Asking Flexible Disaggregated Income - Gross or Net Figures - vs Single Total Question: Evaluation from Panel on Household Finance

Junyi Zhu (German Central Bank)

Paper prepared for the 34th IARIW General Conference

Dresden, Germany, August 21-27, 2016

Session 6D: Household Wealth II

Time: Thursday, August 25, 2016 [Afternoon]

Asking flexible disaggregated income - gross or net figures - vs single total question: evaluation from Panel on Household Finance[1]

Junyi Zhu[†]

2016.07.30

Preliminary – please do not cite without permission

Abstract

The PHF (Panel on Household Finance) questionnaire offers a couple of flexibility in answering the income information, especially choosing between gross and net values. We have developed a tax microsimulation model for the standardization (converting between gross and net) and imputation. The survey also collects a total monthly household disposable income as many general purpose surveys do. This paper documents our microsimulation model by showing the effectiveness of this innovation in collecting income through surveys and implementation by incorporating the unique tax class choice in German unfront income tax system. We then evaluate the data quality and potential contribution from this innovation by comparing the distributions from ours and a counterfactual asking only gross incomes as commonly done by other surveys. We also compare the difference between the disposable incomes derived by tax microsimulation and aggregation and the single self-reported one. Both comparisons reveal the disagreements appearing to be correlated with the income tax schedule and become significant in most progressive area of the distribution.

Keywords: income, survey data, measurement error, net/gross

[1] Results and opinions expressed in this paper are those of the author and do not necessarily reflect views of the Deutsche Bundesbank.

[†] Deutsche Bundesbank. Email: junyi.zhu@bundesbank.de.

1 Introduction

As a major innovation, (PHF) Panel on Household Finance survey allows the respondent to answer income questions by different accounting periods (eg, annual, quarterly, monthly or other specific ones) and gross or net figures- among much flexibility. As recommended by many other surveys, our income section gathers from a comprehensive list of disaggregated sources: employment/bonus, self-employment, pension, capital gain and unemployment benefit as individual components and many others as the aggregate household components such as in-kind and public transfers. We have developed a program to convert the gross and net figures bilaterally which considers all relevant complexities in the German tax- and social insurance contribution system. Particularly, there is an algorithm to infer the tax-class choice which is the key parameter for the tax calculator in German withholding tax system. These efforts appear to be the first among the existing German microsimulation models and the surveys collecting income information.

We document the infrastructure discussed above and then demonstrate the quality of our outcome: we had a relatively low rate of item-nonrepsonse in income section, our coverage rate of income is about 98% of the national account figure, our figures are close to major benchmarks such as income tax statistics/EVS/SHARE/SOEP.

Most surveys only ask either gross or net income values. Among those also collecting disaggregated component incomes almost only the gross figures are requested. The item-nonresponse can be much higher than our design since many respondents can be less informed of the gross figures. For example, the average wage earners are more aware of the net employment income through reading the bank transfer information and the presentation of gross employment income can be usually separated into multiple sources and locations in the payroll compared to one single figure in the end. The collective bargaining typical in the German wage setting system also reduces the likelihood for wage earners to access and remember the gross figure because only the labor union representatives are directly involved in the wage bargaining. By contrast, we may postulate that above-average self-employment income earners are more likely to answer the gross figure. They are supposed to actively review and plan their investment by assessing the business revenue which overlaps the gross self-employment

income in a large extent. They also have liability to report gross income to the tax authority by themselves or by hiring the tax advisors. In either way they should have strong incentive to know well about their gross figures for the tax saving purpose. The similar rationale can be applied to the wage earners in the top distribution such as the executives and professionals who participate the wage bargaining by themselves. In a word, subsamples which have higher chance to answer either gross or net incomes can be nonrandom and come from different parts of the distribution. We thus suspect the traditional survey only asking either gross or net values can result in a larger degree of item-nonresponses which violate the missing at random assumption necessary for an unbiased imputation. Our approach should be a remedy for this concern.

To access the contribution from the innovation to permit either gross or net format for answering income questions, we establish a counterfactual environment where there is only gross figures to be solicited and thus potentially much higher item-nonresponse therein. This counterfactual basically assumes all of our respondents answering the net figures would have yielded an item-nonresponse for the same income in the counterfactual design. We then run the imputation on this simulated survey data in order for us to infer the potential bias after providing evidences of our good match with benchmark distributions.

The bottom half of the distribution in the imputed counterfactual survey is slightly lower than our survey and the top half is a bit higher than ours. It is a surprise given that we observe the heterogeneity in the response groups of gross and net incomes in the data as discussed above. The differences increase pronouncedly in the 5^{th} to 20^{th} percentile which corresponds to the area of distribution where taxable income climbs to be above the basic allowance and some of them start to be liable to income tax while the other part of them are still tax free. Following this observation, our potential explanation for the difference between our and counterfactual surveys is that population liable to tax can have higher chance to know net figure better than gross one in relative to the others still paying zero tax. This distinction in the distributions of gross and net response groups can dominate all the other possible behaviors in the bottom distribution. Literatures have provided evidences of strong tax bunching before the basic allowance. They can be the support for our finding in the sense that population with taxable income around basic allowance should have more incentive to gauge their gross income.

Since a single total disposable income question is also asked in the PHF survey, we can compare this measure with our derived aggregated one particularly given the above evidences about the good quality of the derived aggregate household income. The remaining part of the paper performs such a comparison which can serve as guidance for survey designers when confronted with such a tradeoff. As argued by Micklewright and Schnepf (2010), the total recall question can be much cheaper than the disaggregated ones. The item-nonresponse may be lower in a single total question than the synthetic counterpart from the derived aggregate income. The latter is a product out of many component incomes from both household and personal levels as well as a large number of input parameters for tax microsimulation. The missingness from any of these components and inputs can trigger the item-nonresponse for the derived aggregate. Nevertheless, there are sparse validation exercises done in the literature for the single total question. Many surveys simply cannot afford to ask a rich battery of income information since income usually is not the focus of study and there is explicit control on the interview burden. In a result, the single total question for the household as a whole is more frequently asked as a sum of all the income components from both household and personal levels. But the reliability of this income information is rarely accessed although income has a pivotal role in household decisions and behaviors and enters most of the studies using surveys.

The key reason behind the shortage of attention on this issue is that to construct a valid evaluation is not straightforward. Bound, Brown and Mathiowetz (2001) classified the validation through comparing with external benchmark distributions as ‘macrolevel’ studies and the one as ‘microlevel’ exercises by accessing the difference between the single total income and the counterpart from matched administrative sources or from the other set of superior questions for the same households and/or individuals. The macrolevel validation can suffer from the pitfalls that the income concepts, target population and time periods measured can be different between the survey and benchmarks. The chance to carry out a microlevel is limited given the difficult in accessing and matching with administrative data and the design with multiple measurements of income is uncommon. The PHF then provides a precious venue for the much needed microlevel study with the help from the derived aggregate as a good benchmark available in the same survey.

Microlevel evidence suggests a mean-reversion of the income reporting errors in USA according to the benchmark data from employers: the bottom distribution is averagely characterized by the overreporting which contrasts with an average understating for the higher paid employees in surveys (eg, Bound, Brown, Duncan and Rodgers (1994)). Rendtel (2006) found the same pattern for the individual earnings in Finland from European Community Household Panel when comparing with administrative registers. However, the microlevel validation from UK data shows the significant understatement on average over the whole distribution (Bound et al., 2001).

On the other hand, recent research such as Hokayem, Bollinger and Ziliak (2015) does not always treat income from either external (administrative data) or internal (supposedly superior questions) benchmarks as the truth. Roemer (2002) and Abowd and Stinson (2013) suggest that the validity of either single total question or these benchmarks is not certainly maintained. There can exist sizable under-the-table earnings, as indicated by these researches, in the low-income population which are un/underdefined in the administrative registers and become unreported and/or uncovered earnings (both legal and illegal). The same argument can be extended to the internal benchmark of other more detailed income questions: their scope of coverage may not be necessarily complete particularly for those in the bottom of distribution who often receive income from exotic sources.

For the more common underreporting alleged for the single total income, the justification can be the recall bias or also earning sheltering, for example, due to confidentiality concerns. These cognitive aspects and economic motivation can be more pronounced among the relative rich households. Usually they have multiple and heterogeneous earning sources and several income earners. Stinson (1997) (cited in Moore et al. (2000)) discovered using US data that the cognitive coverage of ‘total family income’ can reach short of less significant incomes such as the part-time earnings from the respondents themselves or their spouses or interest payments. The other ignored incomes include those allocated to benefit only the respondents themselves or other members of the extended family. Collins and White (1996) found in UK that some respondents do not consider any other income sources beyond employment earnings.

