years, thereby improving the distributional analysis when estimating self-employed income underreporting. For Germany, Bittschi et al. (2016) have applied the FS-approach to the Taxpayer Panel, finding rather small effects for the different income categories in a fixed-effects Poisson specification for 2001-2006. Fauser (2020) has estimated income tax avoidance along the income distribution, applying a micro data model of the German income tax to the Income and Consumption Survey of 2013. The papers that go beyond constant shares of underreporting by income category show that tax noncompliance tends to be concentrated at the top of the income distribution (among the recent contributions, see e.g. Alstadsæter et al. 2019, Albarea et al. 2020 and Bazzoli et al. 2020 or Guyton et al. 2021).

In our paper, we test both the discrepancy method and the PW/FS-approaches for Germany. We combine different types of micro data, but we are unable to directly match them for confidentiality reasons. Our main datasets for the full period 2001-

2014 are the German Socioeconomic Panel (SOEP), a survey panel provided by the German Institute for Economic Research (DIW Berlin) that is widely used in the social sciences, and the Taxpayer Panel (TPP) which consists of tax records that were linked by the German Federal Statistical Office (Destatis).

Our descriptive analysis shows that SOEP and TPP samples differ somewhat with regards to demographic characteristics and the income categories included. As income variables in the tax data are generally more detailed than in the survey, we adjust the former to the latter by combining relevant variables. We then weight the SOEP figures using distributions drawn from the limited set of sociodemographic variables included in the TPP. The remaining differences between reported mean incomes in the SOEP and TPP are broadly in line with the patterns observed in earlier papers. We find higher average income from self-employment and income from renting and leasing in the survey than in the tax data and higher average discrepancies of self-employment income in the higher income quintiles. Tax evasion by income underreporting may, however, be only one of several possible explanations for the observed discrepancies.

In order to further investigate the potential underreporting of non-wage incomes for tax purposes, our analysis thus focuses on the regression analysis based on the PW/FS-approaches. We test different specifications on several datasets: Following PW and using the SOEP, food expenditure is regressed on different income measures and a host of control variables. We do not find indication of income underreporting by the self-employed in the SOEP based on the food-expenditure regressions. However, self-employment is associated with higher average expenditures on electricity, heating, and warm water and with higher total housing cost. Assuming that unobserved heterogeneity, e.g. with respect to working from home, does not fully explain these differences, this might indicate underreporting of self-employment income even in the SOEP. However, the coefficients are relatively small and the food regressions would not support such an interpretation.

Moreover, using the TPP we estimate donation regressions both on cross-sections and the whole panel. Results indicate that self-employment and business incomes are significantly associated with higher donations, which can be interpreted as evidence of income underreporting. This would once more call into question the equality of tax collection by income source and hence the progressivity of the tax schedule, because self-employment and business incomes are more concentrated at the top of the income distribution. However, we cannot rule out that unobserved heterogeneity is responsible for some part of the effect we find. Unfortunately, the scarce sociodemo-

graphics do not allow to control for possibly relevant factors such as a presumably more frequent solicitation for donations or higher charitable giving for marketing reasons. This could lead to an overestimation of underreporting.

Finally, we use the our results from the FS-type regressions based on TPP data to derive estimates of aggregate underreporting and resulting tax revenue losses. Back-of-the-envelope calculations suggest a tax gap of EUR 21.3 bn in 2001 and 15.8 bn in 2014, when underreporting from all income categories is considered. Relative to "true" income tax due, this amounts to 10.7% in 2001 and 5.7% in 2014.

In a more detailed approach, we also take into account the progressivity of the income tax schedule by applying the estimated underreporting coefficients to the individual tax units observed in the panel. Furthermore, we assume that not the whole "underreported amount" would actually be taxed, e.g. due to eligible deductions. For all income categories, the estimated tax loss in the more detailed estimations is considerably larger: It ranges from EUR 70.2 bn in 2001 to EUR 32.4 bn in 2014, implying a tax gap relative to "proper" tax due of 28.4% in 2001 and 11.1% in 2014 (or of 39.6% and 12.5% relative to the assessed income tax).

The remainder of this paper is organized as follows: Section 2 describes the datasets that were used. Section 3 covers the discrepancy method, our approach and results, while section 4 repeats the same exercise for the indirect regression-based approaches. Section 5 concludes.

2 Data

Our two main data sources are the German Socioeconomic Panel (SOEP) version 35 and the Taxpayer Panel (TPP). The Taxpayer Panel (TPP) includes annual data on German taxpayers since 2001. Until 2012, the data only included the whole population of taxpayers filing tax returns (around 28 Mio. filers per year). Since 2013[2], the data includes also information on the pay-as-you-earn cases which are usually not required to file a tax return (some additional 12 Mio. cases). Therefore, the data are not representative for the whole population of taxpayers until 2013, but are biased against the income-poor wage earners who are less likely to file a tax return. Adding to that, the construction of the Taxpayer Panel changed in 2010. Before, the cases were linked as a panel based on several characteristics (for details,

[2]In theory since 2012. In practice, data delivery delays have caused the TPP to include the additional cases only starting in 2013.

see Vorgrimler et al. 2006), since 2010 the newly introduced unique personal tax identifier is used to build the panel.

Due to the strict confidentiality requirements, researchers can have access to a random sample from the TPP only at regional statistical offices or via controlled remote data processing. For our analysis we thus rely on a 5-percent stratified random sample drawn from the TPP which includes about 840,000 wage earners, 540,000 earners of self-employment or business income and 380,000 earners of income from rent and leasing. Extrapolation factors included in the dataset allow us to correct for the oversampling of richer households compared to the whole population in the complete dataset. The TPP features only a limited set of demographic variables such as sex, age and religion. Number of children and marital status can be inferred from the tax allowances and tax classes. The TPP includes income variables in accordance with the different income categories on the tax return which are not necessarily consistent over time as the tax law changes.

The SOEP is a representative survey of private households in Germany and available as a panel data set since 1984. Between the relevant years (2001-2014), it includes income information on 12,000 to 16,000 households. In the questionnaire, respondents are asked to estimate their monthly earnings from dependent and independent employment, as well as from secondary jobs. In contrast to the TPP, negative self-employment income is not included. The annual labour income is imputed by multiplying the monthly earnings with the months of employment of the previous year. In addition, respondents are asked to estimate their annual income and losses from rent and leasing and from investment. The SOEP covers a broad range of demographic variables, among which detailed housing and education related variables. The data is made available to researchers by the German Institute for Economic Research (DIW Berlin).

3 Discrepancy approach

3.1 Building comparable samples and income categories

As mentioned before, not all income categories are easily comparable between TPP and SOEP as the TPP variables correspond to the legal definitions of the income tax base while the SOEP has broader but stable income categories. For example, the TPP includes several detailed categories of business, freelance and other

self-employment incomes but the SOEP only includes one broad category of self-employment income where respondents are asked to estimate their overall positive income from all types of self-employment. Due to tax reforms, the parts of passive capital income included in the TPP have changed several times over the sample period[3] and are thus not comparable to the capital income in the SOEP. The same applies for the pensions. We thus limit our analysis to the three broad income categories which can be defined consistently in the two databases: wage income, business income including all types of self-employment income, and income from rent and leasing. The samples are compared at the individual level.

In the SOEP, wage income is included in the variables ijob1 and ijob2. Unfortunately, ijob2 includes all sorts of secondary income which can stem from a second job but also from secondary self-employment, honorary work or family workers. Moreover, the source of the secondary income is only given for the years 2017 and 2018. We use this information to impute the shares of secondary income attributable to dependent and independent work for our sample years 2001 to 2014 and add this to wage and self-employment income from the main occupation. We further add extra payments, such as Christmas and holiday bonuses. In the SOEP, income information is "What did you earn from your work last month?". If people are self-employed they are asked to estimate their monthly income before and after tax. The annual income is then extrapolated by multiplying the monthly income by the number of months worked in the previous year. It is very likely that self-employed respondents report their income less cost, i.e. their profit which should make it conceptually comparable to the positive self-employment incomes in the TPP. However, it is not likely that business owners in the SOEP report retained earnings as part of their income even though these would be considered as taxable income in the TPP. For the income from rent and leasing we subtract the losses from renting and leasing and only include the net income if it is positive. To make the SOEP sample comparable to the TPP, we drop all individuals without positive income in any of those three categories. We also drop individuals that report positive income only once during the sample period, as these would not appear in the TPP.

Variables from the TPP sample are chosen accordingly: We take gross wages

[3]Most notably, since the switch to a dual income tax system in 2009, capital income is mostly not included in the income tax statistics anymore. Most passive returns are withheld at source, and no information concerning the taxpayer is transmitted to the tax authority. For details and some approaches to estimate capital incomes in the context of top wealth and income shares, see Bartels & Jenderny (2015).

from dependent employment, which are gross of costs of obtainment and therefore match the SOEP ijob concept. For self-employment income, the matter is more complicated: We take incomes net of costs of obtainment[4], but substract capital gains related to self-employment to enable comparability to the SOEP. The same procedure is followed for incomes from business and agriculture and forestry. Moreover, income from sales of shares in unincorporated businesses is substracted, because these capital gains are likely included in a different variable in the SOEP (capital income). Incomes from these three revenue categories are then added up. For income from rent and lease, we take the revenues net of related costs claimed for tax purposes.

3.2 Adjusting the samples

It is not surprising that our two samples differ with regard to certain key characteristics as they represent two different populations. While the SOEP should be representative of the whole population, the TPP represents the population of taxpayers. We thus drop all individuals without income from our SOEP sample. Before 2013, the TPP only includes taxpayers who filed a tax return. For the years before 2013, we thus drop individuals from the SOEP who earned wage income only and whose income was below the income tax allowance as these are very unlikely to have filed a tax return. After these adjustments, the samples still differ with regard to the age structure, marital status, number of children and region of residence. The SOEP includes a slightly higher share of individuals at both tails of the working age distribution between 16 and 25 and 56 and 64, a lower share of married individuals, a slightly higher share of individuals in East Germany in some years and a slightly lower share in the income-rich region 1 (Hamburg, Bremen, Bayern, Baden-Württemberg and Hessen). As these sample characteristics correlate with average incomes, we reweight the SOEP sample to better match the TPP. For this purpose, we calculate post-stratification weights, treating the TPP as the population and the SOEP as the sample whose distribution needs to be adjusted to fit the characteristics of the TPP "population". As cross-tabulation of frequencies might produce unstable weights for rare combinations of characteristics, we iteratively fit the weights to reflect differences in the single variable frequency tables. After three

[4]These costs are not seperately available in the tax data. Self-employment incomes are only reported after related business expenses are substracted (yielding the revenue, or "Einkünfte" in German Income Tax law). On the contrary for dependent employment, we can observe the related professional expenses, i.e. costs of obtainment.

iterations, our TPP and SOEP samples closely resemble each other in terms of age structure, marital status, regional distribution and number of children.

