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Netting Down Gross Earnings Data in the LIS Database: An Evaluation of Two Procedures

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Abstract

LIS researchers who seek to perform country-comparative and / or trend analyses have to account for the fact that in some LIS datasets income variables were reported net of taxes and social security contributions, while in other datasets income variables were reported gross of taxes and social security contributions. In this technical paper we discuss, develop, and evaluate two 'netting down procedures' that help reduce bias that would be introduced by directly comparing net and gross datasets. Results of evaluating the performance of these netting down procedures indicate that the validity of the comparison of net and gross datasets can be greatly improved when netting down procedures are applied. In several cases, however, substantial amounts of bias remain.

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1 Introduction

LIS researchers who seek to perform country-comparative or trend analyses have to account for the fact that in some LIS datasets earnings variables were reported net of income taxes and social security contributions (paid by the employee), while in other datasets earnings variables were reported gross of income taxes and social security contributions. Directly comparing net and gross earnings variables while assuming both measure the same earnings concept introduces bias to the analysis. Net earnings variables represent earnings after income taxes and contributions were subtracted, while gross earnings variables represent earnings before income taxes and contributions were subtracted. For the users of LIS who seek to perform country-comparative or trend analyses, this results in the challenge that their selected earnings variable(s) refer(s) refer to different earnings concepts in the different datasets used, and therefore in most applications should not be compared directly. In the remainder of this technical paper, wherever it is stated 'taxes', we refer to the combination of income taxes and social security contributions. In addition, throughout this paper, when we use the term 'contributions', we refer to 'social security contributions' (paid by the employee); in other words, we use those terms interchangeably

LIS researchers have available (and have applied) four different strategies for comparing net and gross datasets. The first is to include both types of datasets in the same (comparative) analysis, explicitly stating that the comparison might be biased. The second strategy is to limit the analysis either to only net datasets, or to only gross datasets. This results in correct analyses, but clearly limits the scope of the research. Thirdly, LIS users can

[0]The authors thank Markus Jäntti for valuable comments on an earlier version of this paper, and Thierry Kruten for translating our code to SAS.

present separate analyses for the net datasets, and for the gross datasets. This also results in correct analyses, and users can discuss the differences in results between the two groups of countries. The limitation of this strategy is that differences in the results between the net and gross analyses can originate both from the different earnings concepts that were used, as well as from the analyses being based on different countries. In addition, because separate analyses were performed, no statistical tests can be performed in comparing the differences in outcomes between (groups of) countries. The fourth strategy for comparing net and gross datasets is to modify the gross earnings data to approximate net earnings data. This process is referred to as '*netting down*' gross data, and entails subtracting taxes from the gross data. Research on such netting down procedures, however, is limited. Although some netting down procedures for LIS are available informally, they are undocumented and it has not been evaluated empirically whether such netting down procedures result in measurements of earnings that are equivalent across datasets. Hence, the goals of this technical paper are, in this order, the following:

- Provide background information on the comparison of earnings in net and gross LIS datasets.
- Provide practical guidelines on using two netting down procedures, including program code (for STATA, SPSS, R, and SAS) and an overview of the assumptions that are made in these procedures.
- Quantify the degree of bias introduced by directly comparing net and gross earnings variables, answering the question "*To what extent is bias introduced by directly comparing gross to net earnings data?*"
- Evaluate the degree to which the provided netting down procedures

improve the comparability of net and gross earnings variables, answering the question: "*To what extent do 'netting down' procedures result in measures of net earnings that are equivalent (unbiased) across datasets?*"

2 Comparing Net and Gross Earnings Data

The Luxembourg Income Study Database (LIS) provides harmonized survey data on numerous aspects of income, taxes, social security contributions, transfers, expenditures, consumption, employment, and background information, covering nearly 40 countries with the first wave dating back to around 1980. All datasets in the LIS database are harmonized to a common template, allowing for comparisons between countries and over time. This makes LIS an invaluable source of data for country-comparative and/or trend studies on various aspects of income. From the 205 LIS datasets available at the time of writing, 55 (27%) were classified as providing earnings variables net of taxes, 139 (68%) provide earnings variables gross of taxes, and 11 (5%) were classified as 'mixed'.[1] Newly added datasets are increasingly likely to provide earnings gross of taxes.

The difference between datasets with net or gross earnings variables affects country-comparative research, as the earnings variables for some countries were always classified as net (e.g. Hungary, Mexico, and Slovenia) and others always as gross (e.g. Australia, Canada, and the Netherlands). As in some countries the measurement of earnings variables over time changed from net to gross (e.g. Greece, Italy), the (lack of) comparability between net and gross earnings variables can also affect trend studies on a single

[1] For an updated overview, see: http://www.lisdatacenter.org/our-data/lis-database/datasets-information/

country.

2.1 Why is the difference between net and gross datasets important?

Comparing net and gross data on income can either be a challenge in comparability, or of substantive interest. This applies to income in general, and to earnings as a specific form of income on which this technical paper is focused.

First, the differences between net and gross earnings becomes a challenge in comparability, when comparisons are made *between* datasets of which some are gross and others are net. This is the case in country-comparative analyses and / or in trend analyses. It has been shown that country-comparative studies based on different earnings concepts across countries can be "*seriously misleading*" (p. 777), for instance when net and gross earnings variables are mixed (Atkinson and Brandolini, 2001). Also, in measuring inequality, the earnings concept used was found to not only affect the level of inequality, but also the trend in inequality (ibid.).[2] The comparison between net and gross datasets can then be improved by netting down the gross earnings, so that the comparison is based on a common earnings concept: net of taxes.

Secondly, the difference between gross and net income is of substantive interest when a single dataset contains information on both gross and net income or earnings, when information on taxes is available, and when additional information on social transfers is available. This allows LIS users to,

[2]The literature on comparability of measurements across countries and / or time is well developed (Davidov et al., 2011; Verhagen, 2012; Kline, 2005). However, the methodology in this literature is mostly based on a generalized-latent variable approach. This approach assumes a latent construct that is measured by multiple manifest indicators. Since earnings are not a latent construct, this approach does not apply here.

for instance, compare pre-tax-pre-transfer income to post-tax-post-transfer income, and thereby to answer a set of research questions on how taxes, but also social transfers, affect the income distribution.[3] This approach has been applied to study the effects of social-welfare policies on the poverty rates in the total population of countries (see, e.g., Kenworthy, 1999). Other studies have evaluated how taxes and transfers affected poverty of specific subgroups, such as among children (see, e.g., Gornick and Jäntti, 2012) and migrant households (Sainsbury and Morissens, 2012; Morissens and Sainsbury, 2005). With respect to earnings, questions on redistribution include whether the gender gap in earnings differs between net and gross earnings (cf. England et al., 2012; Blau and Kahn, 2000), and the whether women's net or gross earnings provide more bargaining power in household economic models (cf. Becker, 1991). For such 'redistribution studies', the actual differences between net and gross income are of substantive interest, and both are compared *within* a single dataset.