Compared to the tax evasion purpose in reporting to administrative registers, the motive of earning sheltering in survey is not clear. Hurst, Li and Pugsley (2014) found the self-employed survey responses in US behave like their tax reporting in the sense to systematically underreport income. They provided some explanations: households may attempt to maintain the consistency in multiple income reportings if they are worried about confidentiality protection; on the other hand, it takes less efforts to simply copy the figures respondents have already reported to or received from tax authority. Otherwise, there can be a lengthy recalling and aggregating process as the tax claim they may have completed. Generally, persons always have incentive for pursuing various tax saving measures including particularly tax evasion. Consequently, there can be the same degree underreporting in surveys as that in tax reporting (before any potential tax auditing).

In the German context, compared to answering component incomes from many sources and family members, it is more possible to have similar motives and behaviour in reporting the single total household disposable income as just the reading from the same counterpart available in the end of the annual tax return form. To systematically duplicate the underreporting process in answering all the component incomes may not be straightforward: there are multiple income sources, survey respondents may not be involved with underreporting for tax purpose when tax claim is done by agents and / or this sheltering comes from some individuals other than respondents, the underreporting is less likely to be associated with the upfront tax system which is carried out by the income distributing institutes such as employers or banks which prevents the understatement from most net figures reported.

We show the single total value is mostly under the derived aggregate net figure while the former can be much higher than the latter in the bottom of distribution. The location to switch between upward to downward deviations in the income distribution corresponds closely to the basic allowance and the downward deviation starts to grow stronger when taxable income grows to approach flat rate area in German income tax schedule. These two areas also enjoy the highest local progression in the tax schedule. These two versions of disposable income differ much less in the middle of distribution where marginal tax rate is positive and below flat rates. Generally, our finding suggests single total income response for those with positive tax liability in survey can be similar

to the report towards tax authority: it has underreporting issue which results in a lower disposable income calculated by the tax authority based on the understated total gross income than the possibly more accurate counterpart derived by our tax microsimulation using the undistorted total gross income. On the other hand, tax bunching for those lowering the reported gross income can potentially explain the upward deviation in the bottom: most in the bottom are the singles and their underreport towards tax authority can lead to higher disposable income with no tax liability compared to the case if they had truly reported income. These findings echo and contrast with the evidences reported by Clotfelter (1983) and Hurst, Li and Pugsley (2014) for the US that income underreporting is more pronounced when marginal tax rate is higher in both tax registers and surveys.

The second section of the paper describes the PHF data with the focus on the income section and then documents our implementation of tax conversion procedures. Section 3 evaluates the income distribution and potential contributions of our innovation in income section. Section 4 presents the comparison between the single total and derived aggregate household disposable incomes. Section 5 concludes the analysis.

2 Data and tax conversion model

In this section, we present the data and depict the tax conversion model in details.

2.1 Data

Our tax conversion program is specifically designed to fulfil the data preparation required by the innovation in the income section of PHF. The PHF is part of the Household Finance and Consumption Survey (HFCS), a joint effort which collects ex ante harmonised micro data in the euro-area countries (Von Kalckreuth, Eisele, LeBlanc, Schmidt and Zhu (2012)).

Between September 2010 and July 2011, a net sample of 3,565 households were surveyed on their balance sheets, pension claims, savings, incomes and other issues related to their finances. The reference year for these data was 2009.

We developed a module of the net-gross conversion of income which that is embedded in the imputation process for the PHF. The PHF questionnaire allows the respondent to select from a flexible dimension of formats regarding income information: components

(ege.g. labour, capital, pension, social benefits,…), individual and household levels, time (yearly, monthly, quarterly, other specified duration or months whenever the flows are incomplete throughout the year), gross or net, quantity in brackets and different currencies. Table 1 summarises these specifications for all the income variables involved with tax conversion and micro-simulation.

2.2 Tax conversion model

We have to convert all the income variables to a common unit – the annual gross concept – in order to ensure a legitimate basis for implementing imputation algorithms and miscellaneous estimates. This section presents a description of the main assumptions and procedures involved in the tax conversion. Appendix A describes the key feature complicating our conversion in Germany - tax treatment in the German upfront tax system to account for family splitting, ie., choice of tax class - as well as of the structure of the tax function in Germany. Appendix B provides a complete illustration of the whole implementation.

The raw income data in the PHF contains either gross (*brutto*) or net (*netto*) values. While the survey asked for gross figures to be provided wherever possible, some of the income questions in the questionnaire gave the option of providing net figures. Interviewers recorded this distinction in one two-level categorical BR variable. In order to perform a consistent analysis, we converted all the reported figures so that they are all on the annual gross base.

The conversion carries a few assumptions. The main one is that the respondent reports the upfront net income figure that is the gross figure minus the source tax (usually wage tax / *Lohnsteuer*) and default social insurance contributions. This is usually what the employee respondent can gather from his/her payslip which conforms to the information-retrieving process they should follow. We also assume the same context for pension and self-employment incomes as the setting is similar for these incomes.

The second important assumption is that spouses choose the tax class (*Lohnsteuerklasse*) which ensures that the aggregate upfront net employment income for both is highest among all the alternative combinations: III/V, IV/IV or V/III. One complication in German upfront taxation is the choice of tax class by married partners. In almost all cases, couples have to decide between two arrangements: first, that one spouse receives the full marriage benefits (class III) while the other receives none (class V), and, second, that each shares the marriage benefits (IV for both). The choice of tax

class, however, is not asked for in the questionnaire. Therefore, we have to carry out an optimisation which is equivalent to a rationality assumption. We ignore the possibility of choosing tax class VI, which applies to income from second and subsequent employment.[2] We apply tax class I to all single persons with tax liability who are not single mothers. Tax class VI is assigned to the latter. Tax class I defines the lowest tax deductions and those with class VI can enjoy some additional tax benefits.

The gross to net calculator is specified by strictly following the protocol published by the Federal Ministry of Finance as well as the rules regarding social insurance contributions.[3] Note that capital income is always treated separately with regard to the flat rate withholding tax (*Abgeltungssteuer*).

We then discuss the structure of the tax conversion. Figure 1 outlines the process via a flowchart.[4] The conversion is composed of three major steps.

First, all of the reported income variables are converted one by one to the gross figures under all the eligible tax classes the respondents can take if the BR indicators show they were the net figures. This is achieved by a non-linear solver based on the gross to net tax calculator. The tax class is one input parameter that this tax calculator uses.

Next, for all spouses who are eligible for classes III/IV/V we calculate the alternative aggregate net figures under tax class IV using the version of the gross figures under classes III and V. Using the total net figures across all the income components reported by both partners, a yield test algorithm determines the optimal tax class.

Finally, we assign the gross figure to each variable that is associated with the optimal tax class as produced in the first step.

The bonus income (dpg0210) should be entered into the tax base together with the employment income to determine the joint marginal tax rate as stipulated by the German Tax Code. Our conversion also takes this complex matter into consideration.

This model is similar in many aspects to the Siena Micro-simulation Model (SM2) and EUROMOD, particularly regarding the rules on tax treatment and social insurance

[2] Everyone is asked to report employment income as one figure which we cannot separate among multiple jobs, if any.

[3] See PAP 2009 (*Geänderter Programmablaufplan für die maschinelle Berechnung der vom Arbeitslohn einzubehaltenden Lohnsteuer, des Solidaritätszuschlags und der Maßstabsteuer für die Kirchenlohnsteuer* in 2009: http://www.bundesfinanzministerium.de/Content/DE/Downloads/Steuern/Steuerarten/Lohnsteuer/Programmablaufplan/012_PAP_2009_a.pdf?__blob=publicationFile&v=4, accessed on 7 May 2011).

[4] We use rounded rectangular to denote the programs, or modules and routines which takes inputs and produces outputs. The inputs and outputs are described by the rectangular objects. The flowchart includes only the inputs and outputs within the core tax conversion modules for incomes subject to either income/wage tax and capital one.

contributions. [5] The main difference between the SM2 and the model we used is that we do not perform the iterative process between imputation and net-gross income conversion when some information required for conversion is missing. In the case of social benefits, we only use the self-reported benefit incomes. We use all the lump-sum tax allowances for each tax unit. Instead, EUROMOD imputes the social benefits income by assuming full take-up and matches with official tax statistics to simulate the individual-specific tax expenses.

In the rest of the paper, the disposable income discussed is produced by a tax micro-simulation which can be deemed a gross-to-net conversion where the input is all the gross income components liable to tax aggregated from all members of each tax unit. It is simply an extracted component of the tax conversion model. The tax unit is formed by either single persons or married heterosexual couples. Compared to the tax conversion, the procedures involved in tax class choice are omitted. We assume that spouses always file a joint tax return and that capital income is treated separately by the flat rate withholding tax (Abgeltungssteuer).

