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Income reporting behaviour in sample surveys

by Andrea Neri and Roberta Zizza

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# INCOME REPORTING BEHAVIOUR IN SAMPLE SURVEYS

by Andrea Neri \* and Roberta Zizza \*

## Abstract

This paper analyses respondents' behaviour when reporting their income sources in sample surveys and presents a method to deal with response error. Survey data relating to the number of earning recipients and to amounts received are validated using external information from administrative and statistical sources. Our findings suggest that the response bias on household income is about 12 per cent of reported figures. Misreporting is particularly severe for income from self-employment, financial assets and rents, as well as from secondary jobs. As to the distribution of response error, about 15 per cent of respondents show a high probability of misreporting. Misreporting is more diffuse among males, the older, the self-employed and respondents at the higher end of the earnings distribution.

**JEL Classification:** J65, D21, L11.

**Keywords:** income distribution, response error, item response theory, SHIW, data accuracy.

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# 1 Introduction

Household<sup>1</sup> surveys are a classic source of data on income. For one thing, they improve upon alternative sources, such as social security or tax records, in many respects: they do not suffer from the censoring of low-income earners (e.g. due to tax thresholds); the concept of income is not restricted to the base relevant for tax or social contribution payments but can be the most inclusive one (e.g. including in-kind receipts); administrative sources are usually found lacking in terms of an individual's characteristics and the unit is the individual, with no possibility of matching with information on other household members. On the other hand, household surveys are affected by non-sampling errors. A bias due to the selection into participation, which is usually not compulsory, is often at work. Moreover, response error may arise because of underreporting, recording errors, difficulties in understanding questions, and so on.

The paper studies the accuracy of data in economic surveys, in particular income data. This is an important aspect in empirical research. It helps data users to understand the results and limits of their analysis: for instance, response error could bias regression parameters for variables whose absolute values are biased; in cross-country comparisons, it is important to know whether heterogeneities are due to differences in data quality or to economic behaviours. Moreover, several policy recommendations are based on the analysis of survey data and reliability issues are thus of great importance, not only for the scientific community, but also for policy makers and the general public. Finally, having a good understanding of the distribution of response errors - whether these errors are concentrated in a few respondents or not, what are the characteristics of misreporters - can in fact help data producers to improve the accuracy of their data.

Response error is defined as the difference between the objective truth relating to a respondent's income and what is reported about that income. The consequences of response

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errors are twofold. The first is bias, which affects the size and the sign of the discrepancy between the actual and the reported amount earned. The second is variability or reliability, which refers to the distribution of errors around their average values. Here we focus on the issue of the potential bias due to response error. As we lack administrative records to match exactly at the individual level, we develop a set of statistical exercises (some original, some borrowed from previous work) to derive a set of proxies of response error for each respondent.

The data set we rely upon is the Bank of Italy's Survey on Household Income and Wealth (hereinafter the SHIW), which is conducted biennially and is representative of the Italian population (Banca d'Italia, 2006).

To motivate the paper, we assess the magnitude of response error in the 2004 edition of the SHIW using external information published by the Italian National Statistical Institute (Istat) as a yardstick. A comparison of income estimates from the SHIW with those from the national accounts (NA) shows that the distance between the two sources varies substantially with the income type. In particular, data on payroll income and on income from pensions replicate quite well the corresponding macro figures, while data on income from self-employment and capital tend to be less accurate (table 1).<sup>2</sup> The same has been found in a study by Biancotti *et al.* (2008), with regard to the issue of reliability. As to the occupational status, table 2 shows that the number of workers (broken down into dependent and self-employed) in the SHIW is of the same order of magnitude as that in the Labour Force Survey and in the NA<sup>3</sup>; on the contrary, the number of dependent jobs held equaled around 20 million in the NA, against 16.6 million in the SHIW (underestimated by almost 20 per cent; table 3). People earning from self-employment totaled 6.3 million in the SHIW and around 11 million in the NA (underestimated by more than 40 per cent). Since the micro and macro estimates for the main job are in line, this suggests that multiple positions are underestimated.

The paper is organized as follows: Section 2 reviews the literature; Section 3 describes

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<sup>2</sup>See the appendix for details on the methodology and on the results of the comparison exercise.

<sup>3</sup>The occupational status in the SHIW refers to the prevailing condition, that in the Labour Force Survey to the condition in a reference week.



the adjustment procedure and Section 4 shows its results, with a focus on the characteristics of the misreporters; Section 5 concludes.

## 2 Income response error: a review of the literature

Income reporting in surveys is generally a two-stage process involving the reporting of income sources in the first and of the corresponding amounts in the second (see Moore *et al.*, 2000). Errors can occur at either stage. An entire source of income can be omitted (reported) even if it has (not) actually been received. Or, the source of income may be reported correctly but the amount received for that source can be misreported.