Table 1: TPP and SOEP samples

	TPP	SOEP	SOEP reweighted
Region			
Region 1	0.41	0.40	0.41
Region 2	0.43	0.44	0.43
Region 3	0.16	0.16	0.16
Marital status			
Married	0.67	0.53	0.67
Unmarried	0.33	0.47	0.33
Age class			
16-25	0.07	0.12	0.07
26-35	0.21	0.21	0.21
36-45	0.31	0.28	0.31
46-55	0.30	0.26	0.30
56-64	0.12	0.13	0.12
Number of children			
0	0.50	0.65	0.51
1	0.22	0.19	0.22
2	0.21	0.13	0.21
3 or more	0.07	0.03	0.07

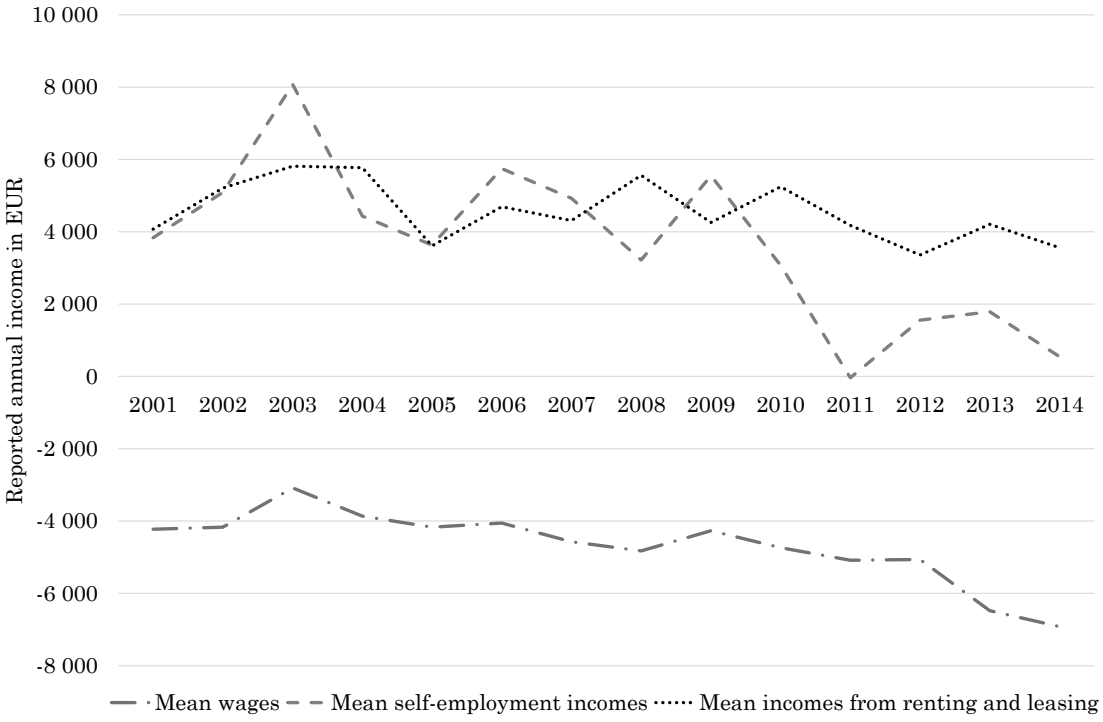
Note: Table includes only individuals with positive taxable income.
Region 1: Baden-Württemberg, Bavaria, Bremen, Hamburg, Hesse; Region 2: Berlin, Northrhine-Westphalia, Lower Saxony, Rhineland-Palatinate, Saarland, Schleswig-Holstein; Region 3: Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt, Thuringia.
Sources: SOEP, RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

3.3 Results

Comparing the means of the different income categories between the adjusted SOEP sample and the TPP, we find that reported self-employment income and income from rent and lease are on average higher in the SOEP than in the TPP. Average wages, in contrast, are lower in the SOEP than in the TPP.[5]

[5]One might suggest that the lower average wages in the TPP stem from the fact that until 2012 only wage earners filing a tax return were included in the TPP and that these are more likely to

Figure 1: Mean discrepancies between SOEP and TPP samples



Source: Own calculations, based on SOEP and TPP (RDC of the Federal Statistical Office and Statistical Offices of the Länder, 2001-2014).

Between 2001 and 2009, the discrepancies are broadly stable over time with the wage income being on average about 4,000 EUR lower in the SOEP than in the TPP, and self-employment and rent income being about 4,000 EUR higher (Figure 1). After 2009, the discrepancy between SOEP and TPP starts to widen for wages and to narrow for self-employment incomes. This might indicate that the two samples underlie different trends and are only of limited comparability. It is noteworthy, however, that those incomes which are self-reported for tax purposes are higher in the SOEP than in the TPP which would be in line with the underreporting hypotheses. However, if the discrepancy was only due to reporting behaviour, reported wage incomes should be the same in the SOEP and TPP, at least after 2012, as wage incomes are subject to the pay-as-you earn tax scheme.

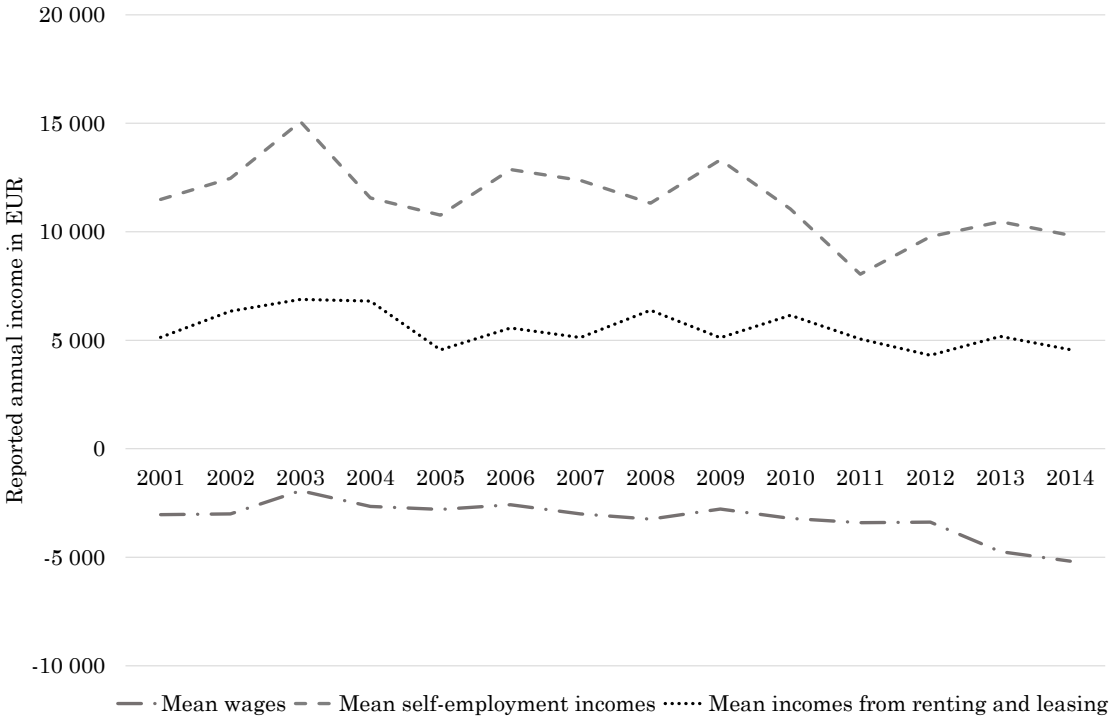
As the top-income percentile is known to be underrepresented in the SOEP, we exclude the top one-percentile from our TPP sample and repeat the analysis. Comparing the SOEP to the top-censored TPP sample, the negative discrepancy between the average reported wage incomes decreases somewhat to approximately 3,000 EUR on average while the positive discrepancy for the self-employment incomes is much higher with approximately 10,000 EUR on average. The discrepancy of income from renting and leasing increases to 5,000 EUR on average (Figure 2).

In order to examine the size of the discrepancy along the income distribution, we compare mean incomes by income quintile between the SOEP and the two TPP samples (Figure 3). We build the quintiles on the sum of wages, income from self-employment and income from renting and leasing.

We find that the negative discrepancy between reported wage incomes is broadly constant across income quintiles. As expected, the discrepancy narrows significantly for the top quintile, when comparing the SOEP to the top-censored TPP sample and remains the same for the other quintiles. For the self-employment incomes in contrast, we find slightly negative discrepancies for the first two income quintiles and positive discrepancies for the third and fourth income quintile. The top-censoring of the TPP affects the discrepancy of the top quintile very strongly as it switches from a slightly negative discrepancy to one of about 28,000 EUR. The average discrepancy of the self-employment incomes seems thus to be caused mainly by the two

be high-wage earners. However, after the inclusion of all wage earners in 2012/2013, the negative discrepancy in wages between SOEP and TPP even increases. Another possible explanatory factor could be the construction of the TPP: Only taxpayers who are observed at least twice over time, are taken into the panel. Therefore, a cross section of the TPP is likely biased downwards for wage incomes, compared with the (full sample) cross section of the wage and income tax statistics (LESt).

Figure 2: Mean discrepancies between SOEP and TPP top-censored sample



Source: Own calculations, based on SOEP and TPP (RDC of the Federal Statistical Office and Statistical Offices of the Länder, 2001-2014).

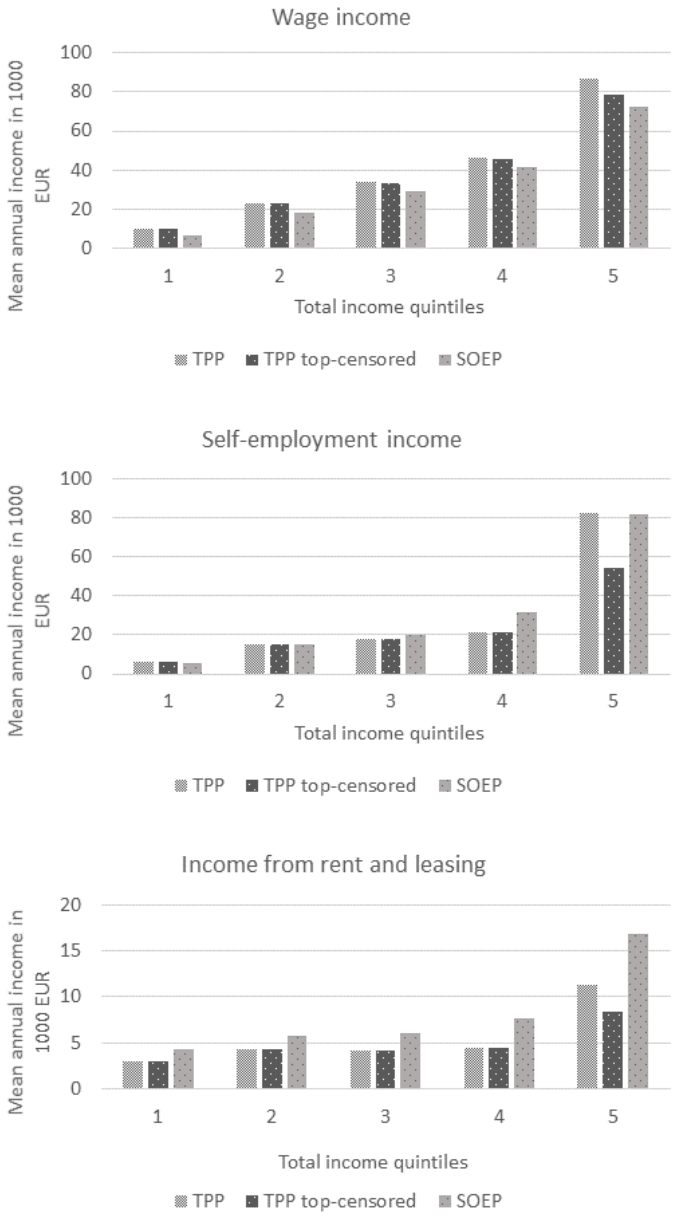
top income quintiles. For the income from rent and lease, we find a positive and significant discrepancy for all income quintiles. Similarly to the self-employment income, the discrepancy for the top quintile is negative in the non-censored sample but turns out positive and large for the top-censored sample.