The issue of comparability between net and gross datasets in LIS also applies to redistribution studies. This is clarified using a detailed example of a typical redistribution study on the comparison between *pre-tax-and-transfer* income (referred to as 'household market income') to *post-tax-and-transfer* income (referred to as 'disposable household income') (Gornick and Jäntti, 2012). However, market income was reported gross of income taxes in some LIS datasets, and net of income taxes in other LIS datasets. As for these 'redistribution' studies, parallel to the issues raised with earnings, bias is introduced when gross and net datasets are mixed and the poverty/inequality reductions associated with taxes and transfers are compared across datasets.

[3]Note that with comparing pre-tax-pre-transfer income to post-tax-post-transfer income, solely using the concept of 'earnings' is not meaningful, as total income can be derived from labor (including earnings), capital and transfers.

That clearly understates poverty/inequality reduction in the net datasets, as the comparison between market income and disposable household income in these datasets only captures the effects of transfers, whereas in gross datasets this comparison would capture the combined effect of taxes and transfers. Thus, although the quantity of interest (the difference between market household income and disposable household income) is derived by comparison *within* a dataset, here again the challenge of comparisons arises when this quantity of interest is compared between net and gross datasets. Thus, here too the comparison between net and gross datasets can then be improved by netting down the gross datasets, so that the comparison is based on a common market household income concept.

2.2 Netting Down, or Grossing up?

It should be noted that in principle there is no difference between netting down gross earnings data, or grossing up net earnings data. Both options can be attractive, depending upon the substantive questions to be answered or hypotheses to be tested with the data.

With LIS, however, grossing up is not possible as the datasets that are labeled as 'net' do not contain information on taxes. To then estimate the gross earnings would require country-specific details on the tax system, which is beyond the scope of this technical paper. Detailed simulations to this end are available for many countries through the Euromod project.[4]

The scope of this technical paper is limited to developing and evaluating netting down procedures.

[4]On the internet: https://www.iser.essex.ac.uk/euromod

3 Practical Guidelines on Netting Down Person-level Earnings

In this section, practical guidelines are provided on netting down person-level earnings. The steps to be taken in netting down person-level earnings in gross datasets are summarized in Figure 1.

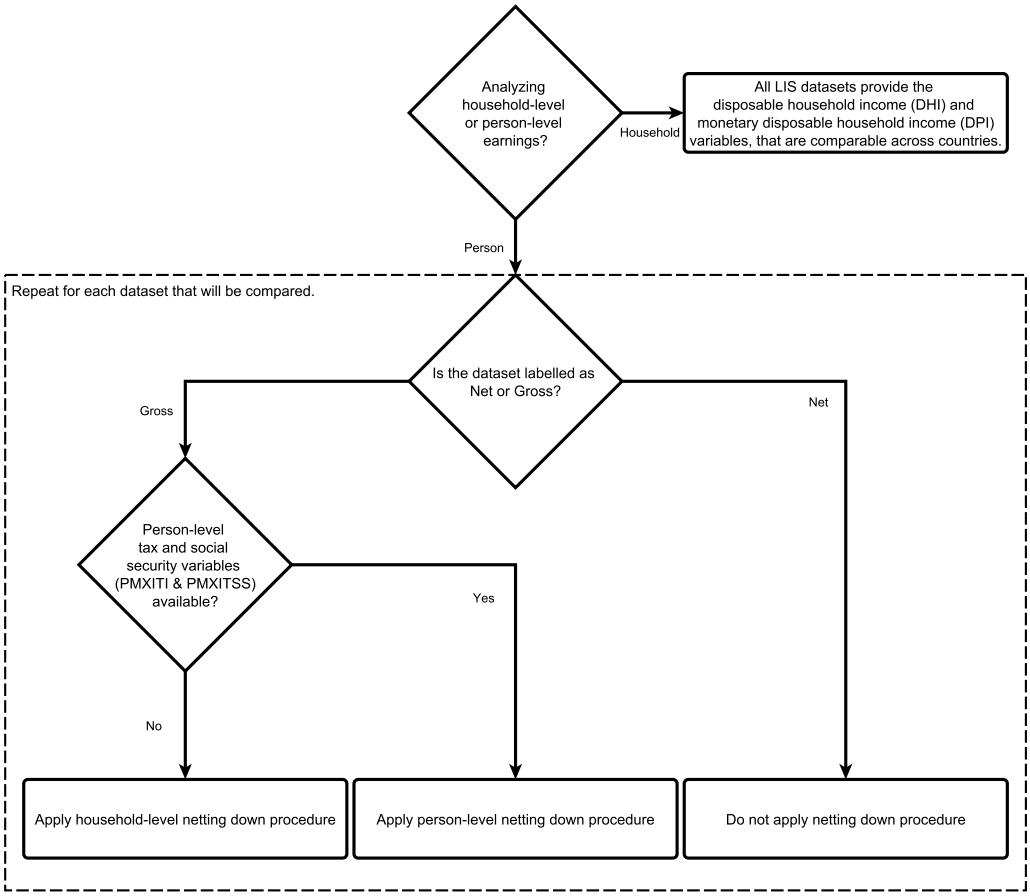

Figure 1: Schematic representation of netting down person-level gross earnings in LIS

3.1 Netting Down Specific Income Sources

Total income is typically recognized to be obtained from three different sources: labor, capital, and transfers. A researcher can be interested in comparing the total income derived from these sources combined, or be interested in the income derived from one of these sources, such as for instance labor. These three main categories can be divided further, for instance by differentiating between earnings derived from dependent employment or from self-employment (both part of labor).

Netting down the income from either labor, capital, or transfers is challenging both conceptually and practically. The conceptual problem with net income from separate sources lies in the fact that typically earners pay their taxes based on all (taxable) income. So, if a household or person has income from multiple sources the amount of income taxes paid is based on the amount of total income, rather than the amount of earnings from each of these sources separately. Nevertheless, studying income from a single source, such as the earnings obtained from employment, may be interesting for many researchers.