3 Evaluation of the tax conversion model

We evaluate the effectiveness of our tax conversion model by comparing our income distribution with the external benchmarks and showing our relatively low item-nonresponse in the income section. We then build a counterfactual environment where there is only gross figures to be solicited and thus potentially much higher item-nonresponse therein. This counterfactual basically assumes all of our respondents answering the net figures would have yielded an item-nonresponse for the same income in the counterfactual design. We run the imputation on this simulated survey data in order for us to infer the potential bias the traditional design only asking gross income may bear – the distributional difference between our and counterfactual income data.

[5] The SM2 is a flexible tool for net-gross income conversion and imputation used in some countries. EU-SILC (EU Statistics on Income and Living Conditions) data (Betti, Donatiello and Verma (2011)).EUROMOD, a tax-benefit micro-simulation model for the European Union (EU), assesses the effects of taxes and benefits on household incomes in a comparative manner. For the case of Germany in 2009, it uses EU-SILC data (Gallego Granados and Ochman (2012)).

3.1 Validity of the income distribution

The weighted proportion of the total income (Summe der Einkünfte) earners estimated from our original data according to the fine brackets in the wage and income tax statistics (Lohn- und Einkommensteuerstatistik 2010, Federal Statistical Office (2014)) agrees with the official statistics satisfactorily (see Table 2). One potential source of deviation lies in the fact that the wage and income tax statistics collect only information on the full population of tax filers but the population of non-tax filers is possibly incomplete. Such a difference is reflected by the evidence that the count is almost always higher in the PHF data, which are supposed to cover all potential taxpayers. This table shows that there is a slightly higher coverage of low income earners, which can be accounted for by the concentration of potential non-tax filers among those marginally employed. Although wealthy households are oversampled in the PHF data (Schmidt and Eisele (2013)), the top rich households are still underrepresented in the PHF income distribution.

To further assess our coverage, we calculate or collect the summary statistics for the total population, the number of tax filing units, gross market income, and relevant income components calculated from income tax statistics, PHF data and, for comparison, the national accounts. This is simply to reproduce Table A2 in Bach et alet al. (2013a) for the case of 2009 using PHF data. That table presents a comparison of the structure of the ITR-SOEP data base with the national accounts. All the figures in our 2009 PHF estimates are very close to those in the ITR-SOEP results, particularly in 2005. The tax filing units represent 57.5% of potential tax units in the 2009 PHF data. The corresponding figure for the 2005 ITR-SOEP data is 57.2%. Given the fact that the total numbers of tax filing units and potential tax units should be stable within such a short time interval, this similarity implies that the PHF data represent the potential tax unit population well. Compared to the national account aggregates, our coverage of income components in the 2009 PHF data resembles that in the 2005 ITR-SOEP data. In the 2009 PHF data, the gross market income totalled 81.2% of primary income of private households, as documented by the national accounts statistics. This is in the range of the ratios in other years. The wage income coverage is 98.1% in the 2009 PHF data, which is close to and better than the counterparts in other years. Business and capital income

from the 2009 PHF data as a percentage of entrepreneurial and property income from national accounts is 58.7%, again close to 57.7% of 2005 ITR-SOEP.

Table 3 provides a comparison of equivalised disposable household income from different sources. The PHF results are by and large close to the other three sources. In particular, the PHF decile means are almost always within the interval between EU-SILC and SOEP for the lower half of the distribution. The PHF data overrepresent deciles six to nine compared with EU-SILC and SEOP, which potentially indicates a higher degree of oversampling. This is also reflected in the higher median and mean from the PHF data. The Gini index is also higher for the PHF. Together with the evidence in Table 2, the PHF income distribution seems to exhibit a longer and thinner tail among the top income earners.

Given these comparison results, we assert that the PHF should be capable of representing the whole distribution of income except the very top.

3.2 Item nonresponse

All of the important income components (eg employment income) have low nonresponse (6-7%).

3.3 A counterfactual

In our counterfactual we drop all of net figures reported in the raw data which we basically assume those answering the net incomes in the PHF survey do not know or reject to answer the gross figures. This counterfactual attempts to represent the traditional survey design collecting income information by asking only gross or net values. Table 4 displays the proportions of households or individuals answering the net figures for each income variables soliciting either gross or net concepts in the deciles defined by equivalised disposable household income. As we have analysed in the introduction, above average employment and self-employment income earners are most likely to report the net values. The total decile households almost always have the least proportion to answer the net values. We thus hypothesize that the bottom distribution is the imputed income data from the counterfactual would be higher than the counterpart from PHF since there is far less observed cases from the bottom in the counterfactual. By the same logic, the top distribution after the imputation for the counterfactual should be higher.

Table 5 shows the comparison of percentile means from two income data: PHF vs the counterfactual. The bottom half of the distribution in the imputed counterfactual survey is slightly lower than our survey (less than 10% in actually most bottom 80% and bottom 1 % with most are less than 3%) and the top half is a bit higher than ours (2-5% in the top 10%). The former evidence is a surprise. The differences increase pronouncedly in the 5th to 20th percentile (24-20%) which corresponds to the area of distribution where taxable income climbs to be above the basic allowance and some of them start to be liable to income tax while the other part of them are still tax free(see Hechtner, Massarrat-Mashhadi, and Sielaff (2012)). Following this observation, our potential explanation for the difference between our and counterfactual surveys is that population liable to tax can have higher chance to know net figure better than gross one in relative to the others still paying zero tax. This distinction in the distributions of gross and net response groups can dominate all the other possible behaviors in the bottom distribution. Literatures have provided evidences of strong tax bunching before the basic allowance. They can be a support for our finding in the sense that population with taxable income around basic allowance should have more incentive to gauge their gross income.

4 Single total vs derived aggregate

This section devotes to the second purpose in our study: to access the validity of the single total household (disposable) income question in our survey by comparing it with the aggregate counterpart derived out of imputed income using tax microsimulation for each household. We have provided evidences for the latter to be an appropriate benchmark in the previous sections.

We first perform the same exercise as Table 6 in Micklewright and Schnepf (2010) for the UK data to reveal some cognitive aspects as discussed in the beginning in explaining the deviation between single total and derived aggregate incomes. Table 6 presents the percentile comparisons of both income distributions for the whole population and according to the classification by respondents in multiadult and single-adult households and their gender. If there is recall and aggregating bias in answering the single total question, we should expect the larger impact on the multiadult housholds than the single ones. We do observe such a pattern in Table 6 for both households

headed by male and female except some bottom percentiles where single households even have an overreporting problem if we treat the derived aggregate as true benchmark. We also observe the underreporting is almost increasing with income which is supposed to be consistent with the concern on recall and aggregating bias.

Different from the UK cases with underreporting almost everywhere (Micklewright and Schnepf (2010)), our single total question overreports in the bottom and underreports in the top – mean reversion like the findings from USA (Bound et al (1994)) and Finland in ECHP (Rendtel, 2006). Single households (esp. headed by females) aggravate the overstating in the bottom which contrasts with the UK experience.

Table 6 seems to not show severe deviation between these two incomes, in the spirit of taking neither as the truth as discussed in the introduction. The largest difference in the proportionate term is 19% in p80. The others are within or not far from 10%. To access the extent of the difference and explore the possible explanation, we tabulate the distribution of the relative percentage difference between single and derived total disposable income by the quintiles of derived total disposable income in Table 7. The average difference reaches at -26%. Namely, there is a sizable underreporting from single total question on average. The extent of deviation can become rather pronounced. For instance, the underreporting can reach almost more than 100% for about 10% population. Additionally, there are both under and over reporting across the whole distribution. The size and population with underreporting is increasing with quintiles of derived total disposable income and those with overreporting is decreasing with quintiles of derived total disposable income.

The above evidences appear to point to both the existence of under-the-table income (overreporting) and recall bias (underreporting) discussed in the introduction. To see the correlation of the deviation with income and explore the motive relevant with tax reporting, we present in Figure 2 the relative difference between single and derived total disposable income vs derived total gross income in the susbsamples classified by quintiles of derived total disposable income. Dividing the samples by quintles is to achieve a better visibility in showing the subtle change of the correlation between the deviation and income when income grows into different parts of distribution. We also overlay the marginal tax rate as calculated from tax microsimulation and medianized around the local neighbor to show the potential tax reporting argument.

We can observe averagely more underreporting in all the quintiles except the first one. The fifth quintile shows the most serious underreporting and the first one shows the other extreme. The evolution of over and underreporting over the income distribution is not constant. We draw a quadratic fitting line of the bivariate observations within each of the quintile subplots. This line is decreasing sharply in the first quintile subsample, increasing in the second and third ones, becomes almost flat in the fourth one and finally is decreasing strongly in the last one. When we compare this trend with the marginal tax rate, the latter can explain the former only for the first and last quintile subsamples. However, the former seems to correspond well with the evolution of local progression: the fitting line drops most sharply where marginal tax rate starts to pick up from the zero in the first quintile subsample and where marginal tax rate starts to become flat in the last quintile subsample. These two areas have the strongest local progression according to German tax schedule (see eg., Figure 3 in Zhu (2014) for the plot of residual progression which has reverse relationship with local progression). The distribution between them bears a U-shaped local progression, which can fit with the evolution of the relationship between the deviation and income in the middle three quintile subsamples.