In conclusion, we find relatively high and positive discrepancies when comparing self-employment incomes and incomes from renting and leasing between the SOEP and the top-censored TPP. This would be in line with under-reporting to the tax authorities as these types of income are self-reported and thus leave more scope for tax avoidance and evasion. For wage income, in contrast, we find a negative and relatively small discrepancy. Our results further suggest that the discrepancy for self-employment income increases along the income distribution. For income of rent and lease and wages we cannot observe such a tendency. The observed discrepancies might indicate under-reporting by taxpayers to the tax authorities while revealing their true amount of income in an anonymous survey. This interpretation is supported by recent findings by Cabral et al. (2021) who match survey and tax register data of a sample of New Zealand households and indeed find that the self-employed report higher average income in the survey compared to their tax filings. However, the negative discrepancy for wages might indicate that our samples are not fully comparable as we would assume no difference in reporting behaviour for wage income. Unfortunately, the limited set of household characteristics included in the TPP does not allow us to investigate this in detail. In addition, it should be noted that the discrepancy for the self-reported incomes may also be explained by other factors, such as a more accurate consideration of expenses and losses for tax purposes.

4 Regression-based approach

We test the classical PW approach (Pissarides & Weber 1989) to estimate Engel Curves in order to detect income underreporting for some income categories, using the SOEP. Moreover, for the same purpose we also follow FS by estimating regressions of donations on income types and a range of controls, using the TPP.

Figure 3: Mean incomes by income quintile, 2014



Source: Own calculations, based on SOEP and TPP (RDC of the Federal Statistical Office and Statistical Offices of the Länder, 2001-2014).

4.1 Food regressions using the SOEP

The PW approach is based on the idea that – in contrast to wage earners - the self-employed might underreport their income also in anonymous surveys but correctly report their expenditures for food consumption. As food is a basic necessity, the interpersonal variation of food expenditures in relation to income might be lower than that of other consumption categories and less affected by personal taste and status considerations. The authors thus assume that wage earners and self-employed having the same level of income and similar personal or household characteristics should spend the same amount of income on food consumption. However, regressing the logarithm of food expenditures on the logarithm of disposable income and a set of control variables, they find that self-employed report significantly higher food expenditures than wage earners which they attribute to underreporting of income by the self-employed. Variations of this approach have been used by several authors among which Engström & Hagen (2017) and Engström & Holmlund (2009) for Sweden, Kukk & Staehr (2017) for Estonia, Kim et al. (2017) for Russia and Korea, and Lichard et al. (2021) for Czechia and Slovakia. A key challenge identified by most authors is that the underreporting of self-employed might be overestimated if based on current income instead of permanent income. Some studies use instrumental variable techniques to address this problem, others proxy permanent income by multiple-year averages of current income if panel data is available.

In this section, we apply the PW approach to the SOEP to test whether we find indication of income underreporting by the self-employed in Germany. The SOEP contains detailed consumption information only for the year 2010, which limits our analysis to this probably untypical year. However, the panel data allows us to calculate multiple-year averages of income around that year in order to proxy permanent household income. Similar to Engström & Hagen (2017) but limited to a single cross-section, we regress the logarithm of food expenditures of households on logarithmized 3-year and 5-year averages of their disposable income and a self-employment dummy. As additional control variables, we include the age, sex and education of the household head, marital status, number of children and adults living in the household, three regional dummies, a dummy variable indicating whether the household is a renter or house owner, and a dummy variable indicating whether the household is paying off a loan. We use different operationalisations of the self-employment dummy as suggested in the literature. A household may either be defined as self-employed when any of the household members reports being self-

employed (A), when the household head reports being self-employed (B), or when the share of self-employment income in total household is more than 25 percent (C). We limit the sample to those households which do not switch between the categories for three or five years.

Hence, we estimate the following Engel curve equation:

$$\ln(C_i) = \alpha X_i + \beta \ln(Y_i) + \gamma SE_i + e_i \tag{1}$$

where subscript i denotes the household, X_i a vector of control variables, Y_i permanent household income and SE_i a dummy variable for self-employed households.

Surprisingly, in our data, wage earners and self-employed seem to spend the same share of their income on food consumption on average: 16 percent (see table 7 in the appendix). Using a simple OLS regression to control for additional household characteristics, we do not find any significant correlation of the self-employment dummy and food consumption in none of the specifications. Most of the control variables are significant with the expected signs. A higher household income, the age of the household head, the number of children and adults in the household and being married are associated with higher food expenditures. Being based in East Germany and being widowed is associated with lower food expenditures (see detailed results in the appendix table 9). The self-employment dummy is very small and negative but never significant. These results would be consistent with self-employed reporting their income accurately in the SOEP. It should be noted however, that - depending on the definition of self-employed - only 431-600 households fall into this category as compared to about 4,000 households defined as wage earner households. This relatively low number of self-employed and the limited availability of consumption data shed doubts on the representativeness of results.

4.2 Housing-cost regressions using the SOEP

As an alternative to the food regressions, we estimate similar equations for expenditures on housing, an approach also taken by Albarea et al. (2020). The SOEP includes several housing-related variables which - in contrast to the food expenditures - are available for a greater number of households and years. These include expenditures on electricity, heating and hot water, additional cost, rent payments, amortization, and maintenance cost. Based on these variables, we build two alternative housing-cost variables, the first (EHW) including only electricity, heating

and hot water, and the second (total housing cost) including all available housing-cost variables as in Albarea et al. (2020). For 2013, we obtain a sample of about 10,000 households of which we consider 500-800 as self-employed. A first look at the descriptive statistics suggests that the self-employed spend a little less on electricity, heating, and hot water, and on total housing cost on average as compared to the wage-earner households (appendix table 8). As in the previous section, we regress the logarithm of the dependent variable on a self-employment dummy, the logarithm of household income and the same set of control variables. The regression results suggest that being self-employed is associated with higher expenditures for electricity, heating, and hot water which exceed those of wage-earner households by approximately 10 percent on average. Total housing expenditures are higher by approximately 3-5 percent (see tables 10 and 11 in the appendix). The positive coefficients of the self-employment dummies are significant for all three definitions of self-employment and also for the other available years 2010-2012.

Under the assumption that - everything else being equal - self-employed and wage-earner households have the same preferences with regard to housing, the positive coefficient of the self-employment dummy variable could be interpreted as indication of underreporting of self-employment income even in the SOEP. This would suggest that our previous assumption of correct reporting in the survey - on which we base the discrepancy approach in section 3 - is not fulfilled. We would argue that underreporting of self-employment income in the SOEP might lead to even higher discrepancies between the TPP and the SOEP and would therefore not put our previous results into question. However, the assumption that, in the absence of underreporting, self-employed have the same housing-related expenditures as wage earners might also be problematic. Some unobserved household characteristics might correlate both with the likelihood of being self-employed and the housing cost, e.g. a preference for spacious or prestigious appartments or a less economical consumption behaviour. Importantly, we cannot control whether the self-employed are working from home. We would expect that the self-employed are more likely to work from home which might partly explain higher expenditures for electricity and heating, and even higher total housing cost, if more space is needed. We would therefore interpret our results with caution and even more so, as the results from the food regressions did not seem to be line with underreporting.

4.3 Donation equations using the TPP

Most of the literature estimates underreporting of income for single years using cross-sectional data. With the panel structure of the TPP on the contrary, we are able to identify effects of changes in income variables over time. The disadvantage of standard panel data models in this context is, however, that fixed effects cancel out a big portion of the underreporting effect across income categories which is found using cross-sections. Therefore, with the TPP we estimate both single year (cross-sectional) levels of underreporting, and the effect of changes over time.

In contrast to the direct comparison performed in section 3, we employ different variables because there is no more need to adjust the samples to match the SOEP figures. Hence, to explain donation behaviour we take the household as the level of analysis here. Accordingly, monetary variables are aggregated at the household level. We use the seven different income categories of German income tax law, which are net of costs of obtainment but before other deductions: Income from agriculture and forestry, self-employment, business, dependent employment, capital, rent and lease, and other sources. Total income is summed up over all these categories.

As is standard in the literature, we construct a variable that measures the tax price of giving. The general idea is that due to the progressivity of the income tax, a donation is cheaper for richer households. Reducing their tax base yields higher tax savings at the margin. Therefore, the tax price of giving is defined as $1 - m$, where m is the marginal tax rate. Because the tax rates changed regularly over the observation period[6], there is sufficient intertemporal variation. In contrast to Bittschi et al. (2016), we do not assign a value of 1 to non-itemizers who exhibit donations below the standard deduction for special expenses for two reasons. First, as special expenses are the quantitatively most important deduction category in the German income tax, it is fairly unlikely that the standard deduction (which was set at merely EUR 36 for single filers during most of the observation period) would be exceeded only as a result of the donation[7]. Second, assigning the full price of 1 would pertain to all observations that have zero donations (again, implicitly assuming that

[6]Inter alia, the rates were adjusted to keep the minimum subsistence level tax-free and to account for the so-called "cold progression" through a rightward shift of the schedule. Moreover, there were substantial tax cuts at the beginning of the millenium and the introduction of the so-called "tax on the rich" in 2007, a three percentage point higher rate for taxable incomes exceeding EUR 250,000 for singles (this threshold increased over time). For details, see BMF (2020).

[7]As we have the full range of tax data items at our disposal, we may explicitly account for this by looking at all special expenses. In light of the probably limited impact on the analysis, we reserve this for future updates of the paper.

the standard deduction is not exceeded by other non-donation items), which biases results in case that these observations are kept and not discarded from regressions as missing values.

Furthermore, we construct several dummies for self-employment to test for differential effects of these operationalizations (which were shown to matter in Estonian survey data by Kukk & Staehr 2017). We differentiate by 25% and 50% thresholds of income (as a share of total income) derived from self-employment, business or agriculture and forestry, both seperately by income source and jointly. The remainder of control variables are standard demographics, their choice is mostly dictated by availability. It should be noted that the gender variable in the TPP is flagged as unreliable by Destatis, because values are missing in most cases if a couple is jointly assessed for tax.

A problem that arises when estimating donation regressions, is that many households report not having donated at all. Only using the observations with positive donations may then lead to biased estimates, because people who choose to donate may systematically differ from those who do not. One possibility to account for this possible selection bias is the use of Tobit models. Unfortunately, a consistent estimation of Tobit regressions requires assumptions that are unlikely to be fulfilled in the case at hand. Bittschi et al. (2016) discuss three points: Error terms that are neither normally distributed nor homoscedastic, differential effects of explanatory variables along the intensive and extensive margin (i.e., they may affect the decision whether to donate differently than the decision how much to donate, which a Tobit model assumes to be the same) and the infeasibility of estimating a Tobit panel model with fixed effects because of the incidental parameters problem (i.e., when the length of a panel is small and fixed, the MLE of nonlinear panel models is biased and inconsistent). Therefore, they resort to using fixed effects Poisson models (FEPM), which are borrowed from the trade literature (Silva & Tenreyro 2006). Some of these challenges can alternatively be met by using fixed effects with log-linearized OLS models, or with nonlinear least squares estimation. However, the former requires adjustments to the dependent variable and the latter is only feasible for cross-sections.