The practical problem with net income from separate sources is that as a result of the above, only information on total taxes is available. Therefore, to calculate the net income from a separate source, the assumption that income from each source was taxed at the same rate, is required.

In the empirical part of this technical paper we will evaluate the netting down of just those *earnings* that were obtained from dependent employment (not including self-employment).

3.2 Netting Down Person Level Earnings

All LIS datasets provide disposable household income (LIS variable name: DHI) and monetary disposable household income (LIS variable name: DPI). These household-level variables are comparable across countries.

However, it may also be desirable to calculate net earnings at the person level, rather than at the household level. To do so, person-level taxes (thus both income taxes and social security contributions) are subtracted from person-level gross earnings. Doing so, however, is challenging in countries with joint taxation of members of the same household. So, if no person-level tax variables are available, netting down person-level earnings requires the assumption that the taxes paid at the household level were paid by each household member proportionally to the share of the total household income received by that member.

The decision whether to compare household-level or person-level earnings depends, of course, of the substantive research interest. Netting down procedures can be developed for both person-level and household-level income concepts. As LIS provides comparable data on several specific income concepts on the household-level, but not on the person-level, the focus of this technical paper is on developing and evaluating netting down procedures for person-level earnings. This is represented in the top row of Figure 1.

3.3 Programs for Netting Down

We developed two programs that perform netting down procedures, available for STATA, SPSS, R, and SAS. These procedures either use information on taxes on the person-level or, if these are not available, or household level tax information. The LIS website has a table providing information on whether

datasets are gross or net (URL was given above). Datasets classified as mixed should be treated with more caution, as the earnings reported in these datasets can be gross of income taxes but net of contributions, or vice versa. This is reported in detail in the LIS data documentation per country. All LIS datasets also contain a variable named 'GROSSNET', providing information on how earnings (and other income variables) were reported.

Users should carefully apply the correct netting down program for each dataset in their analysis. The second row from the top in Figure 1 indicates that netting down procedures should not be applied to datasets that were classified as net.

If person-level variables on taxes (LIS variable PMXITI) and (self-paid) social security contributions (LIS variable PMXITSS) are available, the person-level netting down procedure should be applied. Otherwise, the household-level netting down procedure should be applied. This is represented by the third row from the top in Figure 1. The person-level and household-level netting down procedures are described below. These descriptions also state the assumptions that are required for the procedure to result in information on person-level net earnings.

Person-level Netting Down Procedure: When person level tax information is available, the netting down procedure first calculates the total taxable income (earnings from dependent employment, self employment, unemployment compensation benefits, short-term sickness and work injury benefits, family leave benefits, and pensions). Next, it calculates the proportion of that total income that was obtained by dependent employment. Next, it is assumed that the total amount of taxes was distributed proportionally over all sources of income. As taxable income is made up of different components across countries,

this procedure is based merely on an approximation of taxable income. The person level net earnings are then calculated by subtracting the paid income taxes from the gross earnings, proportional to the amount of total income obtained from earnings.

Household-level Netting Down Procedure: When tax information is only available at the household level, the netting down procedure first calculates the percentage of the total household income that was paid as taxes. Next, it is assumed that this percentage is equal to all members of the household, and applies equally to all sources of income. The person level net earnings are then calculated by reducing the person level gross earnings by the percentage taxes.

4 Method and Data

4.1 Method

In a select number of LIS datasets both gross and net earnings variables were reported at the person level, as well as information on taxes and social security contributions on both the person-level and the household-level. Thereby, these datasets provide a unique opportunity for quantifying the amount of bias that arises from directly comparing net and gross datasets, as well as for evaluating netting down procedures.

To quantify the degree of bias that is introduced by directly comparing datasets with either net or gross earnings, we calculated different measures of the earnings distribution, such as for instance the average earnings. We did so twice for each dataset: once using the gross earnings variable, and once using the net earnings variable. The two resulting averages thus refer to the same country and year, and they were calculated based on exactly the

same respondents. The difference between gross and net does not always indicate bias, as they represent different earnings concepts. However, this difference does represent the amount of bias that would have been introduced to analyses directly comparing average earnings from gross and net datasets while assuming both are indeed directly comparable. This difference is expressed as a percentage of the value of the measure based on net earnings:

$$Difference(\%) = \frac{\overline{X}_g - \overline{X}_n}{\overline{X}_g} \times 100\% \quad (1)$$

in which $\overline{X}_g$ represents the average earnings calculated on the gross data as reported by respondents, and $\overline{X}_n$ represents the average earnings calculated based on the net data as reported by respondents.

We have not only calculated the average earnings, but have also four commonly used measures of inequality. In total, we evaluate bias using five measures at the person-level:

- Average earnings;
- Ratio between 25th and 75 percentile of earnings;
- Gini of earnings;
- Low earnings rate (Defined as percentage population with earnings below 2/3 of median earnings);
- Gender gap in earnings (Defined as: (male earnings - female earnings) / male earnings).

In addition to calculating the difference between gross and net gross measures of the earnings distribution, we evaluated to what extent the described netting down procedures results in an unbiased approximation of

net earnings. To evaluate a netting down procedure, we applied this procedure to a gross earnings variable, calculated the average earnings (or one of the other measures of the earnings distribution) based on the netted down earnings variable, and compared the results to those based on the reported net earnings. The reported net earnings thus serve as a benchmark against which the netted down net earnings are evaluated. We calculated the degree to which the netted down results are biased (compared to the reported net results) using the following equation:

$$Bias(\%) = \frac{\overline{X}_{nd} - \overline{X}_{n}}{\overline{X}_{n}} \times 100\% \tag{2}$$

in which $\overline{X}_{nd}$ represents the (for example) average earnings calculated on the netted down net data, and $\overline{X}_{n}$ represents the average earnings calculated based on the net data as reported by respondents. The resulting bias is expressed as a percentage of the reported net earnings. So, a bias of 0% means that the results based on the approximated net earnings ($\overline{X}_{nd}$, obtained using the netting down procedure) is identical to those based on the net earnings as reported by respondents ($\overline{X}_{n}$). In that case the netting down procedure results in an unbiased measure of net earnings. If the bias % is larger than 0, this means that the results based on the approximated net earnings are higher than those based on the reported net earnings, a percentage below 0 indicates that the approximated results are lower.

To evaluate whether the netting down procedure improves the quality of a comparison of earnings across net and gross datasets, the bias of the netting down procedure (Bias %, defined in 2) is to be compared to the difference between reported net and gross earnings (Difference %, defined in 1). If the (absolute) percentage of bias of the netting down procedure is smaller than the difference between the reported net and gross earnings,

this indicates that the netted down earnings are closer to the benchmark of the reported net earnings than the reported gross earnings are.