5 Conclusion

The PHF (Panel on Household Finance) questionnaire offers a couple of flexibility in answering the income information, especially choosing between gross and net values. We have developed a tax microsimulation model for the standardization (converting between gross and net) and imputation. The survey also collects a total monthly household disposable income as many general purpose surveys do. This paper documents our microsimulation model by showing the effectiveness of this innovation in collecting income through surveys and implementation by incorporating the unique tax class choice in German unfront income tax system. We then evaluate the data quality and potential contribution from this innovation by comparing the distributions from ours and a counterfactual asking only gross incomes as commonly done by other surveys. We also compare the difference between the disposable incomes derived by tax microsimulation and aggregation and the single self-reported one. Both comparisons

reveal the disagreements appearing to be correlated with the income tax schedule and become significant in most progressive area of the distribution.

Our evidence implies that survey design should be more careful in deciding the format to collect income information since either single total or a battery of component questions might not be accurate in particular part of the distribution. It can be sufficient in providing more flexibility in the critical area of tax schedule.

Appendix A German system of tax and social security contributions

The German income tax schedule includes a basic allowance, the directly progressive and the marginally flat tax brackets. Nominal taxable incomes above the basic allowance are subject to a marginal tax rate increasing linearly with income until a threshold is hit. Incomes exceeding this threshold are taxed by the constant marginal tax rates.[6] Married couples can enjoy the marriage tax benefit mainly through a splitting rule for spouses (joint taxation of couples) such that the joint tax liability is twice the tax liability derived from the point of the tax function where taxable income is half of the couple's income. Due to tax progressivity, almost all couples can reduce the total tax liability by filing tax jointly.

Furthermore, since 2009, capital incomes of private households have been – in the normal case – subject to a flat tax rate of 25% for the part above a saver's allowance. They are treated as a withholding tax separate from the above-mentioned income tax. However, tax payers can instead include the capital incomes in the income tax base if filing jointly is more favourable. This can be done when they file their annual tax return. The authorities then perform a yield test to determine whether withheld tax is to be refunded. Initially designed for funding German re-unification, a surcharge of 5.5% on both income and capital income tax burdens (as well as on the corporate tax burden for corporations) is additionally levied. Members of the catholic and protestant churches (and some smaller churches) are supposed to pay a church tax, with income and capital income tax burdens as the tax base. There is a flat rate of 8% or 9% on this tax base, depending on the federal state.

Wage tax and withholding taxes on interest and dividends have to be paid upfront. By filing a tax return every year, the discrepancies between up-front and final tax liability are then resolved. The obligation to file tax, however, is binding only for the self-employed and anyone with multiple income sources, but only in particular cases for wage earners. It is much more favourable for high income earners to file tax because they can claim itemised deductions as well as other allowances to save tax; this possibility is only available when filing a tax return. Consequently, low income earners are more likely to be underrepresented in the income tax statistics covering only the tax filer population.

[6] There was only one marginal flat tax bracket before 2007. The rich tax (*Reichensteuer*) was introduced in 2007 with the other bracket bearing a higher flat marginal tax rate at the top of the distribution. In 2009, a flat 42% was levied in respect of taxable income between €52,552 and €250,400. For taxable income above €250,400, a flat 45% tax was levied.

Many Germans are subject to statutory social insurance contributions. Theese include pension insurance, health insurance, long-term care insurance, statutory unemployment insurance, and accident insurance. Employees and employers are obliged to pay statutory social insurance contributions. These levies are progressive for the lower part of the income distribution because there are limits below which contributions on earnings are waived. For earners with gross income above the limits, contributions are proportional to nominal gross income up to a ceiling. Gross income above this ceiling is disregarded. Income ceilings are adjusted roughly according to wage growth.

Civil servants and the self-employed are not obligated to pay compulsory social insurance contributions. Many opt out of such insurance and choose to be covered by the private system, e.g. private health insurance. Pensioners only have to contribute to health insurance and long-term care insurance.

Appendix B A note on time and tax conversion in PHF

Before the core tax conversion program, we carry out three major steps: preparatory imputation, time conversion and producing the auxiliary parameters as inputs for tax calculator in the conversion program. In this note, the purposes and detailed algorithm of each step will be discussed.

B.1 Preparatory imputation

We perform a preparatory imputation to ensure the auxiliary parameters for tax conversion are nonmissing. Since the degree of item-nonresponse is quite low and the variables involved are basic demographic characteristics asked for every respondent household or individual which means the potentially available observable information is ample, we should be confident on the quality of this imputation when they are served for the purpose of tax calculation.[7] Variables imputed are dpe1275, dpa0400, dhh0900, dpe0200a, dpa0100 and ra0300. The imputation infrastructure is exactly same as the main one which is run after conversions.

B.2 Time conversion

Since many income variables are reported on the individual specific accounting time base, we have to transform all of these variables into the annual base in order to facilitate the imputation and further internal analysis.[8] If the bounds instead of the exact values are responded, the same practices apply to the bounds. There are two types of time period information:

1. The respondent is firstly asked to report how the time base will be for the flow value he is going to report: monthly or annually. If it is not an annual figure, he is asked whether this flow accrues constantly throughout the year. If he answered no, he is asked how many months this flow accrues actually.
2. The respondent is only asked to report how the time base will be for the flow he is going to respond from four sorts: annually, monthly, quarterly or other period.[9]

[7] There are specific rules proposed to deal with the item-nonresponses present in all of the tax liable income variables during the process of tax conversion. These rules are necessary for the determination of tax class in the German upfront tax system when the spouse's income is missing. All of these details will be discussed in the section of tax conversion.

[8] Those tax liable value variables are first converted to a monthly base for the requirement of tax conversion. The rationale of doing this will be explained in the section on tax conversion (see the text where we discuss the input parameter lzz in the section B.4.2). After tax conversion, they are retransformed into the annual figures.

[9] We use the respondent comments following the response of "other period" to collapse this type into three sorts.

Our converted annual figures reflect the total flows aggregated according to the time information reported in either of these two types. If the respondent provided the value of the income variable (exact one or the bounds) but failed to do so for the accounting time information, we transform the value information into bounds to cover as likely as possible all the potential annual figures corresponding to the choice set of the time information. In the main imputation, the annual income for this case would be recovered constrained by the bounds together with the other item-nonresponses. For example, if the reported income value is 5000 and the associated accounting time variable belongs to the second type, then the lower bound is 5000 which arises if the chosen period were annual, and the upper bound is 60000 which is equivalent to assume the chose period were monthly.

B.3 A module to produce the auxiliary variables dependent on the intra-household relationship

In this program we use the household matrix data to create many input variables for the tax calculator. It loads the whole household relationship matrix (vsmq1601-vsmq1615) together with many input variables. Then there are an outer loop over each person *i* and an inner loop over each household member *j* of this person *i*. Two operations are carried out for each step of the inner loop:

1. Identify the ralationship of *j* w.r.t. the family member *i*. The relationship variable vsmq16j for person *i* shows the relationship of the member with pid (personal id – a counter within each household) *j* w.r.t. *i*, which we map to an opposite relationship table in order to derive the ralationship of the member with pid *j* w.r.t. the family member *i*. This is saved to a variable nvsmq16x (here x=j).
2. Create the auxiliary variables. They are produced by using this new relationship variable nvsmq16x together with other information each *i* has.

Here is a list of auxiliary variables as output (besides nvsmq1601-nvsmq1615):
n_id: a new id number.
yrbrh: year of birth.
ctchx: count of economically tied children derived from the relationship matrix.
ctcyt: count of tax related children derived from the relationship matrix.
ctcbw: count of children born in life by a woman or the spouse of a man.
spuse: number of spouse.
spsdx: number of spouse with different sex.
pisp1-**pisp3**: n_id of the first three spouse.

pidx1-**pidx3**: n_id of the first three spouse with different sex.

The explanations on these variables are presented here as well as the motivation regarding tax calculation:

n_id: this is a shorter version of persid which can facilitate the manipulation and display. It is simply a sequence of natural number starting from one for everyone appearing in the household matrix data.

yrbrh: it is the interview year for FKP minus the age variable ra0300 since this variable is answered by FKP. If it is missing, we will use dpe9050 whenever the latter is nonmissng.

ctchx: these children are defined as the biological, adoptive, step or foster son or daughter (i.e. those with nvsmq16x equal to five or six). Due to the definition of the household in our questionnaire, they should be all of the children whom household finance decision is related with.

ctcyt: these form the subset of those defined for ctchx who are strictly under 18 or older than 18 and strictly below 25 and still participating training (i.e. those with yrbrh<18 or ((yrbrh>=18 and yrbrh<25) and dpa0400=1)). Parents with this kind of children can be eligible for particular tax treatment in Germany. This variable will be an input for the tax calculator.

ctcbw: this is retrieved from her own dpe1275 if the respondent is a woman or dpe1275 of his spouse if he is a man (for the homosexual spouse of two men, this is zero).

spsdx: the respondent is defined as “tax married” if this value is positive. If someone is not mentioned within the scope of our definition of "economic household" - household matrix, he/she might rarely participate the decision-making on tax class choice for wage tax. Therefore, they might be *de facto* "tax divorced" though their reported marital status is still "married" (dpa0100=4/5/6). On the other hand, homosexual marriage cannot enjoy family splitting for income tax.