We tackle these points along different avenues. First, for cross-sections of the TPP we control for the selection problem by using a two-step Heckman approach following Torregrosa-Hetland (2020). From a 1st stage probit estimation, the inverse Mills ratio is derived and then included in the 2nd stage OLS and NLS estimations to

account for the probability of selection into the positive donations sample. Second, we use both log-linearized OLS with fixed effects and FEPM for the panel dimension of the data. The former is quite robust, and the latter even accounts for nonlinearity and other factors (Silva & Tenreyro 2006 and Bittschi et al. 2016). FEPM was developed for count data, but it works well for continuous data as long as strict exogeneity of the conditional mean is given (Wooldridge 2010). With these specifications, we avoid both the incidental parameters problems and the computational complexity of fitting nonlinear least squares with panel data.

4.3.1 Single-year estimations

As in the SOEP case, due to the longitudinal structure of the data we are able to test different measures of income to proxy for (unobservable) permanent income. Following Engström & Hagen (2017), we use the mean for different ranges around the respective year, namely three, five and seven years. These may be interpreted as a medium choice between current yearly income and long-term permanent income.[8] To control for the large share of zero observations for the donations, we estimate a Heckman specification that uses a probit regression as the first stage selection equation. Following Torregrosa-Hetland (2020), we construct a wealth dummy that measures whether a household receives capital gains. It can be argued that this dummy is associated with status considerations of households and thereby only affects the decision whether to donate, but not the amount donated once income is controlled for. It may therefore satisfy the exclusion restriction required for at least one variable in the selection equation.

The first-stage Probit estimation seeks to explain who donates:

$$Prob(s_i = 1|\ln(Y_i), Z_i) = \Phi(\alpha + \beta \ln(Y_i) + \gamma X_i + \delta WD_i + e_i) \tag{2}$$

where Y_i are total revenues from all income categories , X_i are controls (included also in the second stage) and WD_i the wealth dummy that indicates capital gains in the tax return. From the estimation, the inverse Mills ratio λ is calculated.

For the second stage main equation, we use both ordinary and nonlinear least

[8] Additionally, we have also tested instruments that are applied to control for permanent income when only current income is available. Using capital income as identified to be the best IV by Engström & Hagen (2017) however did not improve the precision or efficiency of estimations and was therefore discarded.

squares to test different approaches that are common in the literature. While the OLS specification has the advantage of simplicity by requiring merely a dummy for the desired income category, the NLS allows to estimate the underreporting for all non-wage incomes relative to wage income in a single specification.

We apply an OLS specification that includes all income in one variable and identifies differences between households with a self-employment dummy, similarly to the food equation:

$$\ln(don_i) = \alpha + \beta \ln(Y_i) + \gamma SE_i + \delta X_i + \lambda_i + e_i \tag{3}$$

where the self-employment dummy SE_i is again operationalized in different ways: 25 vs. 50% share of income from self-employment, business and agriculture and forestry, and all three income categories separately or jointly in a composite dummy. Additionally, for total income Y_i the 7-year-average is applied to approximate permanent income. As a default, we only use balanced sample-observations that are available for 3 years before and after the current year. Moreover, the inverse Mills ratio λ_i from the first stage is included to account for the selection bias. X_i includes all available demographics (i.a. age, no. of children, religion and gender) and the tax price of giving $1 - m$, m being the marginal tax rate.

A second specification is run for all income types seperately using NLS:

$$\ln(don_i) = \alpha + \beta \ln \left[L_i + \sum_{j=1}^{6} k_j y_{ij} + k_7 N_i \right] + \gamma X_i + \lambda_i + e_i \tag{4}$$

where L_i is positive income from dependent employment, k_j are coefficients for positive revenues from the other j income categories y_{ij} (self-emplyoment, business, agriculture and forestry, rent and lease, capital and other income) and the absolute value of the sum of all negative incomes N_i, and X_i are controls. $1/k_j$ can be interpreted as the compliance ratio of an income category y_{ij} relative to labour income L_i.

To moreover test for distributional effects, we add an interacted term with a dummy for the top decile in a similar way like Torregrosa-Hetland (2020):

$$\ln(don_i) = \alpha + \beta \ln \left[L_i + \sum_{j=1}^{6} (k_j y_{ij} + k_j^{top} y_{ij} * top10_i) + k_7 N_i \right] + \gamma X_i + \lambda_i + e_i \tag{5}$$

where k_j^{top} denotes the coefficient for the *top*10-interacted income categories y_{ij}, and X_i includes a dummy for the *top*10.

Descriptives and results

In the TPP sample that is used for the donation regressions, on average about 36% of tax units have made a donation. This share increased over time, from 34% in 2001 to 42% in 2014. [9] Moreover, the average amount donated and the total income of the respective tax payers have increased as well (see table 2). COnsistently and expectedly, donors earn higher incomes than non-donors on average.

Table 2: Selected descriptive statistics for the TPP regressions sample

	donation				no donation	
Year	Donation	Total income	No. of obs.	% of all obs.	Total Income	No. of obs.
2001	347	53,890	6,805,963	34	31,117	13,502,416
2002	360	52,017	7,416,485	35	30,398	13,842,170
2003	351	51,786	7,402,453	33	30,301	14,891,212
2004	368	52,974	8,022,086	35	30,208	15,184,054
2005	392	54,903	8,483,991	35	30,296	15,704,795
2006	404	57,335	7,947,386	33	31,605	16,146,839
2007	479	60,165	8,038,604	33	32,788	16,265,129
2008	482	62,013	8,309,649	34	33,730	15,851,930
2009	455	58,026	8,493,536	35	33,035	15,872,698
2010	483	59,546	8,945,669	36	33,627	15,696,125
2011	498	62,218	8,929,930	37	35,961	15,121,196
2012	511	71,761	7,044,483	40	42,668	10,758,719
2013	550	73,552	7,185,375	41	44,200	10,141,568
2014	563	76,171	7,142,893	42	46,418	9,804,254

Note: Donations and total incomes are provided as the average for the respective groups, i.e. for people who donated in column 2 and 3 and for people with zero donations in column 6.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

Results of the baseline OLS regression indicate underreporting of a magnitude that has been found for other countries in the literature as well. For the composite dummy that aggregates over the three self-employed categories in German income tax law[10], donations are increased by a range of 20 to 27 % over the years 2004 to

[9] The marked increase after 2011 is probably due to dataset issues, as the sample size drops at the same time. As was mentioned in section 2, due to data delivery issues apparently not all tax units that could be are already included in the TPP sample.

[10] These three are called "profit incomes", in distinction to the remaining "surplus incomes" (dependent employment, rent and lease, capital and other).

2011. Over time, the effect decreases somewhat from 27 % in 2004 to 21 % in 2011.

Table 3: Coefficients of self-employment dummy in OLS baseline

	2004	2005	2006	2007	2008	2009	2010	2011
self-employment	0.37	0.37	0.33	0.31	0.27	0.28	0.29	0.29
business	0.27	0.28	0.29	0.25	0.21	0.23	0.23	0.23
agriculture	-0.15	-0.13	-0.18	-0.18	-0.22	-0.18	-0.22	-0.23
composite	0.27	0.27	0.26	0.23	0.20	0.21	0.21	0.21

Note: All coefficients are significant at the 0.01% level, hence no * indication is given. Composite refers to a dummy that aggregates the three income categories. Dummies for which results are shown were defined using a 50 % threshold of the respective income(s) in total income of the tax unit. In order to have balanced panel observations for the seven-year average of total income, only the years 2004-2011 are included.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

These results are affirmed by the nonlinear least squares baseline estimation (see table 4 and figure 4). In contrast to the previous OLS regression, current revenues for all income categories[11] are included in the equation.Compliance ratios derived from the estimated coefficients generally increase over time, yet the level seems lower indicating higher underreporting than in the OLS specification. For example for business incomes, the ncompliance ratio is estimated at 54% in 2001 and 75% in 2014. This time trend is broadly in line with rising tax morale, as pointed out in the introduction.

A problem for the estimations is posed by the the wealth dummy which is supposed to fulfill the exclusion restriction: The main difficulty seems to be that only a very small fraction of tax units receives relevant capital gains, less than two percent of observations. We have tried to increase this share by including capital gains from different sources (not only those that are categorized as "other income" in German income tax law, but also some from business and self-employment), unfortunately to no avail. Logically, such a small fraction of observations is unlikely to explain the bulk of donating or not decisions. Hence, the robustness of the exclusion restriction is rather questionable: The wealth dummy is only signficant in half of the years in the 1st stage, it is correlated with the error terms in the 2nd stage and when included in the 2nd stage, it is often significant.[12]

[11]It should be recalled at this point, that due to the introduction of the withholding tax on capital incomes, the income tax data on capital revenues is seriously flawed from 2009 onwards.

[12]So far, we have not found a better "instrument", because the range of possible variables in the TPP is limited. Any advice on this point is greatly appreciated.

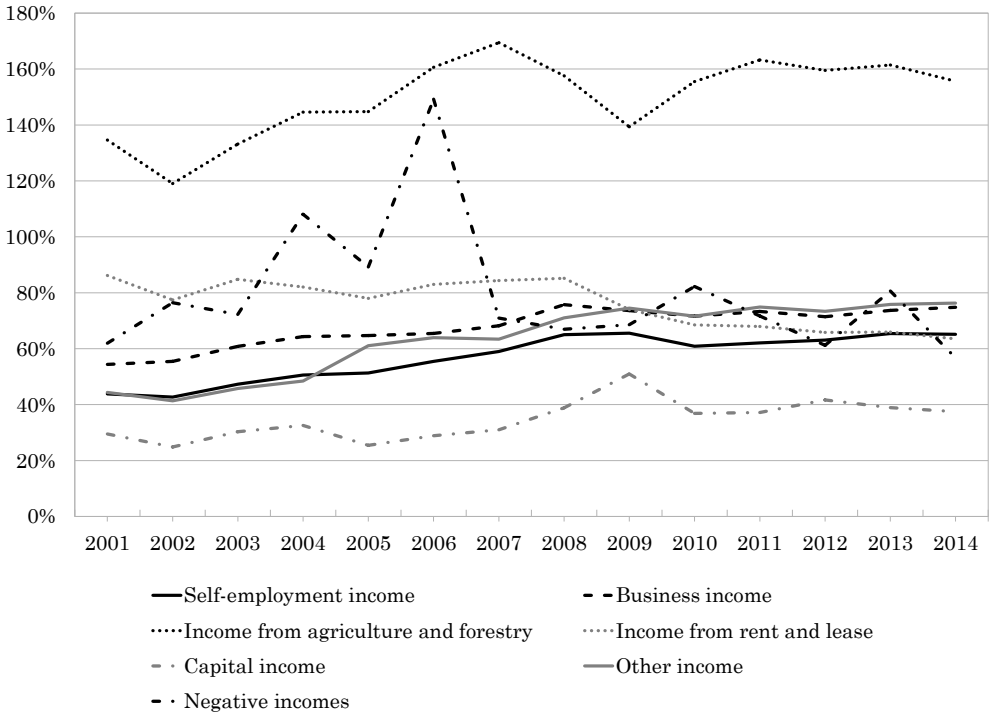
As a consequence, we cannot assume that the exclusion restriction is fulfilled, so a possible selection into donating may not be fully explained by our approach. The resulting underreporting estimates should therefore be interpreted with caution. They only reliably compare taxpayers with donations on their tax return, not necessarily all tax payers. The former may not be representative for the latter.