4.2 Data

The netting down procedures described in this technical paper can be applied to LIS datasets of the 'new' (post-2011) template that are classified as gross. The evaluation of these netting down procedures, however, required the availability of both gross and net earnings as reported by the respondent. This could only be the case in the 'old' template (pre-2011; these are still available to users).[5] The required earnings variables, as well as person- and household level variables on taxes and social contribution were available in 7 datasets: Austria 2004, Belgium 1992, Belgium 1997, Estonia 2004, Ireland 2004, United Kingdom 1999, and United Kingdom 2004.

We have restricted our analyses to those observations with valid information on both the gross and net earnings variables. Although this introduced some missing observations (either by persons not having reported their gross earnings, their net earnings, or both), the goal of this technical paper is not to obtain valid inferences regarding the measures of earnings, but to understand the bias that was introduced by directly comparing net and gross earnings data. By deleting observations in which any or both of the earnings measures were missing, we assured that our measurement of bias was not affected by the gross and net earnings variables were based on different observations. Person-level sampling weights were applied. The total number of person-level observations is presented in Table 1.

[5] *Luxembourg Income Study Database (LIS)*, www.lisdatacenter.org (multiple countries; October 2012-November 2013). Luxembourg: LIS

Table 1: Countries and Number of person level observations

Country	Year	Number Observations
Austria	2004	5,563
Belgium	1992	4,138
Belgium	1997	4,001
Estonia	2004	5,155
Ireland	2004	3,297
United Kingdom	1999	21,791
United Kingdom	2004	24,161

5 Results

5.1 Results on Average Earnings

First, we present in detail our results regarding netting down average earnings. In the next sub-section, we present the outcomes of netting down the measures of inequality. In Figure 2 the results of our analyses are presented graphically. In panel A, the average earnings are shown, standardized by setting the average gross earnings to 100 to account for widely different averages between countries. The average gross earnings were directly observed in the data and are represented by the white bars. The observed net earnings are shown as black bars, and unsurprisingly the average net earnings are much lower than the average gross earnings. Of course, this is the result of paying taxes, but if directly compared between datasets this would result in the amount of bias as calculated.

Next, the dark-gray bars represent an approximation of the average net earnings, that was based on the netting down procedure using person-level taxes. This average of the approximated net earnings is very close to the average of the net earnings that were reported by respondents, suggesting that the netting down procedure performed well. The same holds for the netting

down procedure based on the household-level tax information household, represented by the light-gray bars.

Next, we quantify the difference between the measures of net and gross earnings, as an indicator of the amount of bias that would be introduced by directly comparing measures of the net and gross earnings distribution. In addition, we calculate the bias associated with the two netting down procedures described above. In Table 2, the results are presented for the average person-level earnings. The first two columns present results that were directly observed from the data: the average gross earnings and the average net earnings. The third column presents the difference between the first two columns, expressed as a percentage of the net average earnings.

For instance, in Austria 2004 the average gross earnings were 24,555.88 and the average net earnings 17,268.49. The absolute difference between those is 7287.39, which is reported in the third column as 42.20 percent of the net average earnings (following equation 1). Based on the third column in Table 2 we conclude that the amount of bias introduced by directly comparing net and gross average earnings ranges from about 27 percent in Estonia 2004 to 85 percent in Belgium 1997.[6] These percentages are based on the net earnings, suggesting that in Belgium 1997 the gross earnings were close to twice as high as the net earnings.

Next, under the header 'Netted Down: Person', an approximation is presented of the average net earnings based on the netting down procedure using the person-level taxes. We observe that using the person level tax data, much of the difference between average gross and net earnings is accounted for by the netting down pro-

[6]It should be noted that the average earnings (both net and gross) in Belgium are much higher in 1997 than in 1992. This, however, is simply due to the fact that in 1997 the currency was expressed in Belgium Francs and in 1992 the currency was expressed in 1000s of Belgium Francs.