B.4 Tax conversion

Some of the income questions in our questionnaire are provided with the choice to answer either gross (brutto) or net (netto) figures while we encourage the gross one to be reported. Interviewers record this distinction in the other two-level categorical BR variable whose name is the initial name for the income value variable followed by a suffix “br”. In order to form a consistent base for imputation and further analysis, we convert all the reported net figures (when BR indicator is “netto”) to a gross counterpart.

This conversion relies on a few assumptions. The main one is that respondents report the upfront net income figure which is the gross figure minus the source tax (Lohnsteuer; wage tax) and default social contribution. This is usually what the employee can recall from the payroll which we believe conforms to the information retrieving process most respondents should follow as we encourage the use of payroll and bank statement during interview. We also assume the same for the pension and self-employment incomes.

The second important assumption is the spouse has chosen the tax class (Lohnsteuerklasse) for each such that the aggregate net income from both is highest among all the alternative combinations: III/V, IV/IV or V/III. There are totally six tax classes for wage tax in Germany. There are different upfront deduction rules for these tax classes. Only the married heterosexual couple can be eligible for the class III, IV and V. In the III/V and V/III combinations, the marriage tax benefits (splitting advantage and allowance) are fully assigned to the class III by assuming the other partner has zero income. In the IV/IV combination, the marriage benefits are equally divided by basically assuming the other partner has exactly the same income. Single mother can claim the class II to enjoy the additional benefits the other singles cannot access. The decision on the choice of tax class is not asked in our questionnaire. The inference on the choice of the single (mother) is straightforward. By contrast, we have to make the assumption for the married couple which is equivalent to assume the spouse is economically rational conditional only on the information we know from the survey. We exclude the possibility to choose the tax class VI which applies to the income of the second and subsequent employment.[10]

There are two groups of tax liable variables:

1. dpg0200 dpg0210 dpg1300 dpg0400 dpg1500 dpg0600
2. dpg0800 dhg0800

The first group contains those in our questionnaire which are subject to wage/income tax and default social contribution. And the second covers those subject to capital income tax only. We develop a tax calculator – gross to net calculator - to derive the wage/income tax and default social contribution according to a program flow chart provided by the Federal Ministry of Finance (we will refert to this as PAP2009 in the following text).[11] Our conversion is dependent on this core programe which actually assumes the employer files the wage tax for the employee in our sample in compliance with the section 42b of the Income Tax Act (*Einkommenssteuergesetz*, or EStG). This

[10] Everyone is asked to report the employment income as one figure which we cannot separate among multiple jobs if any.

[11] This document can be accessed from this link: https:www.abgabenrechner.de/pruefdaten/pap2009.pdf.

also applies to whoever files the source tax for the freelancers and pensioneers. A detailed exposition will be present in the following section devoted to this tax calculator.

The core tax conversion consists of two modules respectively for two groups of tax liable variables. We start by describing the structure of the first module. Next, the gross-to-net calculator and net-to-gross solver are presented. We then discuss the optimizer to determine the tax class the spouse chooses. Finally, the module to convert using capital income tax rules concludes this section.

B.4.1 The structure of the tax conversion for income variables subject to wage/income tax and default social contributions

The conversion is composed of four major steps:

1) All of the reported values in the group one tax liable variables except dpg0210 (income from bonus payment) are converted to the gross figures if the BR indicators show they were the net figures. This conversion produces all the versions of net figures corresponding to tax classes the respondent is eligible. This is achieved by a non-linear solver based on the tax calculator which will be explained in the section B.4.3B.4.3. The tax class is one input parameter the tax calculator uses. At this stage, every nonmissing value of these variables has a gross version for each eligible tax classes. This version is either reported (same as the initial value) or converted. For singles (mothers) their conversion is settled in this step.

2) Next, for all the spouses who are eligible for classes III/IV/V, we calculate the alternative net figures under tax class IV using the version of the gross figures under class III and V. This is accomplished by the tax calculator which will be unfolded in the section B.4.2. This alternative net figure under tax class IV is used to determine the optimal tax classes the spouse will choose which will be discussed in the section B.4.4.

3) An optimizer determines the tax classes both sides of the spouse choose among III/IV/V.

4) Finally, the gross figures for the spouse are picked from the results reached in step 1 according to the optimal tax classes derived in step 2 and 3.

Besides, bonus income dpg0210 goes through the first two steps after we finish these steps for the others, particularly dpg0200 (income from employment income). The bonus income should enter the tax base together with the employment income to determine the average tax rate. And, using this rate, the tax calculator will produce only one net figure if there are inputs from both employment and bonus incomes. Due to this fact, we can extract the net figure for dpg0210 only when we have the net figure for dpg0200.

B.4.2 Tax calculator (gross to net)

This section will present the input and output parameters of this calculator. We will use the same notation as in PAP2009 where the definitions are officially stipulated. Thus, we will mainly explain and justify how we extract the information for input parameters. Those variables in italic are produced by the module present in the section B.3. All of the input parameters in PAP2009 are discussed here. This calculator contains some additional features on social contributions which are not covered by PAP2009 but deemed to be default in the tax filing by the employer. If the definitions are not shown in PAP2009, we will then illustrate them here. Furthermore, some extra output and particular considerations are discussed in the end of this section.

Input parameters:

ajahr: this is derived from *yrbrh*.

zkf: this is equal to *ctcyt*.

stkl: tax class. I if *spsdx* is zero and zkf is zero (single and childless), II if *spsdx* is zero and zkf is positive (single and with children) and eligible for III/IV/V if *spsdx* is positive (married). As described in the section B.4.1, anyone eligible for III/IV/V will always receive three versions of income corresponding to these three classes in the beginning.

bundesland: the German state the respondent resides.

r: this is derived from dhh0900 (actually this variable is the percentage rate of church tax: zero if dhh0900 is not one, eight if dhh0900 is one and bundesland is either Baden-Würtenberg or Bayern and nine if dhh0900 is one and bundesland is neither of these two).

kinderlos: a dummy to show whether the respondent is not a parent and above 23. If this dummy is one, he/she should pay a supplementary contribution of 0.25% for nursing insurance (1.225% instead of 0.975%). The respondent is considered to be childless in this context if both *ctchx* and *ctcbw* are zero. This is to account for the possiblity of adoptive children and children separate from the “economic household” (e.g. those grow-ups).

krv: the equivalence of the definition in PAP2009 – zero if the respondent is subject the general contribution for statutory pension, and one if he/she is not. The subset who is waived of this contribution includes the civil servant (dpe0200a is three), freelancer (dpg0400 or dpg1500 is positive) and pensioneer (dpg0600 is positive).

kvsatz: rate of public health insurance. We assume 14% for all.

e_pkv: rate of private health/nursing insurance. We assume zero for all.

lzz: we set it as two (monthly income flow) always. Regardless the fact whether the respondent works through the full year, the calculator always extrapolates the monthly

gross income to the annual figure by a multiple of twelve which is used to determine the marginal tax rate. This is also the behavior most employers will follow when making payroll. We also assume the figure for employment income the respondent reports is same as what he/she see from the payroll. Therefore, our setting can avoid the underestimation of the wage tax (a source tax) for those not working through the full year.

re4: value of the gross income for all the tax liable variables.

sonstb: this is the gross value of dpg0210.

vbezs: this is the gross value of dpg0600.

vmt, jfreib, jhinzu, vbez, sterbe, vkapa and **vbezm**: they are set to be zero.

zmvb: we set it to be 12.

vjahr: we set it to be 2009.

Output parameters:

The main outputs include wage tax (Lohnsteuer), solidaritary tax (Solidaritätszuschlag), church tax (Kirchensteuer), contributions for social security (Rentenversicherung), unemployment benefit (Arbeitslosenversicherung), public/private insurance (Krankenversicherung) and nursing insurance (Pflegeversicherung), and net income (Nettoverdienst).

Additional considerations:

In Germany, those receiving less than 400 euros will not pay any tax and social contributions and those receiving between 400 and 800 euros are supposed to pay a much favorable rate of social contributions. This fact is taken into account by the calculator.