Table 4: Coefficients and compliance ratios for some income categories, NLS baseline

Coef. k_j	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
self-employment	2.28	2.34	2.11	1.98	1.95	1.80	1.69	1.54	1.53	1.64	1.61	1.59	1.53	1.53
compliance ratio	44%	43%	47%	51%	51%	55%	59%	65%	66%	61%	62%	63%	65%	65%
business	1.84	1.80	1.64	1.55	1.55	1.53	1.47	1.32	1.36	1.40	1.36	1.40	1.36	1.34
compliance ratio	54%	55%	61%	64%	65%	65%	68%	76%	74%	72%	73%	71%	74%	75%
agriculture & forestry	0.74	0.84	0.75	0.69	0.69	0.62	0.59	0.63	0.72	0.64	0.61	0.63	0.62	0.64
compliance ratio	135%	119%	133%	145%	145%	161%	169%	158%	139%	156%	163%	160%	161%	156%
rent and lease	1.16	1.29	1.18	1.22	1.28	1.21	1.19	1.17	1.35	1.46	1.47	1.52	1.52	1.57
compliance ratio	86%	77%	85%	82%	78%	83%	84%	85%	74%	69%	68%	66%	66%	64%
capital	3.39	4.02	3.30	3.07	3.93	3.46	3.23	2.57	1.96	2.71	2.69	2.40	2.57	2.66
compliance ratio	29%	25%	30%	33%	25%	29%	31%	39%	51%	37%	37%	42%	39%	38%
other	2.25	2.42	2.18	2.06	1.64	1.56	1.58	1.41	1.34	1.40	1.33	1.36	1.32	1.31
compliance ratio	44%	41%	46%	48%	61%	64%	63%	71%	75%	72%	75%	73%	76%	76%
negative	1.61	1.31	1.38	0.93	1.12	0.67	1.41	1.49	1.46	1.22	1.39	1.63	1.24	1.76
compliance ratio	62%	76%	72%	108%	89%	149%	71%	67%	69%	82%	72%	61%	81%	57%

Note: All coefficients are significant at the 0.01% level, hence no * indication is given. Compliance ratios are given by $1/k_j$.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

Figure 4: Compliance ratios derived from NLS baseline



Note: The percentage values indicate the compliance with respect to income from dependent employment, which is assumed to be correctly reported. Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

Moreover, given the limited availability of demographic variables in the TPP dataset, it is likely that our estimation suffers from omitted variables bias. For instance, unobserved heterogeneity with respect to earners of self-employment and business income could bias our estimate of underreporting. As Bittschi et al. (2016) argue, these individuals could be more likely to be asked to donate (solicitation effect). Also, donating to charity may be a behaviour expected from them through social norms or out of business considerations (marketing). Hence, systematic differences between the dependly employed and self-employed are likely not fully captured by the controls available in the dataset.

Therefore, when interpreted as underreporting of income, these results should be viewed as an upper bound for tax evasion of earners of income from self-employment or business.

For the distributional regression, we do find a higher noncompliance for the top decile in almost all income categories (see table 16 in the appendix). For revenues from business and rent and lease, the compliance ratio of the Top10 is substantially

lower. For self-employment, the additional effect for the Top10 becomes insignificant from 2008 onwards.

4.3.2 Panel estimations

When exploiting the panel dimension of the data we cannot expect that the errors are uncorrelated with the explanatory variables, which is why using fixed effects is appropriate. However, this entails the disadvantage that a lot of the variation between individuals that is interpreted as underreporting in the cross-section, is lost. This may explain why Bittschi et al. (2016) report a rather small effect of relevant income categories on donations. They show that a 10% increase in business income is associated with a 0.76% increase in donations, which may be interpreted as tax evasion[13].

As a simple baseline specification, we run several fixed-effects OLS specifications:

$$\ln(don_{it}) = \alpha + \beta \ln Y_{it} + \gamma X_{it} + FE_i + e_i \tag{6}$$

where Y_{it} is positive income from different categories, X_{it} are controls including the tax price of giving and FE_i are individual fixed effects. Alternatively,

$$\ln(don_{it}) = \alpha + \beta \ln Y_{it} + \gamma SE_{it} + \delta X_{it} + FE_i + e_i \tag{7}$$

where Y_{it} is total income again and SE_{it} is a self-employment dummy. As before, i denotes the individual, while now t additionally indicates the year.

Following Bittschi et al. (2016), we also estimate a fixed-effects Poisson model:

$$E(don_{it}|Z_{it}, FE_i) = exp(\alpha + \beta Y_{it} + \gamma X_{it} + T_t + FE_i + e_i) \tag{8}$$

where Z_{it} are all covariates, Y_{it} positive income from different categories and T_t time fixed effects.

Results

Coefficients from the OLS fixed-effects panels show that the estimated effect of self-employment on donations is slightly higher when self-employment is defined more

[13] Bittschi et al. (2016) note that one may alternatively interpret the effect as that of the respective income types on donations, as the fixed effects arguably account for time-invariant tax evading behaviour.

broadly (25% share in total revenues rather than 50%). In line with our expectations, using the 7-year-average instead of current income decreases the self-employment coefficient size substantially (see table 5). Inversely, the importance of income rises. Full regression tables are provided in table 12 in the appendix.

Table 5: Coefficients from OLS panel

Total income	0,093
SE dummy, 50% share	0.164
Total income	0,093
SE dummy, 25% share	0.180
Total income, 7-year average	0.181
SE dummy, 50% share	0.086
Total income, 7-year average	0.181
SE dummy, 25% share	0.108

Note: Full regression tables are provided in table 12 in the appendix.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

When applying the fixed-effects poisson model over the whole sample period, the effect of self-employment and business incomes on donations is much smaller. Descriptives statistics and results are given in tables 13 and 14 in the appendix. For the specification, we largely follow Bittschi et al. (2016). We have a longer sample period at our disposal, extending theirs by eight years. Moreover, when comparing the descriptive statistics, we probably employ the more representative sample: Our average income (as well as the mean donation) is much lower and closer to the population average in tax statistics. Consequently, we arrive at even lower coefficients: For a 10% increase in business income, we estimate a 0.39% increase in donations. For income from self-employment, said effect is roughly half in size. This difference to Bittschi et al. (2016) strengthens the interpretation that richer households drive the effect. Expectedly, the effect of changes in income over time is much smaller than the level effect in any yearly cross-section.

4.3.3 Macro implications

Based on the cross-sectional estimates from section 4.3.1, we gauge the losses incurred by the public coffers. As we have identified several issues that could bias our estimation of tax evasion upwards, we select the more conservate figures. For exam-

ple, 7-year average incomes are preferred over 5-year, 3-year or current year incomes and the 50% share of self-employment income is selected over the 25% share.

We first perform some simple back-of-envelope calculations by applying the coefficients estimated in the cross-section regressions to assessed tax due [14]. This requires some simplifying assumptions: Firstly, we have to assume that the share and income category in total revenues is equivalent to its share in assessed income tax. Implicitly, this means that the average tax rate is applied to the additional income which goes unreported. Secondly, the coefficient for composite and separate self-employment dummies must be assumed to reflect underreporting with respect to the respective income categories (self-employment, business and agriculture and forestry). Thirdly, it is assumed that income from dependent employment is correctly reported, as the compliance of other income categories is measured against it.

Additionally, we also exploit the micro dimension of the TPP, by applying the estimated coefficients from the different cross-section regressions directly at the individual tax units. We recalculate taxable income after deductions by adding the estimated underreported amount, and apply the tax schedule. We assume that only 75% of the underreported amount could be taxed, because taxpayers may be eligible for deductions or decrease their earnings by working less when facing a higher tax burden. By comparing the resulting tax due with originally assessed tax due, we get an alternative result for the tax loss. This method has the advantage of better reflecting the progressivity of the tax schedule, as well as differential estimates for taxpayers below and above the richest 10%.

Importantly, all macro estimates are static and do not ar at best partly and sweepingly consider behavioural responses of taxpayers.

The resulting tax losses are depicted in table 6, where columns 1, 3 and 5 show the simpler and columns 2, 4 and 6 the more nuanced estimates. Unsurprisingly, estimates based on current-year nonlinear least squares for all income categories are somewhat higher than those based on 7-year average income and a self-employment dummy. This holds also when only revenues from self-employment, business and agriculture are considered for the NLS estimates (table 15 in the appendix). Moreover, when comparing the two methodologies, taking into account the progressivity of the tax scheduale matters, as it increases the tax losses incurred.

On the time axis, the declining magnitude of income underreporting is confirmed.

[14] For an application to published income tax statistics, see table 15 in the appendix.

Tax losses in the NLS baseline simple estimate (column 5) decrease from EUR 21.3 bn in 2001 to EUR 15.8 bn in 2014. Relative to assessed income tax, this amounts to 12.0% in 2001 and 6.1% in 2014. If the avoided amount is included in the denominator, the implied tax gap is 10.7% in 2001 and 5.7% in 2014. In the estimate accounting for progressivity of the income tax (column 6), the amount is much higher but drops from EUR 70.2 bn in 2001 to EUR 32.4 bn in 2014. This implies a share of assessed income taxes of 39.6% in 2001 and 12.5% in 2014, and a tax gap relative to "true" tax due of 28.4% in 2001 and 11.1% in 2014. We can only speculate about factors that may explain this time trend: Possible explanations include rising tax morale, policy measures and measurement problems, which of course are neither mutually exclusive nor a finite list.

It should be noted that the tax gaps are calculated relative to total assessed income tax, i.e. including wage tax levied on income from dependent employment, which is assumed to be 100% correctly reported in the FS-methodology. Hence, the estimated tax loss for the earlier years of our sample period, say up to the financial crisis of 2008, can be considered relatively large.

5 Conclusion

In this paper, we combine different approaches to analyse the extent of income underreporting by German taxpayers. By comparing adjusted samples from the Taxpayer Panel and the Socioeconomic Panel, we find that incomes from self-employment and rent and lease reported to tax authorities are on average much lower than those reported in the anonymous survey. For wage incomes, in contrast, the discrepancy is negative and smaller. We furthermore find that the discrepancy for self-employment incomes increases along the income distribution. However, as income underreporting to tax authorities might be only one of several possible explanations for the observed discrepancies, we also employ econometric approaches to estimate the degree of underreporting by non-wage earners.

Based on SOEP data, we estimate a food equation, relating the households' food expenditures to their income and other control variables. If the predicted food expenditures of self-employed differ significantly from the predicted food expenditures of wage earners, this might - everything else being equal - be interpreted as income underreporting by the self employed. For our data we do not find any signifcant differences in food expenditures between wage earners and self-employed and thus no indication of income underreporting. In contrast, we do find that self-employment is

Table 6: Estimated tax losses from underreporting

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS composite SE dummy		OLS separate SE dummies		NLS all income categories	
	simple average	tax schedule	simple average	tax schedule	simple average	tax schedule
2001					21.3	70.2
2002					18.8	63.7
2003					16.6	50.6
2004	8.4	11.4	9.4	12.1	16.2	41.9
2005	9.5	12.5	10.4	13.0	18.1	49.4
2006	9.8	12.7	11.0	13.4	18.7	44.5
2007	9.9	12.7	11.0	13.2	20.2	50.3
2008	8.7	11.6	9.8	12.2	18.2	41.5
2009	8.1	10.9	9.3	11.7	13.4	28.3
2010	8.7	11.9	10.0	12.8	15.6	34.9
2011	9.5	12.7	10.9	13.6	16.1	35.0
2012					15.2	32.5
2013					14.5	29.1
2014					15.8	32.4

Note: SE = self-employment. Estimates based on OLS and NLS cross-section regressions using the TPP, as described in section 4.3.1. Coefficients from these estimations are applied to the assessed income tax for the "simple average" columns. For the "tax schedule" results, the coefficients are applied to taxable income and assessed tax is recalculated taking into account the tax schedule. For more details on the methodology, see text.
RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

associated with higher average expenditures on electricity, heating, and warm water and with higher total housing cost. Provided that only a negligible share of self-employed works from home, this might indicate underreporting of self-employment income even in the SOEP and increase the gap between self-employent incomes between SOEP and TPP even more. However, the estimated coefficients are relatively small and the food regressions do not support such an interpretation.