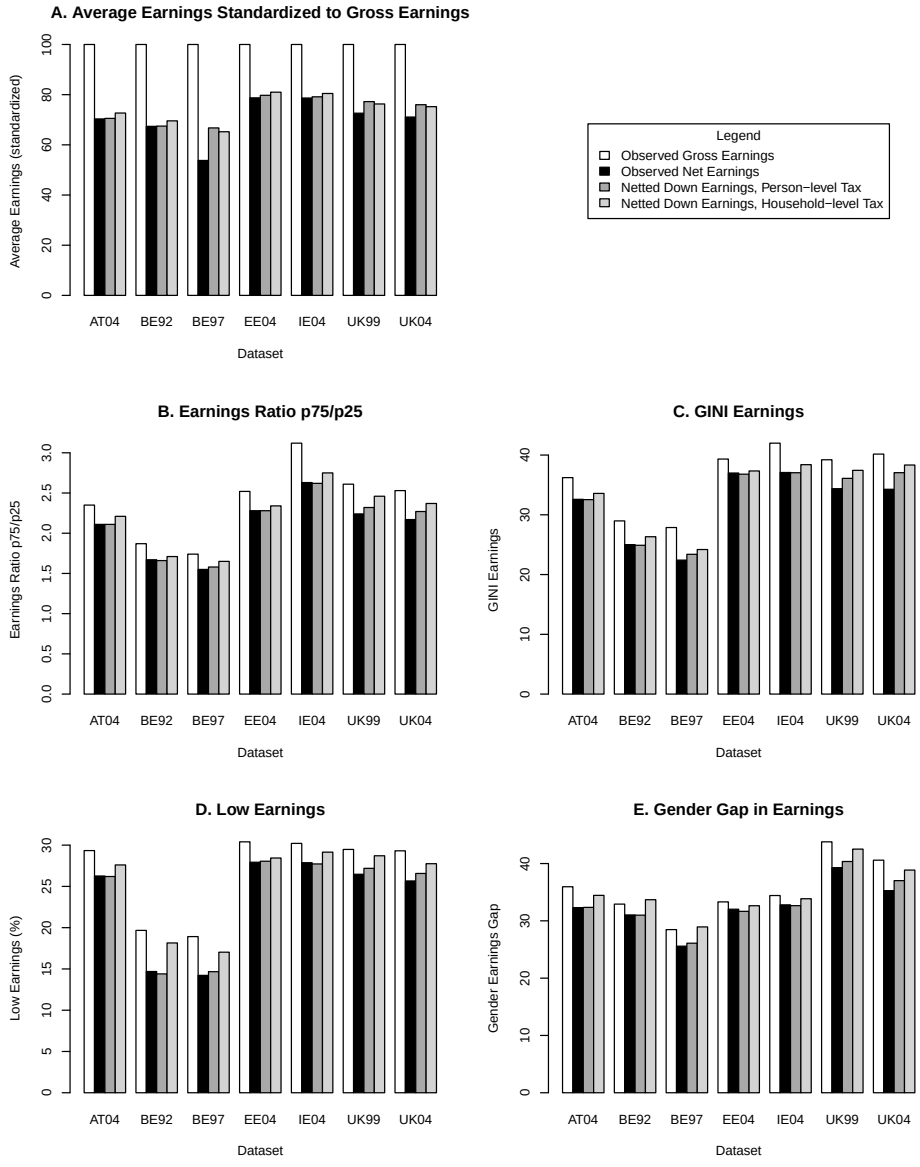

Figure 2: Visual Representation of Bias Comparing Net and Gross Earnings Data and the Performance of Two Netting Down Procedures

Table 2: Comparing Gross and Net Average Earnings: Quantifying Bias and Evaluating Two Netting Down Procedures

		Observed from Data			Netted Down: Person		Netted Down: Household	
Country	Year	Gross	Net	Difference (%)	abs.	Bias (%)	abs.	Bias (%)
Austria	2004	24555.88	17268.49	42.20	17323.61	0.32	17846.89	3.35
Belgium	1992	7863.32	5297.93	48.42	5305.25	0.14	5469.41	3.24
Belgium	1997	1105850.00	594700.10	85.95	738104.20	24.11	721286.80	21.29
Estonia	2004	76243.25	60022.50	27.02	60796.69	1.29	61745.79	2.87
Ireland	2004	26523.79	20864.45	27.12	20992.20	0.61	21343.59	2.30
United Kingdom	1999	16893.31	12266.87	37.71	13047.11	6.36	12887.84	5.06
United Kingdom	2004	21335.35	15164.91	40.69	16212.84	6.91	16047.22	5.82

cedure results in approximations of net earnings that have very little bias compared to the benchmark of reported net earnings. For instance, applying the netting down procedures on the Austrian gross earnings data, results in an average of the netted down wage of 17,323.61 Euros. The reported net earnings averaged at 17,268.49. This means that the netting down procedure performed very well using the person level tax information in the data, and resulted in an approximation of average net earnings that was very close to the reported net earnings. Following equation 2, the bias in this case was only 0.32%. This is, of course, much lower than the 42.20% bias that would have been introduced by directly comparing average earnings based on gross and net earnings data. When only household level tax data was available (presented in the final two columns), the netting down procedure performed slightly less well with a calculated bias of 3.35%. Based on the performance of the two netting down procedures in other countries, it was clear that the netting down procedures substantially reduce the bias for calculating average earnings, but no conclusions can be drawn on whether the netting down procedure based on person level taxes, or the netting down procedure based on household level taxes, performed better.

5.2 Results on Measures of Inequality

Looking back at Figure 2, panels B through E represent the results of the ratio of the earnings of the 75th and 25th percentile of the earnings distribution, the GINI, the percentage of individuals with low earnings, and the gender gap in earnings. The overall patterns in each of these four measures of inequality are similar. The results based on the reported gross earnings are different from those based on the reported net earnings, with inequalities being smaller in the net data. In all cases, this suggests that bias would

be introduced by directly comparing net and gross earnings. In most cases, the results for the netted down earnings are closer to the reported net than the reported gross. This holds both for the person-level and household-level netting down procedures, suggesting that both procedures perform well in reducing bias.

These findings based on Figure 2 are generally supported by the quantified results presented in Tables 3 (earnings ratio of the 75th and 25th percentile), 4 (GINI), 5 (low earnings rate), and 6 (gender gap in earnings). Closer examination of these quantified results reveals several further findings, including some exceptions to the general pattern. We discuss five.

First, the bias that is introduced when directly comparing gross and net earnings (indicated in the columns labeled *Difference (%)*) is bigger with average earnings than it is with the four measures of inequality.

Secondly, the performance of the netting down procedures is typically poorer with the measures of inequality compared to with the average earnings. This thus means that the remaining bias is smallest where the differences between net and gross earnings were largest to begin with.

Third, for all measures of inequality and in all countries that were evaluated, the person-level netting down procedure outperformed the household-level netting-down procedures. The bias associated with the person-level netting down procedure typically was around reduced the bias by 0-8%. When household-level tax variables were used, however, performance degraded: the bias associated with this netting down procedure typically ranged from 1% to 24%. So, for comparing measures of inequality, using the person-level netting down procedure is preferable when person-level tax information is available.

Fourth, in some cases the netting down procedures corrected more than

100% of the existing difference between net and gross earnings. This is indicated by a negative estimate of bias. An example is the 75p/25p earnings ratio in Belgium 1992: the person-level netting down procedure is associated with a bias of -1.02%.

Fifth, and finally, in the specific case of the gender gap in earnings in Belgium (1992 and 1997), applying the household-level netting down procedure actually introduced bias. This is indicated by the fact that the bias associated with this netting down procedure was larger than the actual differences between the measurements of the gender gap in earnings based on the (reported) net and gross earnings.

5.3 Two Notes on the Benchmark

As indicated, the benchmark we used to evaluate the netting down procedures was the difference between the reported gross and reported net earnings from dependent employment. Closer examination of the original micro-level surveys that were used to create the LIS data, however, showed that this benchmark was not correct for all countries. The reason for this is that the reported gross and net earnings were calculated in different ways (other than of course the exclusion of income taxes and social security contributions in the net earnings). Two such exceptions are described in this section.