A theoretical framework for the cognitive factors in reporting is proposed by Tourangeau *et al.* (1984), who distinguish three stages in the cognitive process required to answer a survey question: understanding, retrieval and response production.

In either of these stages there are areas of potential error. One reason for this is the understanding of terms. Tourangeau *et al.* (2000) identify seven major types of comprehension problems: grammatical ambiguity, excessive complexity, faulty presuppositions, vague concepts, vague quantifiers, unfamiliar terms and false inferences. For instance, for questions relating to non-cash benefits it is not always possible to include in the questionnaire a fully exhaustive list of examples to help the respondent. Therefore, it may not be clear to him or her which items to include.

A second reason has to do with retrieval problems, that is the failure to bring to mind information stored in long term memory (Groves *et al.*, 2004). Even if the respondents have fully understood the question, they may fail to retrieve the correct information. Lack of knowledge is the primary cause. For instance, in the SHIW the respondent is often asked to report the income sources earned by all the household members. Even if the respondent is selected as the most knowledgeable person in the household, he or she may not know detailed income proceedings of the other components (i.e. in the case of a working son still living with his parents). Recall problems often arise as a result of the presence of multiple jobs and/or of the low level of some incomes, e.g. in case of temporary jobs or small forms of financial assistance. As a matter of fact, classical interference and information-processing

theories suggest that as the number of similar or related events occurring to an individual increases, the probability of recalling any one of those events declines (Groves *et al.*, 2004). Moreover, when the required information is not directly retrievable from their memory, respondents adopt a reconstruction strategy which is unlikely to be completely successful. For instance, it can lead to a sort of rounding (Pudney, 2008).

In the final stage, after recalling the requested information, the respondent adopts a response strategy. Deliberate underreporting is probably the major cause of response error at this stage. Nonetheless, besides deliberate prevarication, there are further possible sources of error. Questions on household income may be considered impolite or very personal, making the respondent more reticent. Another source of error may come from the interaction between the interviewer and the respondent. For instance, if the respondent belongs to a very rich household he or she may decide to underreport their income because of a desire for “social conformability” with the interviewer, or because of a fear of being robbed. This could be considered as a special case of the so-called “social desirability bias” (Bagozzi, 1994), namely, the tendency for individuals to present themselves in a way that makes them look positive in respect of cultural norms or standards. On the flip side, response error and overreporting in particular, may arise from the respondent wanting to impress the interviewer. Other studies show that the “social presence” of the interviewer stimulates the respondents to consider social norms at the judgment phase of their response, leading to response errors (Turner *et al.*, 1998). Interviewers also play a motivational role, setting expectations for respondent performance (Groves *et al.*, 2004; Fowler and Mangione, 1990). The higher the interviewer’s concern about accuracy and their request for “precise answers” rather than “general ideas”, the higher the quality of the data provided by the respondents. Indeed, the practice of matching interviewers and respondents on demographic traits is also widespread in surveys, especially in the case of sensitive questions.

Response error is also affected by the data collection method. For instance, according to the existing literature, computer-assisted personal interviewing (CAPI) should reduce errors (Couper *et al.*, 1998). On the flip side, the respondent might not feel at ease if a computer is used during the interview.

### 3 The adjustment procedure for response bias

There is an extensive literature on models dealing with response or measurement error. We can separate the different approaches to response errors into two broad categories, according to whether or not identification is achieved with external information. In the absence of external information, identification can be achieved in some particular cases (see for instance Schennach, Hu and Lewbel, 2007; Bollinger, 1996; Imbens and Manski, 2004).

When external information is available, several possibilities arise. For instance, identification can be achieved with repeated observations of a variable within the same survey (Kan and Pudney, 2008) or using panel data (Griliches and Hausman, 1986). The most common approach consists of matching survey and administrative data. Matching is done by either asking respondents for their relevant identification number directly, or using statistical matching based on personal data such as name, location and date of birth (see, among others Bollinger and David, 2005; Pedace and Bates, 2001).

Our method lies in between those two approaches. As we lack respondents' personal identifiers we cannot perform any exact linkage with administrative data. Nonetheless, we have collected several external data on earners and on income earned that can be used for validating income survey data. Namely, our identification strategy rests on a sequence of statistical exercises devised according to the kind of external information available. In each step of the adjustment, we use the adjusted data from the previous steps. We also perform a robustness check to assess whether the ordering of the adjustment steps affects the results (see infra section 4).

#### 3.1 Adjustment for unit nonresponse

In the first step of the adjustment we separate the effect of response error from the effect of non-participation (unit nonresponse). Here we propose a new set of weights which exploits recently available external information drawn from the EU-SILC (*European Union Statistics on Income and Living Conditions*) survey. For Italy and starting from the 2004 wave, EU-SILC survey data are linked with tax and administrative records containing information on self-employment income, on wages and salaries and on public pensions. Survey data are

then adjusted both on recipients and on amounts. When survey respondents fail to report a source of income, it is imputed using administrative records. Moreover, income is set to the maximum value between the net income resulting from the administrative record and the net income reported in the survey (Consolini *et al.*, 2006; Istat, 2009).