As a third approach, we regress individuals' donations on their income and other control variables using the Taxpayer Panel. Results suggest that in particular receivers of income from self-employment and business donate more on average and that their propensity to donate out of the respective income is higher than the propensity to donate out of wage income. This might be interpreted as indication of income underreporting under the assumption that - ceteris paribus - only the level of income but not the source of income should determine taxpayers' preferences for

making charitable donations. Unfortunately though, we are not fully able to control for heterogeneity with respect to receivers of different income types, because the tax micro data only contain a limited set of sociodemographics. Nonetheless, these findings call into question the equality of tax collection by income source and hence the progressivity of the tax schedule, because self-employment and business incomes are more concentrated at the top of the income distribution. This is in line with the literature, which tends to find underreporting of self-employed incomes in the range of 15-40% and increasing tax noncompliance with rising income. We estimate tax losses from income underreporting at EUR 15.8 to 32.4 bn in 2014, which implies a tax gap relative to true income tax due of 5.7 to 11.1%.

A Bibliography

Albarea, A., Bernasconi, M., Marenzi, A. & Rizzi, D. (2020), 'Income underreporting and tax evasion in Italy: Estimates and distributional effects', *Review of Income and Wealth* **66**(4), 904–930.

Alstadsæter, A., Johannesen, N. & Zucman, G. (2019), 'Tax Evasion and Inequality', *American Economic Review* **109**(6), 2073–2103.

Bartels, C. & Jenderny, K. (2015), The Role of Capital Income for Top Incomes Shares in Germany, World Inequality Lab Working Papers 201501, HAL.

Bazzoli, M., Caro, P. D., Figari, F., Fiorio, C. V. & Manzo, M. (2020), Size, heterogeneity and distributional effects of self-employment income tax evasion in Italy, FBK-IRVAPP Working Papers 2020-02, Research Institute for the Evaluation of Public Policies (IRVAPP), Bruno Kessler Foundation.

Benedek, D. & Lelkes, O. (2011), 'The Distributional Implications of Income Under-Reporting in Hungary', *Fiscal Studies* **32**(4), 539–560.

Bittschi, B., Borgloh, S. & Moessinger, M.-D. (2016), On tax evasion, entrepreneurial generosity and fungible assets, ZEW Discussion Papers 16-024, ZEW - Leibniz Centre for European Economic Research.

BMF (2020), Datensammlungen zur Steuerpolitik 2019, Technical report, Bundesministerium der Finanzen.

Cabral, A. C. G., Gemmell, N. & Alinaghi, N. (2021), 'Are survey-based self-employment income underreporting estimates biased? New evidence from matched register and survey data', *International Tax and Public Finance* **28**(2), 284–322.

Casi, E., Spengel, C. & Stage, B. M. (2020), 'Cross-border tax evasion after the common reporting standard: Game over?', *Journal of Public Economics* **190**(C).

Dörrenberg, P. & Peichl, A. (2018), Tax Morale and the Role of Social Norms and Reciprocity. Evidence from a Randomized Survey Experiment, CESifo Working Paper Series 7149, CESifo Group Munich.

Engström, P. & Hagen, J. (2017), 'Income underreporting among the self-employed: A permanent income approach', *European Economic Review* **92**(C), 92–109.

Engström, P. & Holmlund, B. (2009), 'Tax evasion and self-employment in a high-tax country: evidence from Sweden', *Applied Economics* **41**(19), 2419–2430.

Fauser, H. (2020), On income tax avoidance – a new microsimulation for the German case, Working paper, mimeo.

Feldman, N. E. & Slemrod, J. (2007), 'Estimating tax noncompliance with evidence from unaudited tax returns', *Economic Journal* **117**(518), 327–352.

Fiorio, C. V. & D'Amuri, F. (2005), 'Workers' Tax Evasion in Italy', *Giornale degli Economisti e Annali di Economia* **64**(2-3), 247–270.

Garz, M. & Pagels, V. (2018), 'Cautionary tales: Celebrities, the news media, and participation in tax amnesties', *Journal of Economic Behavior & Organization* **155**, 288–300.

Guyton, J., Langetieg, P., Reck, D., Risch, M. & Zucman, G. (2021), Tax Evasion at the Top of the Income Distribution: Theory and Evidence, NBER Working Papers 28542, National Bureau of Economic Research.

Johannesen, N. & Zucman, G. (2014), 'The End of Bank Secrecy? An Evaluation of the G20 Tax Haven Crackdown', *American Economic Journal: Economic Policy* **6**(1), 65–91.

Kim, B., Gibson, J. & Chung, C. (2017), 'Using Panel Data to Estimate Income Under-Reporting by the Self-Employed', *Manchester School* **85**(1), 41–64.

Kukk, M. & Staehr, K. (2017), 'Identification of Households Prone to Income Underreporting', *Public Finance Review* **45**(5), 599–627.

Lejour, A., Rabaté, S. & van 't Riet, M. (2020), Offshore Tax Evasion and Wealth Inequality: Evidence from a Tax Amnesty in the Netherlands, CPB Discussion Paper 417, CPB Netherlands Bureau for Economic Policy Analysis.

Leventi, C., Matsaganis, M. & Flevotomou, M. (2013), Distributional implications of tax evasion and the crisis in Greece, EUROMOD Working Papers EM17/13, EUROMOD at the Institute for Social and Economic Research.

Lichard, T., Hanousek, J. & Filer, R. K. (2021), 'Hidden in plain sight: using household data to measure the shadow economy', *Empirical Economics* **60**(3), 1449–1476.

Matsaganis, M., Benedek, D., Flevotomou, M., Lelkes, O., Mantovani, D. & Nienadowska, S. (2010), Distributional implications of income tax evasion in Greece, Hungary and Italy, MPRA Paper 21465, University Library of Munich, Germany.

Menkhoff, L. & Miethe, J. (2019), 'Tax evasion in new disguise? Examining tax havens' international bank deposits', *Journal of Public Economics* **176**(C), 53–78.

Pissarides, C. A. & Weber, G. (1989), 'An expenditure-based estimate of Britain's black economy', *Journal of Public Economics* **39**(1), 17–32.

Silva, J. M. C. S. & Tenreyro, S. (2006), 'The Log of Gravity', *The Review of Economics and Statistics* **88**(4), 641–658.

Spengel, C. (2017), 'Kollektivversagen: Cum/Cum, Cum/Ex und Hopp! [Collective Failure: The Problem of Dividend Stripping]', *Wirtschaftsdienst* **97**(7), 454–455.

Torregrosa-Hetland, S. (2020), 'Inequality in tax evasion: the case of the Spanish income tax', *Applied Economic Analysis* **28**(83), 89–109.

Vorgrimler, D., Gräb, C. & Kriete-Dodds, S. (2006), Zur Konzeption eines Taxpayer-Panels für Deutschland, FDZ-Arbeitspapier Nr. 14, Statistisches Bundesamt.

Wooldridge, J. M. (2010), *Econometric analysis of cross section and panel data*, 2nd edn, MIT Press.

B Appendix

Table 7: Food-income ratio and key control variables

Definition of self-employed	Self-employment status	Number of households	Food-income ratio	Household income	Age of household head	Number of children
A	0	4025	0.16	3077	45	0.54
	1	600	0.16	4133	48	0.63
B	0	4025	0.16	3077	45	0.54
	1	431	0.16	4096	48	0.59
C	0	4142	0.16	3088	45	0.54
	1	487	0.16	4124	47	0.63

Note: Definitions of self-employed households: A: At least one person in the household defines herself as self-employed; B: The household head defines herself as self-employed; C: more than 25% self-employment in total household income. Source: SOEP_v35, own calculations.

Table 8: Housing cost-income ratios and key control variables, 2013

Def. of self-employment	Self-employed	N	EHW-income ratio	total housing cost - income ratio	household income (3-year avg.)	age	number of children
A	0	9,586	0.074	0.32	2971	44	0.97
	1	801	0.071	0.3	4242	49	0.95
B	0	9,586	0.074	0.32	2971	44	0.97
	1	542	0.075	0.29	4138	49	0.91
C	0	9,587	0.074	0.32	2970	44	0.97
	1	633	0.072	0.31	4219	49	0.89

Note: Definitions of self-employed households: A: At least one person in the household defines herself as self-employed; B: The household head defines herself as self-employed; C: more than 25% self-employment in total household income. EHW are expenditures for electricity, heating and hot water. Age refers to the oldest working-age member of the household. Source: SOEP_v35, own calculations.

Table 9: Food regressions

Dep var: ln (food expenditure)	(1)	(2)	(3)
	self-employment def. A b/se	self-employment def. B b/se	self-employment def. C b/se
self-employed	-0.013	-0.018	-0.017
	(0.020)	(0.023)	(0.022)
ln (HH income)	0.450***	0.455***	0.446***
	(0.017)	(0.018)	(0.017)
age	0.010***	0.010***	0.010***
	(0.001)	(0.001)	(0.001)
female	0.012	0.013	0.015
	(0.014)	(0.014)	(0.014)
n_children	0.128***	0.127***	0.127***
	(0.009)	(0.009)	(0.009)
n_adults	0.134***	0.131***	0.135***
	(0.010)	(0.010)	(0.010)
region2	0.000	-0.002	0.001
	(0.015)	(0.015)	(0.015)
region3	-0.134***	-0.135***	-0.134***
	(0.018)	(0.019)	(0.018)
education	-0.003	-0.003	-0.001
	(0.003)	(0.003)	(0.003)
married	0.045*	0.050*	0.048*
	(0.022)	(0.022)	(0.022)
widowed	-0.133*	-0.129*	-0.127*
	(0.052)	(0.052)	(0.052)
divorced	-0.034	-0.031	-0.036
	(0.024)	(0.024)	(0.024)
credit	-0.002	-0.003	-0.005
	(0.015)	(0.015)	(0.015)
rent	0.037*	0.039*	0.037*
	(0.015)	(0.015)	(0.015)
cons	1.623***	1.598***	1.636***
	(0.130)	(0.134)	(0.130)
r2	0.406	0.406	0.408
N	4573	4406	4577

Note: + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. The variables age, female, education, married, widowed, and divorced refer to the oldest working-age household member. Education is proxied by the number of years of education. Rent is a dummy variable indicating whether the household is a renter i.e. not a home owner. The variable credit indicates whether the household is paying off a loan. Regressions includes only working age individuals and those households which can consistently be defined as either wage earners or self-employed between 2009 and 2011. Date source: SOEP_v35, own calculations.