First, the LIS dataset on Belgium in 1997 was based on Socio-Economic Panel. In this original dataset, the information on holiday- and end-of-year bonuses was only available net of taxes, but unavailable gross of taxes. Hence, in calculating the yearly gross earnings in preparation of the LIS dataset, the monthly earnings were multiplied by 13,85 (approximating the average bonuses). For the net yearly earnings the information on bonuses

Table 3: Comparing Gross and Net 75p/25p Earnings Ratios: Quantifying Bias and Evaluating Two Netting Down Procedures

		Observed from Data			Person		Household	
Country	Year	Gross	Net	Difference (%)	abs.	Bias (%)	abs.	Bias (%)
Austria	2004	2.35	2.11	11.22	2.11	0.05	2.21	4.35
Belgium	1992	1.87	1.67	12.08	1.66	-1.02	1.71	2.27
Belgium	1997	1.74	1.55	12.48	1.58	2.39	1.65	6.60
Estonia	2004	2.52	2.28	10.52	2.28	0.00	2.34	2.72
Ireland	2004	3.12	2.63	18.62	2.62	-0.61	2.75	4.71
United Kingdom	1999	2.61	2.24	16.39	2.32	3.71	2.46	10.09
United Kingdom	2004	2.53	2.17	16.79	2.27	4.66	2.37	9.50

Table 4: Comparing Gross and Net Earnings GINI: Quantifying Bias and Evaluating Two Netting Down Procedures

		Observed from Data			Person		Household	
Country	Year	Gross	Net	Difference (%)	abs.	Bias (%)	abs.	Bias (%)
Austria	2004	36.22	32.59	11.13	32.54	-0.16	33.58	3.05
Belgium	1992	28.98	25.01	15.88	24.90	-0.44	26.33	5.28
Belgium	1997	27.87	22.42	24.32	23.39	4.34	24.19	7.92
Estonia	2004	39.33	36.99	6.35	36.80	-0.49	37.34	0.95
Ireland	2004	41.99	37.08	13.26	37.04	-0.09	38.39	3.54
United Kingdom	1999	39.21	34.37	14.09	36.10	5.05	37.44	8.93
United Kingdom	2004	40.16	34.27	17.19	37.05	8.14	38.33	11.85

Table 5: Comparing Gross and Net Low Earnings Rate: Quantifying Bias and Evaluating Two Netting Down Procedures

		Observed from Data			Person		Household	
Country	Year	Gross	Net	Difference (%)	abs.	Bias (%)	abs.	Bias (%)
Austria	2004	29.34	26.26	11.73	26.20	-0.23	27.60	5.10
Belgium	1992	19.67	14.69	33.90	14.40	-1.97	18.15	23.55
Belgium	1997	18.92	14.22	33.05	14.67	3.16	17.03	19.76
Estonia	2004	30.40	27.93	8.84	28.05	0.43	28.44	1.83
Ireland	2004	30.21	27.87	8.40	27.72	-0.54	29.15	4.59
United Kingdom	1999	29.48	26.47	11.37	27.19	2.72	28.71	8.46
United Kingdom	2004	29.31	25.66	14.22	26.57	3.55	27.75	8.14

Table 6: Comparing Gross and Net Gender Gap in Earnings: Quantifying Bias and Evaluating Two Netting Down Procedures

		Observed from Data			Person		Household	
Country	Year	Gross	Net	Difference (%)	abs.	Bias (%)	abs.	Bias (%)
Austria	2004	34.95	32.31	8.17	32.35	0.12	34.45	6.62
Belgium	1992	32.92	31.03	6.09	30.99	-0.13	33.69	8.57
Belgium	1997	28.47	25.58	11.30	26.10	2.03	28.94	13.14
Estonia	2004	33.31	32.03	4.00	31.66	-1.16	32.64	1.90
Ireland	2004	34.42	32.79	4.97	32.65	-0.43	33.86	3.26
United Kingdom	1999	43.79	39.28	11.48	40.36	2.75	42.52	8.25
United Kingdom	2004	40.59	35.27	15.08	37.02	4.96	38.86	10.18

was available in the original data. Hence, whereas in the LIS dataset the net yearly earnings account for person-level variation in bonuses independent of other earnings, in the gross yearly earnings the bonuses such person-level variation was not accounted for.

Second, the LIS datasets on the United Kingdom (both in 1999 and 2004) were based on the Family Resources Survey. During the recoding of these datasets to the LIS templates, the gross earnings were specified to include income from odd jobs, while net earnings could not be specified to include this source of income. Hence, the difference between gross and net yearly earnings is an overestimation of the 'real' difference. Therefore, the netted down results presented in the Tables of this technical paper may actually be a better representation of persons' true net earnings than the net earnings reported in the data. It should be noted, that within the scope of this paper it was not possible to empirically test this statement.

5.4 Alternative Netting Down Procedures

The two netting down procedures evaluated in this technical paper were designed to use as few variables as possible, thereby allowing to be used on a as large as possible number of LIS datasets. Despite their simplicity, the presented netting down procedures outperformed several alternatives that were based on more variables, but also required more assumptions. Several of these alternative netting down procedures were evaluated, but not presented. These procedures performed less well and were associated with more bias. These procedures are described below, so that users do not need to evaluate themselves.

The following alternatives were evaluated to perform less well than those presented, or not to apply to the new LIS template:

Person-level Gross/Net Wages In some LIS datasets, the person level files provide both gross and net hourly wages (earned in a set period of time). Although this period of time (hourly, weekly, monthly, etc.) varies between datasets, it is always identical in the gross and net variables of a single datasets. Based on these variables, it was expected that a good approximation of person level taxes for earnings from paid employment could be established. This procedure could only be evaluated in Austria and Ireland, and generally performed worse compared to the netting down procedure based on both the household- and person level taxes.

Household-level gross/net wages In the pre-revised LIS datasets, household level variables representing both the gross and the net 'wages and salaries' (V1 / V1NET) were available. These were used to calculate the percentage of gross wages that were paid as taxes by the household, and this percentage was used to net down the person-level gross earnings. This netting down procedure actually performed better than the one using household level tax variables presented above (but worse than the one based on person level tax data). These variables (or equivalents) are not available in the revised LIS-template. Therefore, this procedure cannot be used with most recent LIS datasets, and therefore these results are not presented here.

6 Conclusion

In this technical paper guidelines were presented for comparing earnings using both net and gross LIS datasets. Two netting down procedures were developed that approximate net earnings based on information regarding

gross earnings, taxes and social security contributions. One netting down procedure uses tax variables measured on the person-level, and one netting down procedure uses household-level tax variables.

Descriptive analyses quantified the difference between measures of gross and net earnings, as an indication of the bias that would be introduced if net and gross datasets are directly compared. The difference between net and gross earnings was (unsurprisingly) substantial, but varied with the measure of the earnings distribution used. The difference was smallest with about 5-15% in the gender gap in earnings, and largest with about 30-85% in the average earnings. This suggests that, depending on the measure of the earnings distribution that is used, country-comparative and / or trend analyses should treat comparisons between net and gross LIS datasets with caution.