Even though it can be more beneficial to apply for children allowance (Kinderfreibeträge) than child benefit (Kindergeld) for very rich parents, this is not incorporated in this calculator as well as PAP 2009. Since this is the measure taken by PAP 2009, it is safe to assume this is also a common practice for filing source tax. However, input zkf will always have impact on solidarity and church taxes as well as social contributions.

B.4.3 Net to gross solver based on the tax calculator

We use bi-section method as a root finder for the inverse conversion of German tax function. Since the german tax function is always a continuous function w.r.t. the taxable income and the rates of social contributions are fixed given all the other parameters, the bi-section method can always converge. The other feature is that the root search is parallelly computed for the homogeneous individuals sharing the identical inputs in order to improve the efficiency.

B.4.4 Optimizer to determine the tax class

Here is the procedure this optimizer goes through:

1) Calculate the sums of gross income components (only those related with tax class choice: dpg0200, dpg0210, dpg0400 and dpg0600) under class III-V (the mid point of bounds or one of them is inserted if answered; treat the sum as missing if all of the components (bounds or the variable itself) of any income are missing (-1/-2)).

2) Do the same for the sums of net income components.

3) Determine the optimal tax class by these rules: first, find the main income earner by comparing their gross figures between couples; then, assume they will take III/V combination for tax class (i.e. III for main income earner and V for the other); next, validate this assumption by testing if the sum of net figures under an alternative scheme (i.e. both with class IV) is smaller than the sum of the net figures under the assumed scheme (i.e. III/V). If this test fails, the optimal scheme they will take should be IV/IV.

For those whose spouse is missing in the person file (but present in the household matrix) and those with any income item (either his own or his spouse's) missing (-1/-2), we apply the following rule: if the part with nonmissing total net income under class III is larger than 80% of the dhi0600 (household total net income), this part is assigned class III; if this part has net figure under class V less than 20% of the dhi0600, this part is assigned class V; otherwise, this part is assigned class IV. This is a rule of thumb as a reasonable starting point. This also applies to the practice to insert mid-points of the bounds in step 1).

B.4.5 Tax conversion for income variables subject to capital income tax only

We have discussed the conversion process for all of the variables in the group one mentioned in the beginning of section B.4.[12] The others in the group two are related with the tax for capital gain in Germany.

[12] We use PAP2009 for the conversion of dpg1300 (income from current employment) and dpg1500 (income from current self-employment) which were responded in 2010/2011 (interview year). This is not accurate because the tax rate brackets (Tarifzonen) changed as well as the marginal rate for the one bracket (Progressionszone 1). But the change is quite minor (there are also other minor changes regarding social contributions). Most changes happen in the Progressionszone 1's for the tax scheme of either 2009 or 2010/2011: the area where taxable income is between 7835 andd 13469 euros. The maximum rate of differences for tax payment w.r.t the taxable income is only 0.36% withinthis area. The persons who are affected by using the old tax scheme are also just quite a few. For example, the number of persons who reported a gross figure for dpg1300 between 7834 and 13469 euros are 37 out of 329 persons whoever reported a gross figure. Given these facts, we decide to keep using the old tax scheme for these two variables.

Interested reader can read these references:

1. § 32a Absatz 1 EStG in der Fassung vom 6. März 2009 - http://www.gesetze-im-internet.de/estg/__32a.html

For dpg0800 (income from private pension), we assume the tax liable is the capital gain tax institute deducts automatically according to the profit share (Ertragsanteil). And we further assume respondents started receiving the payout from the private pension at age 65, which is the statutory early retirement age in Germany. Then, their profit share is 18% according to § 22 EStG. The flat rate withholding tax rate on capital gain introduced in 2009 is 25 % plus solidarity surcharge of 5.5 % on the final withholding tax and possible church tax (8 or 9 % of the flat tax). The same flat rate tax is applied for the conversion of dhg0800 (total income from financial investments).

2. § 52 Absatz 41 EStG in der Fassung vom 6. März 2009 - http://www.gesetze-im-internet.de/estg/__52.html

3. Tax rate parameters in 2009 and 2010/2011: http://de.wikipedia.org/wiki/Einkommensteuer_%28Deutschland%29#Entwicklung_der_Parameter

References

Abowd, J., and Stinson, M. (2013), “Estimating Measurement Error in Annual Job Earnings: A Comparison of Survey and Administrative Data,” *Review of Economics and Statistics*, 95, 1451–1467.

Andreoni, James, Brian Erard, and Jonathan Feinstein (1998). "Tax Compliance," *Journal of Economic Literature*, 36(2), pp. 818-60.

Betti, G., Donatiello, G. and Verma, V. (2011). The siena micro-simulation model (SM2) for net-gross conversion of EU-Silc variables, International Journal of Micro-simulation, 4(1), 35-53.

Bollinger, C. R., Hirsch, B. T., Hokayem, C. and Ziliak, J. P. (2014). Trouble in the Tails: Earnings Nonresponse and Response Bias across the Distribution. Presented at Joint Statistical Meetings, Boston, August.

Bound, J., Brown, C., Duncan, G. and Rodgers, W. (1994) Evidence on the validity of cross-sectional and longitudinal labor market data. *J. Lab. Econ.*, **12**, 345–368.

Bound, J., Brown, C. and Mathiowetz,N. (2001) Measurement error in survey data. In *Handbook of Econometrics* (eds J. J. Heckman and E. Leamer), vol. 5, pp. 3705–3843. Amsterdam: Elsevier.

Clotfelter, C. (1983). "Tax Evasion and Tax Rates: An Analysis of Individual Returns," *Review of Economics and Statistics*, 65(3), pp. 363-73.

Collins, D. and White, A. (1996) In search of an income question for the 2001 Census. *Surv. Methodol. Bull.*, **39**, no. 7, 2–10.

Gallego Granados, P. and Ochmann, R. (2012). EUROMOD Country Report – Germany. Discussion Paper No. 12.EUROMOD.

Hechtner, F., Massarrat-Mashhadi, N. and Sielaff, C. (2012). Eine Analyse zur Einkommensteuerbelastung und Wirkung der kalten Progression der vergangenen 20 Jahre in Deutschland. Discussion Paper No. 137, Arbeitskreis Quantitative Steuerlehre (arqus).

Hurst, E., Li, G., & Pugsley, B. (2014). Are household surveys like tax forms? Evidence from income underreporting of the self-employed. Review of economics and statistics, 96(1), 19-33.

Hokayem, C., Bollinger, C. and Ziliak, J. P. (2015). The Role of CPS Nonresponse in the Measurement of Poverty, Journal of the American Statistical Association, 110:511, 935-945.

Micklewright, J., & Schnepf, S. V. (2010). How reliable are income data collected with a single question?. Journal of the Royal Statistical Society: Series A (Statistics in Society), 173(2), 409-429.

Moore, J., Stinson, L. and Welniak, E. (2000) Income measurement error in surveys. *J. Off. Statist.*, **16**, 331–361. Office for National Statistics (2006) The 2011 Census: assessment of initial user requirements on content for England and Wales—income. Office for National Statistics, London. (Available from http://www.statistics.gov.uk/about/consultations/downloads/2011Census-assessment-income.pdf.)

Rendtel, U. (2006) The 2005 plenary meeting on "Missing Data and Measurement Error". *Allg. Statist. Arch.*, **90**, 493–499.

Roemer, M. (2002), *Using Administrative Earnings Records to Assess Wage Data Quality in the March Current Population Survey and the Survey of Income and Program Participation*, Longitudinal Employer-Household Dynamics Program, Technical Paper No. TP-2002-22, Washington, DC: U.S. Census Bureau.

Schmidt, T. and Eisele, M. (2013). Oversampling vermögender Haushalte im Rahmen der Studie „Private Haushalte und ihre Finanzen (PHF)". http://www.bundesbank.de/Redaktion/EN/Downloads/Bundesbank/Research_Centre/phf_oversampling.pdf?__blob=publicationFile, accessed on 10 May 2014.

Stinson, L. (1997) The subjective assessment of income and expenses: cognitive test results. *Report*. US Bureau of Labor Statistics, Washington DC. Unpublished.

Von Kalckreuth, U., Eisele, M., Le Blanc, J., Schmidt, T. and Zhu, J. (2012). The PHF: a comprehensive panel survey on household and wealth in Germany. Discussion Paper No. 13, Deutsche Bundesbank.

Zhu, J. (2014). Bracket Creep Revisited–with and without r> g: Evidence from Germany. Journal of Income Distribution, 23, 3-4.