Table 10: Housing-cost regressions - electricity, heating and hot water, 2013

Dep var: ln (EWH expenditure)	(1)	(2)	(3)
	self-employment def. A	self-employment def. B	self-employment def. C
	b/se	b/se	b/se
self-employed	0.099***	0.111***	0.098***
	(0.014)	(0.017)	(0.016)
ln (HH income)	0.151***	0.148***	0.149***
	(0.010)	(0.010)	(0.010)
age	0.006***	0.006***	0.006***
	(0.000)	(0.000)	(0.000)
female	0.042***	0.043***	0.043***
	(0.008)	(0.008)	(0.008)
n_children	0.096***	0.097***	0.097***
	(0.004)	(0.004)	(0.004)
n_adult	0.136***	0.139***	0.137***
	(0.006)	(0.006)	(0.006)
region2	0.016*	0.017*	0.016+
	(0.008)	(0.008)	(0.008)
region3	-0.005	-0.003	-0.006
	(0.011)	(0.011)	(0.011)
education	-0.010***	-0.010***	-0.010***
	(0.002)	(0.002)	(0.002)
married	0.045***	0.044***	0.045***
	(0.012)	(0.012)	(0.012)
widowed	0.141***	0.141***	0.141***
	(0.029)	(0.029)	(0.029)
divorced	0.055***	0.055***	0.055***
	(0.013)	(0.013)	(0.013)
credit	0.022**	0.022**	0.020*
	(0.008)	(0.008)	(0.008)
rent	-0.076***	-0.075***	-0.077***
	(0.009)	(0.009)	(0.009)
_cons	3.431***	3.447***	3.444***
	(0.074)	(0.075)	(0.075)
r2	0.288	0.286	0.288
N	10155	9898	9990

Note: + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. EWH is expenditure for electricity, heating and hot water. The variables age, female, education, married, widowed, and divorced refer to the oldest working-age household member. Education is proxied by the number of years of education. Rent is a dummy variable indicating whether the household is a renter i.e. not a home owner. The variable credit indicates whether the household is paying off a loan. Regressions includes only working age individuals and those households which can consistently be defined as either wage earners or self-employed between 2012 and 2014. Date source: SOEP_v35, own calculations.

Table 11: Housing-cost regressions - total housing costs, 2013

Dep var: ln (total housing cost)	(1)	(2)	(3)
	self-employment def. A	self-employment def. B	self-employment def. C
	b/se	b/se	b/se
self-employed	0.053**	0.041*	0.032+
	(0.018)	(0.021)	(0.020)
ln (HH income)	0.353***	0.353***	0.350***
	(0.013)	(0.013)	(0.013)
age	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)
female	0.024*	0.026*	0.025*
	(0.010)	(0.010)	(0.010)
n_children	0.082***	0.082***	0.083***
	(0.005)	(0.005)	(0.005)
n_adult	0.045***	0.046***	0.047***
	(0.007)	(0.008)	(0.007)
region2	-0.017+	-0.017	-0.018+
	(0.010)	(0.010)	(0.010)
region3	-0.140***	-0.141***	-0.138***
	(0.014)	(0.014)	(0.014)
education	0.009***	0.008***	0.008***
	(0.002)	(0.002)	(0.002)
married	0.083***	0.076***	0.081***
	(0.015)	(0.015)	(0.015)
widowed	0.135***	0.127***	0.133***
	(0.036)	(0.036)	(0.036)
divorced	0.105***	0.099***	0.104***
	(0.016)	(0.016)	(0.016)
credit	0.084***	0.081***	0.083***
	(0.010)	(0.010)	(0.010)
rent	0.178***	0.179***	0.177***
	(0.011)	(0.011)	(0.011)
_cons	3.454***	3.452***	3.480***
	(0.093)	(0.093)	(0.094)
r2	0.223	0.222	0.219
N	10155	9898	9990

Note: + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. total housing cost includes expenditure for electricity, heating and hot water, additional cost, rent, amortizations, maintenance. The variables age, female, education, married, widowed, and divorced refer to the oldest working-age household member. Education is proxied by the number of years of education. Rent is a dummy variable indicating whether the household is a renter i.e. not a home owner. The variable credit indicates whether the household is paying off a loan. Regressions includes only working age individuals and those households which can consistently be defined as either wage earners or self-employed between 2012 and 2014. Date source: SOEP_v35, own calculations.

Table 12: Panel OLS regressions, TPP 2001-2014

dependent variable: ln (donation)	(1)	(2)	(3)	(4)
	current income		7-year average income	
	50% SE share	25% SE share	50% SE share	25% SE share
ln (pos. total income)	0.093***	0.093***	0.181***	0.181***
	(0.001)	(0.001	(0.003	(0.003
self-employed	0.164***	0.180***	0.086***	0.108***
	(0.005)	(0.004)	(0.005)	(0.005)
ln (Taxprice giving)	-0.944***	-0.945***	-1.185***	-1.185***
	(0.009	(0.009)	(0.010)	(0.010)
Age	0.074***	0.074***	0.061***	0.061***
	(0.001)	(0.001)	(0.002)	(0.002)
Age^2	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
1 child	0.079***	0.079***	0.053***	0.053***
	(0.004)	(0.004)	(0.004)	(0.004)
2 children	0.176***	0.176***	0.112***	0.112***
	(0.005)	(0.005)	(0.006)	(0.006)
3 children	0.249***	0.249***	0.182***	0.182***
	(0.009)	(0.009)	(0.011)	(0.011)
4 or more children	0.315***	0.316***	0.229***	0.229***
	(0.016)	(0.016)	(0.020)	(0.020)
Gender	-0.277***	-0.275***	-0.280***	-0.279***
	(0.016)	(0.016)	(0.019)	(0.019)
East Germany	-0.178***	-0.178***	-0.173***	-0.174***
	(0.012)	(0.012)	(0.014)	(0.014)
No religion	0.028***	0.028***	0.013+	0.013+
	(0.007)	(0.007)	(0.008)	(0.008)
Catholic	0.138***	0.137***	0.128***	0.128***
	(0.009)	(0.009)	(0.009)	(0.009)
Protestant	0.084***	0.083***	0.071***	0.071***
	(0.007)	(0.007)	(0.007)	(0.007)
Other religion	0.036	0.035	0.009	0.008
	(0.101)	(0.101)	(0.132)	(0.132)
Constant	-1.948***	-1.941***	-2.560***	-2.556***
	(0.026)	(0.026)	(0.045)	(0.045)
Fixed effects	Yes	Yes	Yes	Yes
R2	0.238	0.239	0.267	0.269
N	16,062,058	16,062,058	9,851,091	9,851,091

Note: + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors are given in parentheses below the coefficients. A composite self-employment (SE) dummy is used, which aggregates information for revenues from self-employment, agriculture and forestry and business, depending on their share in total revenues.

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

Table 13: Descriptive statistics, TPP FEPM regressions

Variable	Mean	Std. dev.
donation	272.9	10860.6
Log positive income from		
Employment	8.782	3.938
Self-employment	0.825	2.711
Business	1.434	3.410
Agriculture	0.244	1.466
Rent and lease	1.261	3.001
Capital	1.092	2.749
Other sources	1.872	3.601
Log tax price of giving	-0.303	0.157
Dummy variables		
Age 15-24	0.043	0.202
Age 25-34	0.133	0.340
Age 35-44	0.236	0.425
Age 45-54	0.252	0.434
Age 55-64	0.186	0.389
Age 65 and above	0.159	0.366
Single female	0.004	0.060
Single male	0.010	0.102
Married	0.622	0.485
East Germany	0.100	0.300
Catholic	0.340	0.474
Protestant	0.263	0.440
Other religion	0.000	0.018
No religion	0.327	0.469
One child	0.175	0.380
Two children	0.177	0.382
Threechildren	0.047	0.212
Four or more children	0.013	0.111
Year 2002	0.070	0.255

Year 2003	0.073	0.260
Year 2004	0.075	0.264
Year 2005	0.078	0.268
Year 2006	0.078	0.268
Year 2007	0.078	0.268
Year 2008	0.077	0.267
Year 2009	0.077	0.267
Year 2010	0.077	0.266
Year 2011	0.075	0.264
Year 2012	0.059	0.236
Year 2013	0.058	0.234
Year 2014	0.057	0.232

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations. Monetary values have been converted to 2014 Euros. The number of observations is 11,837,397 for all variables.

Table 14: Panel FEPM regressions, TPP 2001-2014

dependent variable: ln (donation)	(1)	(2)	(3)
Log income from employment			
Positive Income	0.000 (0.001)	0.001 (0.001)	0.000 (0.001)
Abs. neg. income			0.000 (0.008)
Log income from self-employment			
Positive Income	0.020*** (0.001)	0.022*** (0.001)	0.020*** (0.002)
Abs. neg. income			0.004 (0.003)
Log income from business			
Positive Income	0.039*** (0.002)	0.043*** (0.002)	0.047*** (0.002)
Abs. neg. income			0.016*** (0.002)

Log income from agriculture			
Positive Income	-0.002 (0.004)	0.001 (0.004)	-0.009 (0.006)
Abs. neg. income			-0.013 (0.011)
Log income from rent and lease			
Positive Income	0.005** (0.001)	0.014*** (0.001)	0.016*** (0.003)
Abs. neg. income			0.014** (0.004)
Log income from capital			
Positive Income	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)
Abs. neg. income			0.007 (0.006)
Log income from other income			
Positive Income	0.008*** (0.002)	0.008*** (0.002)	0.008*** (0.002)
Abs. neg. income			0.006 (0.004)
Total abs. neg. income		0.015*** (0.002)	
log tax price of giving	-2.190*** (0.018)	-2.198*** (0.018)	-2.192*** (0.018)
Dummy variables			
Age 15-24	-0.152*** (0.012)	-0.145*** (0.012)	-0.143*** (0.012)
Age 25-34	0.198*** (0.013)	0.192*** (0.013)	0.191*** (0.012)
Age 35-44	0.323*** (0.018)	0.304*** (0.019)	0.302*** (0.019)
Age 45-54	0.317*** (0.024)	0.291*** (0.026)	0.288*** (0.026)
Age 55-64	0.282*** (0.027)	0.253*** (0.028)	0.251*** (0.028)
Age 65 and above	0.326*** (0.029)	0.302*** (0.030)	0.300*** (0.030)
Single female	-0.434*** (0.030)	-0.421*** (0.030)	-0.421*** (0.030)
Single male	-0.411*** (0.020)	-0.397 *** (0.020)	-0.394*** (0.020)
Married	0.446*** (0.016)	0.434*** (0.016)	0.435*** (0.016)
East Germany	-0.197*** (0.056)	-0.197*** (0.056)	-0.199*** (0.056)
Catholic	-0.099*** (0.025)	-0.098*** (0.025)	-0.098*** (0.024)
Protestant	-0.043*** (0.012)	-0.043*** (0.012)	-0.044*** (0.012)
Other religion	0.000 (0.068)	0.001 (0.067)	0.002 (0.067)
No religion	0.024 (0.019)	0.023 (0.019)	0.023 (0.018)

One child	0.060*** (0.011)	0.058*** (0.011)	0.058*** (0.011)
Two children	0.108*** (0.013)	0.106*** (0.013)	0.105*** (0.013)
Three children	0.166*** (0.018)	0.165*** (0.018)	0.165*** (0.017)
Four or more children	0.183*** (0.020)	0.183*** (0.020)	0.183*** (0.020)
Year 2002	0.188*** (0.005)	0.189*** (0.005)	0.189*** (0.005)
Year 2003	0.120*** (0.006)	0.122*** (0.006)	0.122*** (0.006)
Year 2004	0.184*** (0.009)	0.186*** (0.009)	0.186*** (0.009)
Year 2005	0.295*** (0.006)	0.298*** (0.006)	0.298*** (0.006)
Year 2006	0.245*** (0.008)	0.248*** (0.008)	0.249*** (0.008)
Year 2007	0.373*** (0.012)	0.377*** (0.012)	0.379*** (0.012)
Year 2008	0.399*** (0.010)	0.404*** (0.010)	0.405*** (0.010)
Year 2009	0.412*** (0.010)	0.418*** (0.010)	0.420*** (0.010)
Year 2010	0.519*** (0.012)	0.526*** (0.012)	0.527*** (0.012)
Year 2011	0.529*** (0.013)	0.535*** (0.013)	0.536*** (0.013)
Year 2012	0.473*** (0.012)	0.479*** (0.012)	0.480*** (0.012)
Year 2013	0.561*** (0.012)	0.568*** (0.012)	0.569*** (0.012)
Year 2014	0.573*** (0.021)	0.579*** (0.021)	0.580*** (0.021)
Observations	11,837,397	11,837,397	11,837,397
Log pseudolikelihood	-2,05e+10	-2,05e+10	-2,05e+10