The netting down procedures that were developed in this technical paper typically were associated with lower amounts of bias than the original difference between net and gross earnings. Generally, this suggests that applying a netting down procedure is preferable over not netting down. The exception to this, we found in the Belgium 1992 and 1997 datasets, was with the gender earnings ratio when netted down using only household-level tax variables. In these specific cases the netting down procedure actually resulted in more bias than a direct comparison between net and gross earnings would have resulted in.

The results of our analyses also strongly suggest that when seeking to net down earnings to estimate measures of inequality, using person level taxes is desirable over using the netting down procedure based on household-level tax variables only. Nevertheless, the person-level tax variables are not available in all LIS datasets.

In many cases, data availability will dictate which of the two netting down procedures users can apply. It should be noted, however, that it is to be expected that the household-level netting down procedure is expected to perform better in a country with joint-taxation, rather than in countries in which spouses pay taxes separately. Furthermore, in both netting down procedures it is assumed that all sources of income are taxed at the same rate. From this, the expectation follows that the procedures will perform better in countries with a single, rather than a dual tax system in which separate tax rates exist for capital income and other income. Finally, we expect the procedures to perform better in countries with a tax system that is close to proportional (=flat rate).

A user seeking to compare a large number of both net and gross datasets, may want to statistically control for the different netting down procedures used. In regression-based analyses, for instance, this could be done by adding dummy-variables indicating the observations derived from datasets netted down with the person-level procedure, and another dummy for the observations from datasets that were netted down using the household-level procedure (the observations from datasets that were reported as net then function as the reference category). This would capture the average bias associated with the different netting down procedures, thereby further improving the analyses.

The program code of the two netting down procedures developed and evaluated in this technical paper is available as appendices.[7] The code presented here serves as an example, and users will notice how simple the code is. In addition to the steps describe above, several lines of code are

[7]Please note that the results presented in this technical paper are based on the pre-revised LIS template, whereas the code provided here is prepared for using in the new LIS template. As a result of slight coding differences, results may vary, but only slightly. Conclusions in this paper still hold.

intended to prepare variables for use in the procedure, and to deal with missing values. Of course, more detailed netting down procedures can be developed. Initial attempts to do so, as discussed, did not improve the performance of our netting down procedures, could not be applied to all LIS datasets, or even resulted in a poorer performance. In addition, if we had developed country-specific netting down procedures this would have limited the ability to compare the consequences of the assumptions made in these procedures across countries.

To conclude, country-comparative and trend analyses of earnings based on both net and gross LIS datasets should be executed with caution. The netting down procedures presented here typically improve comparability. However, depending on the outcome measure of interest, and especially when no person-level tax variables were available, netting down procedures result in approximations of net earnings that are substantially biased.

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A STATA Program Person-Level netting down

```
* Check whether a program with name 'persontax' exists
* Removes the program from memory if needed:
capture program drop persontax

* Start definition of the person-level netting down procedure:
program define persontax

* Removes variables from memory if needed (e.g. from previous runs)
capture drop propwage
capture drop earnings

* Replace the missing values into zeros for variables that are completely empty:
quietly sum pmils
replace pmils=0 if  r(N) == 0
quietly sum pmitsisun
replace pmitsisun=0 if  r(N) == 0
quietly sum pmitsissi
replace pmitsissi=0 if  r(N) == 0
quietly sum pmitsisma
replace pmitsisma=0 if  r(N) == 0
quietly sum ppension
replace ppension=0 if  r(N) == 0
quietly sum pmxiti
replace pmxiti=0 if  r(N) == 0
quietly sum pmxitss
replace pmxitss=0 if  r(N) == 0

* Calculate the proportion of earnings into total taxable earnings:
gen propwage = pmile / (pmile+pmils+pmitsisun+pmitsissi+pmitsisma+ppension)

* Calculate net earnings by subtracting from the gross earnings,
* the income taxes and contributions in the same proportion
* as earnings into total taxable earnings:
gen earnings = pmile - ((pmxiti + pmxitss) * propwage)

* End definition of the person-level netting down procedure:
end
```

B STATA Program Household-Level netting down

```
* This program assumes that household and person-level datasets are merged
* Check whether a program with name 'household' exists
* Removes the program from memory if needed:
capture program drop householdtax

* Start definition of the household-level netting down procedure:
program define householdtax

* Removes variables from memory if needed (e.g. from previous runs)
capture drop netpercentage
capture drop earnings

* Calculate the proportion of net household earnings
* as percentage of gross household earnings:
gen netpercentage = (hmi - hmxit) / hmi if hi!=0

* Calculate net person-level earnings by multiplying
* gross earnings with the percentage net earnings:
gen earnings = pmile * netpercentage

* End definition of the household-level netting down procedure:
end
```

C R Program Person-Level netting down

```
# Start definition of the person-level netting down procedure:
persontax <- function(x)
{

# Replace the missing values into zeros for variables that are completely empty:
if(sum(is.na(x$pmils)) ==length(x$pmils))  x$pmils <- 0
if(sum(is.na(x$pmitsisun)) ==length(x$pmitsisun))  x$pmitsisun <- 0
if(sum(is.na(x$pmitsissi)) ==length(x$pmitsissi))  x$pmitsissi <- 0
if(sum(is.na(x$pmitsisma)) ==length(x$pmitsisma))  x$pmitsisma <- 0
if(sum(is.na(x$ppension)) ==length(x$ppension))  x$ppension <- 0
if(sum(is.na(x$pmxiti)) ==length(x$pmxiti))  x$pmxiti <- 0
if(sum(is.na(x$pmxitss)) ==length(x$pmxitss))  x$pmxitss <- 0

# Calculate the proportion of earnings into total taxable earnings:
x <- within(x, propwage <-
pmile / (pmile+pmils+pmitsisun+pmitsissi+pmitsisma+ppension))

# Calculate net earnings by subtracting from the gross earnings
# the taxes and contributions in the same proportion
# as earnings into total taxable earnings:
x <- within(x, earnings <- pmile - ((pmxiti + pmxitss) * propwage))

# End definition of the person-level netting down procedure:
return(x)
}
```

D R Program Household-Level netting down

```
# This program assumes that household and person-level datasets are merged
# Start definition of the household-level netting down procedure:
householdtax <- function(x)
{

# Calculate the proportion of net household earnings
# as percentage of gross household earnings:
x <- within(x, netpercentage <- (hmi - hmxit) / hmi)
x <- within(x, netpercentage[hi==0] <- NA)

# Calculate net person-level earnings by multiplying
# gross earnings with the percentage net earnings:
x <- within(x, earnings <- pmile * netpercentage)

# End definition of the household-level netting down procedure:
return(x)
}
```