Table 1 Income variables relevant to tax conversion and microsimulation

Income variable	Household (h) or personal (p) level	Label	Accounting period variable[1)]	Variable to determine whether income flow is received throughout the year[2)]	Months received if the income flow is not received throughout the year[3)]	Gross-net option[4)]
dhg0200	h	INCOME FROM REGULAR SOCIAL TRANSFERS	dhg0100	dhg0110	dhg0120	
dhg0400	h	INCOME FROM REGULAR PRIVATE TRANSFERS	dhg0300	dhg0310	dhg0320	
dhg0600	h	RENTAL INCOME FROM REAL ESTATE PROPERTY	dhg0500	dhg0530	dhg0510	
dhg1000	h	INCOME FROM PRIVATE BUSINESSES OR COMPANIES	dhg0900	dhg0910	dhg0920	
dhg0800	h	INCOME FROM FINANCIAL INVESTMENT				available
dhg1150	h	INCOME FROM OTHER REGULAR SOURCES				
dhg1200	h	INCOME FROM OTHER IRREGULAR SOURCES				
dpg0200	p	EMPLOYEE INCOME	dpg0100	dpg0110	dpg0150	available
dpg0400	p	SELF-EMPLOYMENT INCOME	dpg0300	dpg0310	dpg0320	available
dpg0600	p	INCOME FROM STATUTORY PENSION	dpg0500	dpg0530	pg0510	available
dpg0800	p	INCOME FROM PRIVATE PENSIONS	dpg0700	dpg0730	dpg0750	available
dpg1000	p	INCOME FROM UNEMPLOYMENT BENEFITS	dpg0900	dpg0910	dpg0920	
dpg0210	p	INCOME FROM BONUS PAYMENT				available[5)]

Notes: 1) Income value can be provided on either an annual or monthly basis. This variable does not exist when we only ask for annual income. 2-3) When we ask for annual income only, this variable does not exist. 4) Respondents can provide either gross or net figures. We assume that the gross income is always reported if this option is not available. Usually, they are not liable for tax pursuant to the tax code or the respondents most probably provide the gross value given the special institutional setting in Germany (e.g. unemployment income (dpg1000) is partially levied since it enters the tax base to boost the marginal tax rate for the other income components due to progressivity, but the tax on it is waived). 5) In German upfront taxation, bonus income (dpg0210) is added to annual employment income (dpg0200) to determine the total annual tax liability. Then the tax liability for the annual employment income is calculated separately. The difference becomes the tax liability for the bonus income which we perceive in forming the net bonus income reported.

Figure 1 The flowchart of tax conversion program

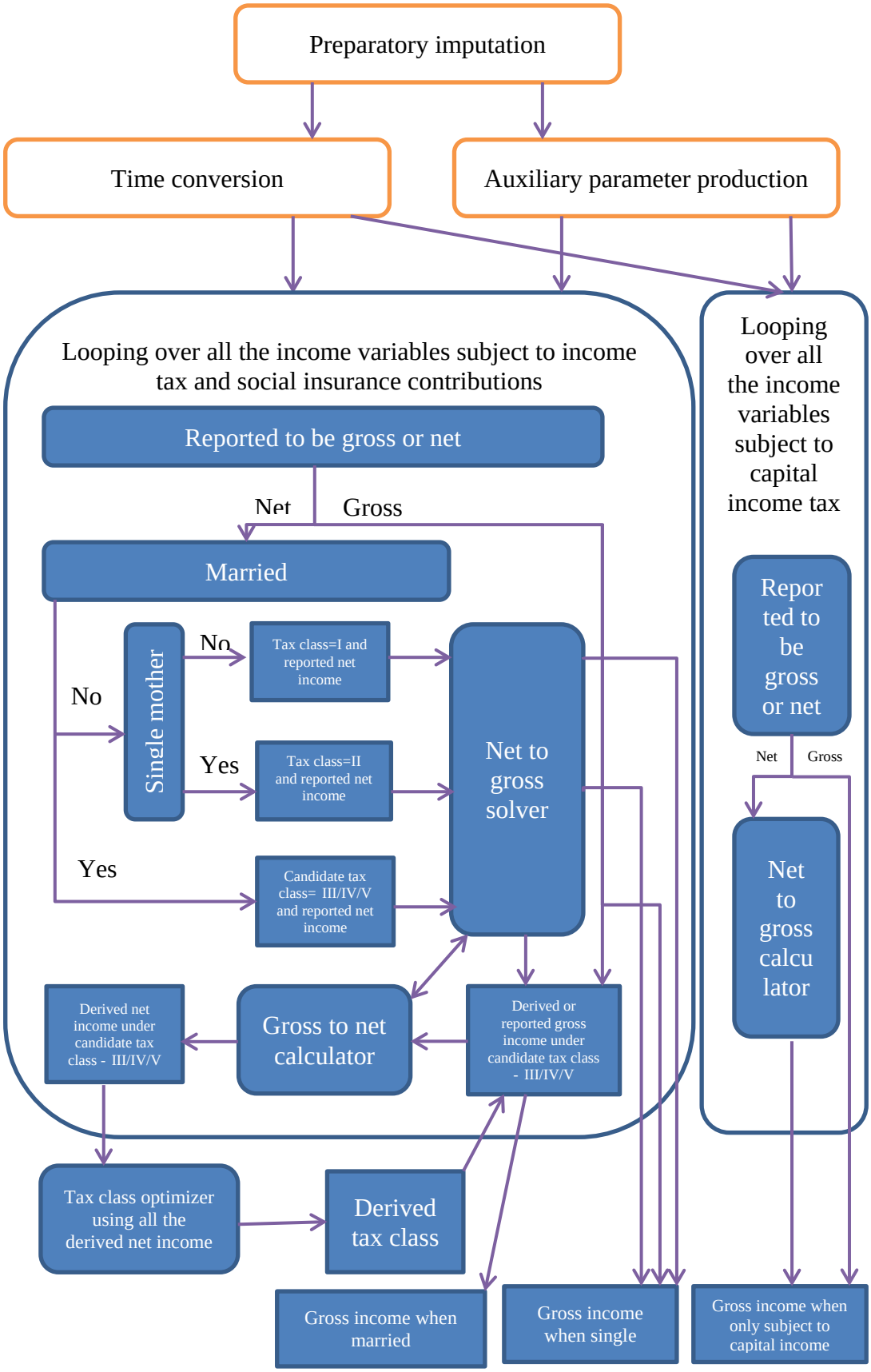


Table 2: Income distribution of tax payers: Wage and Income tax statistics vs PHF

Brackets of total income (Summe der Einkünfte)			2010 wage and income tax statistics		PHF	
			Persons liable for tax	%	Persons liable for tax	%
0[1)]	-	5,000	7,725,718	16.9	12,115,932	18.8
5,000	-	10,000	5,486,101	12.0	6,636,510	10.3
10,000	-	15,000	5,255,273	11.5	7,732,530	12.0
15,000	-	20,000	4,669,959	10.2	8,030,584	12.5
20,000	-	25,000	4,195,657	9.2	6,533,975	10.2
25,000	-	30,000	3,901,934	8.5	5,095,524	7.9
30,000	-	35,000	3,366,891	7.4	4,171,173	6.5
35,000	-	40,000	2,637,706	5.8	2,812,074	4.4
40,000	-	45,000	1,956,018	4.3	2,411,172	3.7
45,000	-	50,000	1,434,029	3.1	1,709,532	2.7
50,000	-	60,000	1,775,482	3.9	2,289,549	3.6
60,000	-	70,000	1,017,166	2.2	1,463,212	2.3
70,000	-	80,000	626,003	1.4	887,994	1.4
80,000	-	90,000	411,558	0.9	610,824	0.9
90,000	-	100,000	274,976	0.6	402,759	0.6
100,000	-	125,000	389,225	0.9	596,308	0.9
125,000	-	250,000	489,366	1.1	701,465	1.1
250,000	-	500,000	119,367	0.3	97,763	0.2
500,000	-	1,000,000	30,567	0.1	26,601	0.0
1,000,000	oder mehr		13,909	0.0	1,000	0.0
Sum			45,776,905	100	64,326,480[2)]	100

Notes: 1) The bracket with negative income is collapsed into the first one since negative figures are not allowed in the PHF. 2) We assume that the PHF covers all the residents liable to income tax, which is the entire population of persons aged 20 years and older, minus young adults who are eligible for child benefits. This size estimate is close to the estimates of the 20 years and older population between 1992 and 2005 in Table A2 of Bach et al. (2013a), which is stable at around 65 million. The same estimate from the PHF is around 65.4 million.
Sources: Wage and income tax statistics (Table 3, Federal Statistical Office, 2014, p.14) and own calculation using PHF data and the same concept of total income (*Summe der Einkünft*, § 2, German income tax law (*EStG*)).