Note: + p<0.10, * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors are given in parentheses behind the coefficients. Column 1 gives a baseline without negative incomes, columns 2 includes the latter as one aggregated variable while column 3 includes negative incomes for every income category.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

Table 15: Estimated tax losses (EUR bn), based on published tax statistics

	OLS composite SE	OLS separate SE	NLS baseline		
			only SE	total	tax gap (%)
2001			8.7	13.4	7.59
2004	6.5	7.1	7.7	11.0	6.06
2007	7.7	8.3	9.3	15.2	7.19
2010	6.8	7.5	12.4	17.1	8.29
2012			11.7	16.6	7.12
2013			11.0	16.0	6.52
2014			11.6	16.9	6.52

Note: SE = self-employment. Estimates based on OLS and NLS cross-section regressions using the TPP, as described in section 4.3.1. Coefficients from these estimations are applied to published income tax statistics. The estimated tax gap is based on total tax losses compared to total assessed income tax.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

Table 16: Coefficients and compliance ratios for some income categories, NLS with Top10-interaction

Coef. k_{tj}	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
self-employment	2.57	2.85	2.46	2.31	2.29	2.06	1.91	1.68	1.70	1.83	1.82	1.74	1.65	1.69
compliance ratio	39%	35%	41%	43%	44%	48%	52%	60%	59%	55%	55%	57%	60%	59%
business	1.73	1.73	1.50	1.47	1.45	1.41	1.37	1.24	1.29	1.32	1.30	1.35	1.30	1.28
compliance ratio	58%	58%	67%	68%	69%	71%	73%	81%	78%	76%	77%	74%	77%	78%
agriculture and forestry	0.68	0.77	0.67	0.61	0.62	0.56	0.56	0.60	0.68	0.61	0.58	0.63	0.60	0.63
compliance ratio	146%	130%	149%	163%	161%	177%	178%	165%	147%	163%	171%	158%	166%	159%
rent and lease	1.05	1.22	1.08	1.16	1.22	1.11	1.12	1.12	1.31	1.41	1.44	1.48	1.51	1.55
compliance ratio	95%	82%	93%	86%	82%	90%	89%	89%	76%	71%	70%	68%	66%	64%
capital	4.17	4.69	3.37	3.22	4.45	3.63	3.39	2.72	2.07	3.04	2.94	2.48	2.69	2.73
compliance ratio	24%	21%	30%	31%	22%	28%	29%	37%	48%	33%	34%	40%	37%	37%
other	2.17	2.41	2.10	2.06	1.63	1.53	1.55	1.37	1.31	1.37	1.30	1.33	1.27	1.26
compliance ratio	46%	42%	48%	48%	61%	65%	65%	73%	76%	73%	77%	75%	79%	79%
negative	2.02	1.59	1.58	1.09	1.32	0.72	1.59	1.61	1.59	1.42	1.57	1.71	1.30	1.84
compliance ratio	50%	63%	63%	92%	76%	139%	63%	62%	63%	70%	64%	58%	77%	54%
self-employment*Top10	0.61	0.75	0.76	0.55	0.17$^{\diamond}$	0.27	0.16	0.04$^{\diamond}$	0.03$^{\diamond}$	0.18	0.07$^{\diamond}$	0.08$^{\diamond}$	0.05$^{\diamond}$	0.02$^{\diamond}$
compliance ratio	31%	28%	31%	35%	41%	43%	48%	58%	58%	50%	53%	55%	59%	59%
business*Top10	2.25	2.63	2.62	1.83	1.53	1.51	1.07	0.60	0.70	0.85	0.65	0.47	0.40	0.39
compliance ratio	25%	23%	24%	30%	33%	34%	41%	54%	50%	46%	51%	55%	59%	60%
agriculture and forestry*Top10	-0.03$^{\diamond}$	0.13$^{\diamond}$	0.07$^{\diamond}$	0.10$^{\diamond}$	0.01$^{\diamond}$	-0.01$^{\diamond}$	-0.14	-0.04$^{\diamond}$	0.05$^{\diamond}$	-0.05$^{\diamond}$	-0.03$^{\diamond}$	-0.11$^{\diamond}$	-0.02$^{\diamond}$	-0.03$^{\diamond}$
compliance ratio	152%	112%	136%	140%	158%	179%	237%	179%	138%	177%	182%	190%	172%	167%
rent and lease*Top10	1.40	1.44	1.09	0.90	0.90	1.14	0.51	0.46	0.78	1.24	0.94	0.57	0.35	0.41
compliance ratio	41%	38%	46%	48%	47%	44%	61%	63%	48%	38%	42%	49%	54%	51%
capital*Top10	0.05$^{\diamond}$	8.93	10.85	9.46	7.37	5.64	5.13	1.28	7.47	6.07	7.55	5.95	3.81	4.91
compliance ratio	24%	7%	7%	8%	8%	11%	12%	25%	10%	11%	10%	12%	15%	13%
other*Top10	20.98	19.54	17.41	13.44	9.83	11.47	7.90	5.86	5.54	6.77	5.53	4.33	3.76	3.90
compliance ratio	4%	5%	5%	6%	9%	8%	11%	14%	15%	12%	15%	18%	20%	19%

Note: For readibility and as most coefficients are highly significant, in contrast to standard *-notation it is noted by $\diamond$ when a coefficient is insignificant (the unmarked coefficients are significant at the 0.1% level at least). Compliance ratios are given by $1/k_j$ for the non-interacted incomes. For the Top10-interacted ones, the compliance ratio is given by $1/(k_j + k_{tj})$.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, TPP 2001-2014, own calculations.

IES Working Paper Series

2021

1. Mahir Suleymanov: *Foreign Direct Investment in Emerging Markets: Evidence from Russia since the 2000s*
2. Lenka Nechvátalová: *Multi-Horizon Equity Returns Predictability via Machine Learning*
3. Milan Scasny, Matej Opatrny: *Elasticity of Marginal Utility of Consumption: The Equal-Sacrifice Approach Applied for the Czech Republic*
4. Javier Garcia-Bernardo, Petr Jansky and Vojtech Misak: *Common Agricultural Policy Beneficiaries: Evidence of Inequality from a New Data Set*
5. Petr Jakubik, Saida Teleu: *Suspension of Insurers' Dividends as a Response to the Covid-19 Crisis: Evidence from Equity Market*
6. Boris Fisera, Menbere Workie Tiruneh, David Hojdan: *Currency Depreciations in Emerging Economies: A Blessing or a Curse for External Debt Management?*
7. Vojtech Molnar: *Price Level Targeting with Imperfect Rationality: A Heuristic Approach*
8. Alex Cobham, Tommaso Faccio, Javier Garcia-Bernardo, Petr Jansky, Jeffery Kadet, Sol Picciotto: *A Practical Proposal to End Corporate Tax Abuse: METR, a Minimum Effective Tax Rate for Multinationals*
9. Evžen Kočenda, Ichiro Iwasaki: *Bank Survival Around the World: A Meta-Analytic Review*
10. Michal Kuchta: *Scenario Generation for IFRS9 Purposes using a Bayesian MS-VAR Model*
11. Jozef Barunik, Josef Kurka: *Frequency-Dependent Higher Moment Risks*
12. Petr Pleticha: *Who Benefits from Global Value Chain Participation? Does Functional Specialization Matter?*
13. Alex Cobham, Petr Jansky, Chris Jones, Yama Temouri: *An Evaluation of the Effects of the European Commission's Proposals for the Common Consolidated Corporate Tax Base*
14. Javier Garcia-Bernardo, Petr Jansky: *Profit Shifting of Multinational Corporations Worldwide*
15. Tomas Domonkos, Boris Fisera and Maria Siranova: *Income Inequality as Long-term Conditioning Factor of Monetary Transmission to Bank Interest Rates in EA Countries*
16. Petr Jansky, Natalia Li: *Improving the Corruption Perceptions Index: Additional Data Sources and Their Effects*
17. Dominika Ehrenbergerova, Josef Bajzik, Tomas Havranek: *When Does Monetary Policy Sway House Prices? A Meta-Analysis*
18. Daniel Kolář: *Inequality in Pre-Industrial Urban Bohemia: The City of Budweis*
19. Barbora Malinska: *Forecasting Sovereign Bond Realized Volatility Using Time-Varying Coefficients Model*

20. Jan Pintera: *Regional Convergence in the European Union: What are the Factors of Growth?*
21. Jiří Witzany, Martin Diviš: *Interest Rate Risk of Savings Accounts*
22. Tommaso Faccio, Sarah Godar, Petr Janský, Oliver Seabarron: *How Much Multinational Corporations Pay in Taxes and Where: Evidence from their Country-by-Country Reports*
23. Ondřej Schneider: *Labor Migration in the European Union: The case of Central and Eastern Europe*
24. Alex Cobham, Javier Garcia-Bernardo, Petr Janský, Miroslav Palanský: *Statistical Measurement of Illicit Financial Flows in Sustainable Development Goals: Tax Avoidance by Multinational Corporations*
25. Petr Jakubik, Saida Teleu*: Impact of EU-wide insurance stress tests on equity prices and systemic risk*
26. Alex Cobham, Petr Janský, Jan Mareš: *Illicit Financial Flows and Trade Mispricing: Decomposing the Trade Reporting Gap*
27. Salim Turdaliev: *Increasing Block Rate Electricity Pricing and Propensity to Purchase Electric Appliances: Evidence from a Natural Experiment*
28. Katerina Kroupova, Tomas Havranek, Zuzana Irsova: *Student Employment and Education: A Meta-Analysis*
*29. M*atthew Greenwood-Nimmo, Evžen Kočenda, Viet Hoang Nguyen: *Does the Spillover Index Respond Significantly to Systemic Shocks? A Bootstrap-Based Probabilistic Analysis*
30. Julien Pinter and Evžen Kočenda: *Media Treatment of Monetary Policy Surprises and Their Impact on Firms' and Consumers' Expectations*
31. Weizhi Sun, Ladislav Kristoufek: *Diversification Among Cryptoassets: Bitcoin Maximalism, Active Portfolio Management, and Survival Bias*
32. Yermone Sargsyan: *Electricity Outages and Health Outcomes of Children: Empirical Evidence from Transition Economy*
33. Petra Landovská: *Social Costs of Obesity in the Czech Republic*
34. Anna Alberini, Levan Bezhanishvili, Milan Ščasný: *"Wild" Tariff Schemes: Evidence from the Republic of Georgia*
35. Alex Cobham, Edmund FitzGerald and Petr Janský: *Estimating Tax Progressivity in Developing Countries: The Plato Index*
36. Hannes Fauser, Sarah Godar: *Income tax noncompliance in Germany, 2001-2014*

All papers can be downloaded at: http://ies.fsv.cuni.cz

Univerzita Karlova v Praze, Fakulta sociálních věd
Institut ekonomických studií [UK FSV – IES] Praha 1, Opletalova 26
E-mail : ies@fsv.cuni.cz http://ies.fsv.cuni.cz