E SPSS Program Person-Level netting down

```
* Start definition of the person-level netting down procedure:.
define persontax() .

* Replace the missing values into zeros for variables that are completely empty: .

COMPUTE ismissing = nmiss(pmils) .
AGGREGATE
 /OUTFILE=* MODE=ADDVARIABLES overwrite=YES
 /allmiss=MEAN(ismissing).
IF (allmiss=1) pmils = 0 .

COMPUTE ismissing = nmiss(pmitsisun) .
AGGREGATE
 /OUTFILE=* MODE=ADDVARIABLES overwrite=YES
 /allmiss=MEAN(ismissing).
IF (allmiss=1) pmitsisun = 0 .

COMPUTE ismissing = nmiss(pmitsissi) .
AGGREGATE
 /OUTFILE=* MODE=ADDVARIABLES overwrite=YES
 /allmiss=MEAN(ismissing).
IF (allmiss=1) pmitsissi = 0 .

COMPUTE ismissing = nmiss(pmitsisma) .
AGGREGATE
 /OUTFILE=* MODE=ADDVARIABLES overwrite=YES
 /allmiss=MEAN(ismissing).
IF (allmiss=1) pmitsisma = 0 .

COMPUTE ismissing = nmiss(ppension) .
AGGREGATE
 /OUTFILE=* MODE=ADDVARIABLES overwrite=YES
 /allmiss=MEAN(ismissing).
IF (allmiss=1) ppension = 0 .

COMPUTE ismissing = nmiss(pmxiti) .
AGGREGATE
```

```
 /OUTFILE=* MODE=ADDVARIABLES overwrite=YES
 /allmiss=MEAN(ismissing).
IF (allmiss=1) pmxiti = 0 .

COMPUTE ismissing = nmiss(pmxitss) .
AGGREGATE
 /OUTFILE=* MODE=ADDVARIABLES overwrite=YES
 /allmiss=MEAN(ismissing).
IF (allmiss=1) pmxitss = 0 .

* Calculate the proportion of earnings into total taxable earnings: .
COMPUTE totalinc = pmile + pmils + pmitsisun + pmitsissi + pmitsisma + ppension .
IF (totalinc ~= 0) propwage = pmile / totalinc .

* Calculate net earnings by subtracting from the gross earnings,
* the income taxes and contributions in the same proportion
* as earnings into total taxable earnings: .

COMPUTE earnings = pmile - ((pmxiti + pmxitss) * propwage) .
IF (missing(propwage)) earnings = $sysmis .

* End definition of the person-level netting down procedure: .

!enddefine .
```

F SPSS Program Household-Level netting down

```
* Start definition of the household-level netting down procedure:.
* This program assumes that household and person-level datasets are merged .

define householdtax () .

* Calculate the proportion of net household earnings
* as percentage of gross household earnings: .
if hi~=0 netpercentage = (hmi - hmxit) / hmi .

* Calculate net person-level earnings by multiplying
* gross earnings with the percentage net earnings: .
compute earnings = pmile * netpercentage .

* End definition of the household-level netting down procedure: .
!enddefine .
```

G SAS Program Person-Level netting down

```
%MACRO indNetDown ;
/*-------------------------------------------------------------------*/
/*              INDIVIDUAL-LEVEL NETTING DOWN PROCEDURE              */
/*-------------------------------------------------------------------*/
/* NOTE -- This program assumes that you replace the macro variable */
/* &CCYYp by the valid LIS individual (SAS) dataset name such       */
/* as &ie04p.                                                        */
/*-------------------------------------------------------------------*/

DATA myPFile (DROP=i j k epmils epmitsisun epmitsissi epmitsisma eppension epmxiti epmxitss totalinc) ;
* Keep the value of the former record ;
RETAIN epmils epmitsisun epmitsissi epmitsisma eppension epmxiti epmxitss ;
* Loop over the entire dataset ;
IF _N_ = 1 THEN DO i = 1 TO all;
* Open the dataset ;
SET &CCYYp (KEEP=pmils  pmitsisun  pmitsissi  pmitsisma  ppension  pmxiti  pmxitss pmile) NOBS=all ;
* Create arrays with a new lsit of control variable (VarExist1-varExist7) to count the number of ;
* times a variable is missing ;
ARRAY varList  {7} pmils   pmitsisun pmitsissi  pmitsisma   ppension  pmxiti pmxitss ;
ARRAY varExist {7} epmils epmitsisun epmitsissi epmitsisma eppension epmxiti epmxitss (7*0) ;
* Count the number of times each selected variable (Array: varList) get a missing value;
DO j = 1 TO DIM(varList) ;
IF varList{j} = . THEN varExist{j} + 1 ;
END ;
END ;

* Re-open the dataset including the counters ;
SET &CCYYp  NOBS = total;
* Replace missing by 0 when the entire variable is not filled;
DO k = 1 TO DIM(varList) ;
IF varExist(k) = total  THEN varList(k) = 0 ;
END ;
* Calculate the proportion of earnings into total taxable earnings ;
totalinc = pmile + pmils + pmitsisun + pmitsissi + pmitsisma + ppension;
propwage = . ;
IF (totalinc ne 0) THEN propwage = pmile / totalinc  ;
/* Calculate net earnings by subtracting from the gross earnings, */
```

```
/* the income taxes and contributions in the same proportion as   */
/* earnings into total taxable earnings:                          */
earnings = . ;
IF (propwage ne .) THEN earnings = pmile - ((pmxiti + pmxitss) * propwage) ;
RUN ;
%MEND indNetDown ;
```

H SAS Program Household-Level netting down

```
%MACRO hldNetDown ;
/*-------------------------------------------------------------------------------*/
/*              HOUSEHOLD-LEVEL NETTING DOWN PROCEDURE                           */
/*-------------------------------------------------------------------------------*/
/*  NOTE -- This program assumes that your targeted LIS household dataset and    */
/*  the person-level dataset created in the MACRO indNetDown (myPFile) are       */
/*  merged into a dataset called myMerge.                                        */
/*-------------------------------------------------------------------------------*/

DATA myMerge ;
SET myMerge ;
* Calculate the proportion of net household earnings as ;
* percentage of gross household earnings  ;
netpercentage = . ;
IF (hi ne 0) THEN netpercentage = (hmi - hmxit) / hmi ;
* Calculate net person-level earnings by multiplying gross earnings ;
* with the percentage net earnings ;
earnings = pmile * netpercentage ;
RUN ;

%MEND hldNetDown ;
```