Table 3: Income deciles from the PHF and decile means from survey data in 2009: equivalised disposable household income (€ per year)

Decile	Thresholds from PHF	PHF	EU-SILC	SOEP
1st	8,899	5,701	6,985	4,014
2nd	12,000	10,644	10,969	9,656
3rd	14,376	13,230	13,439	12,330
4th	16,587	15,520	15,570	14,460
5th	18,750	17,648	17,664	16,573
6th	21,398	19,918	19,849	18,751
7th	24,309	22,872	22,361	21,373
8th	28,310	26,326	25,680	24,720
9th	37,241	32,018	30,707	30,284
10th	-	57,591	50,362	55,764
Overall:				
Median		18,758	18,678	18,586
Mean		22,148	21,264	21,223
Gini		32.81	29.26	29.10

Notes: The "modified OECD" scale is used for equalising incomes of households of different structure and size. The respective weights are 1 (first adult), 0.5 (subsequent adults) and 0.3 (children aged below 14).
Source: Own results using PHF data, EU-SILC micro data for 2009 and SOEP micro data from the 2010 wave referring 2009. Disposable income from SOEP has been adjusted to match the EUROMOD/EU-SILC concept where losses and costs from renting and leasing as well as capital investment have been excluded (Gallego, Granados and Ochmann (2012)).

Table 4 Households or persons reporting net value as % of nonmissing respondents for each decile and each variable

Deciles	INCOME FROM FINANCIAL INVESTMENT	EMPLOYEE INCOME	INCOME FROM BONUS PAYMENT	SELF-EMPLOYMENT INCOME	INCOME FROM STATUTORY PENSION	INCOME FROM PRIVATE PENSIONS
1	41	60	52	61	51	30
2	29	57	55	59	86	31
3	27	56	42	46	74	65
4	52	43	53	47	78	74
5	48	49	42	46	78	66
6	49	54	61	27	73	72
7	34	51	50	36	60	46
8	39	49	44	52	66	61
9	33	46	51	35	60	59
10	25	35	37	27	60	50

Table 5 Distributions (percentile and decile means) of household disposable income as derived from tax microsimulation - PHF versus counterfactual

Percentile	PHF	Counterfactual	Counterfactual as % of benchmark
1	1,830	1,791	98
5	7,500	5,711	76
10	10,498	8,430	80
20	14,604	13,219	91
30	18,436	17,222	93
40	22,097	21,491	97
50	26,689	26,033	98
60	31,379	31,311	100
70	37,762	37,293	99
80	45,819	45,701	100
90	60,580	61,725	102
95	76,789	77,975	102
99	121,966	128,192	105

Table 6 Distributions of derived total household net income vs single total one between multiadult or single person household and male or female household heads

Percentile	All			Male (1,969 cases)						Female (1,596 cases)					
				Multiadult			Single household			Multiadult			Single household		
	Single total	Derived sum	*Single as % of derived sum*	Single total	Derived sum	*Single as % of derived sum*	Single total	Derived sum	*Single as % of derived sum*	Single total	Derived sum	*Single as % of derived sum*	Single total	Derived sum	*Single as % of derived sum*
5	7,920	7,500	*106*	13,200	14,266	*93*	5,160	4,742	*109*	12,000	13,397	*90*	6,600	4,450	*148*
10	9,936	10,498	*95*	16,200	19,365	*84*	7,200	7,900	*91*	15,600	17,800	*88*	8,220	7,400	*111*
25	14,700	16,449	*89*	21,600	27,036	*80*	11,400	13,000	*88*	21,600	25,209	*86*	11,400	11,000	*104*
50	22,800	26,689	*85*	30,000	37,866	*79*	15,684	18,471	*85*	30,000	34,936	*86*	14,400	15,582	*92*
75	36,000	41,065	*88*	42,684	53,863	*79*	23,508	25,895	*91*	42,000	49,286	*85*	19,200	21,260	*90*
80	37,200	45,819	*81*	48,000	57,567	*83*	24,000	27,378	*88*	42,000	53,939	*78*	20,400	22,840	*89*

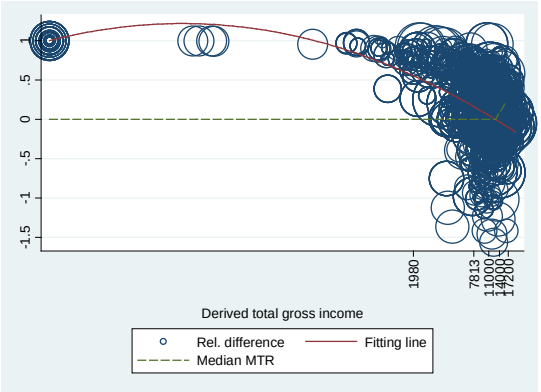
Notes: percentiles are calculated within the subsamples defined by the columns.

Table 7 Distribution of the relative percentage difference between single and derived total disposable income by the quintiles of derived total disposable income

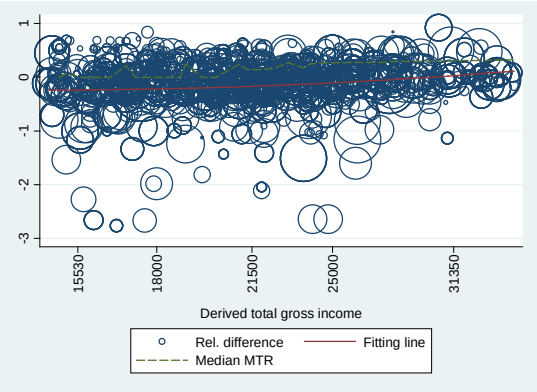
	Quintiles of derived total disposable income					Total
	1	2	3	4	5	
mean	9	-19	-25	-28	-65	-26
p1	-162	-285	-177	-257	-518	-343
p5	-67	-100	-96	-109	-253	-127
p10	-30	-52	-71	-80	-179	-80
p25	-11	-23	-34	-37	-75	-34
p50	3	-12	-15	-14	-31	-13
p75	39	4	-2	-1	-9	3
p90	70	24	14	10	5	25
p95	88	40	24	21	13	44
p99	100	51	45	40	33	89

Notes: The denominator in the relative difference is the single total disposable income for the household minus the derived one out of the tax microsimulation using imputed income. The numerator is the single total disposable income. The percentages of this relative difference are shown.

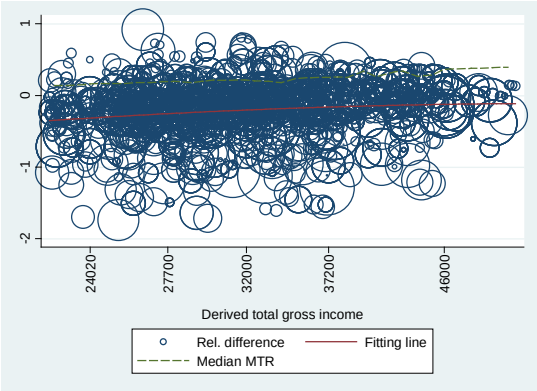
Figure 2 Relative difference between single and derived total disposable income (vertical axis) vs derived total gross income (horizontal axis) in the susbsamples classified by quintiles of derived total disposable income



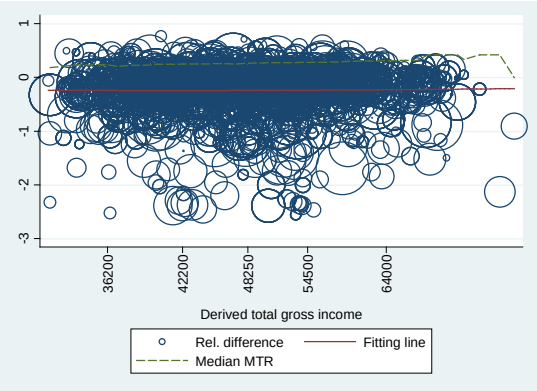
1



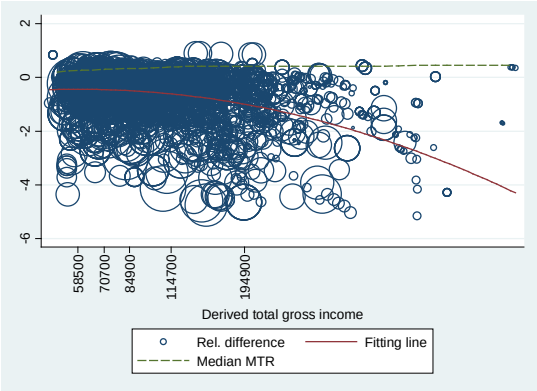
2



3



4



5

Notes: The denominator in the relative difference is the single total disposable income for the household minus the derived one out of the tax microsimulation using imputed income. The numerator is the single total disposable income. The bottom 1% of the relative difference is truncated as outliers. The derived total gross income is an aggregate of all the personal income components over all the household members

and the household level income components using imputed data. The size of circles in each scatterplot is proportional to the weight associated with that observation. The fitting line is a quadratic functional estimate of the bivariate relationship in each subsample. Median MTR is a weighted median band fitting through the observations which basically connects the points defined by the local medians in the x and y dimensions. The following percentiles in the distribution of derived total gross income within each subsample are marked: p5, p25, p50, p75 and p95.