We use the adjusted information on income recipients to build a new set of weights for SHIW survey modifying the actual final raking step (for a description see Faiella and Gambacorta, 2007). Present raking forces weights to conform to marginal distributions with respect to gender, age (4 classes), geographical area (3 classes) and municipality size (4 classes). We modify this scheme including, as a further constraint, the distribution of individuals according to their main source of income: wages and salaries, self-employment income, pensions, capital income, financial assistance.<sup>4</sup>

The proposed new weighting scheme aligns the two populations along a pivotal variable (*main source of income*), which is related to respondents' income. Due to the new weighting scheme the percentage of recipients increases for any source of income, at the expense of the percentage of non-earners (table 4). This is because wealthier households tend to have a lower propensity to participate in the survey (D'Alessio and Faiella, 2002), as corroborated by the fact that the new weight is related positively to education and negatively to household size. For income from self-employment and from property the increase is respectively equal to 3.4 and 5.6 percentage points. The increase in the coefficients of variation is not significant.

The new weights will be used in all the steps of the adjustment procedure. This will enable us to separate the effect of response error from the effect of non-participation if the following assumptions hold: first, the two sources of error are independent; second, unit non-response is correctly accounted for by the new weighting scheme.

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<sup>4</sup>This requires that all incomes are available at the individual level. In the EU-SILC survey, only income from financial assets is collected at the household level, while in the SHIW also income from real investments is available at the household level. In order to make data comparable, the latter revenues are attributed to the members of the household using the following assignment rules: in both surveys, income from financial assets is equally redistributed among earners; in the SHIW, income from non-financial assets has been divided among owners using available information on shares owned by each member.

### 3.2 Misreporting on secondary sources of income

In order to adjust income data from secondary jobs we develop a statistical matching exercise which again exploits the Italian section of EU-SILC as an external source of information. Due to the record linkage with administrative and tax records, we can assume that the number of income recipients is correctly estimated in EU-SILC and perform a statistical matching.

Using the new set of weights, we apply the following procedure. Let  $I_{it}$  be an indicator equal to 1 if the respondent  $i$  has reported the secondary source of income  $t$  ( $I_{it} = 1$ ) and 0 otherwise. Let  $I_{it}^*$  be the true latent respondent's status. We assume that whenever a respondent reports a source of income, his or her answer is "correct". Overreporting is unlikely since it increases respondents' burden significantly: as a matter of fact, for each income source a thorough set of information must be provided.

On the contrary,  $I_{it} = 0$  is a mix of "correct" answers and response error. Namely:

$$\Pr(I_{it} = 0|\mathbf{X}) = \Pr(I_{it}^* = 0|\mathbf{X})\pi_{t0}(\mathbf{X}) + [1 - \Pr(I_{it}^* = 0|\mathbf{X})][1 - \pi_{t0}(\mathbf{X})]$$

where  $\pi_{t0}(\mathbf{X})$  is the (mixing) probability of correct reporting conditional on respondents' characteristics. This probability is unknown for the SHIW, but can be estimated through EU-SILC using a matrix of individual characteristics  $\mathbf{X}$ , also available in the SHIW (gender, age, number of household members, educational attainment, geographical area and main source of income). It can then be extrapolated to SHIW respondents. Once a fitted probability  $\hat{\pi}_{t0}(\mathbf{X})$  is obtained for each respondent in the SHIW, a random experiment is used to impute secondary sources of income. The expected value of the random variable is set equal to the difference between the percentages of recipients calculated from the two surveys. This ensures that in the end the expected number of recipients is aligned.

Two underlying assumptions are needed. Firstly, the two surveys must be representative of the same population: as a matter of fact, the marginal distributions of the conditioning variables are not significantly different (also because of post-stratification). Secondly, conditional on common variables, the streams of income from the two surveys must be independent, as commonly assumed in statistical matching.

In particular, we estimate the following models:

- for respondents whose main source of income is payroll, we estimate their probability of having a secondary source from either self-employment or pensions or other forms of assistance (table 5);
- for respondents whose main source of income derives from self-employment we estimate their probability of perceiving also pensions (table 5);
- for those whose main source of income is either pensions or capital we estimate the probability of also having a payroll or self-employment income (table 6).

Table 7 summarizes the percentages of recipients by income source before and after the adjustment process. The share of self-employment and payroll income earners increases by 3.9 and 2.6 percentage points respectively. The extent of the adjustment increases with the respondent's education and decreases with household size. Moreover, it is higher for the Central and the Northern regions. It appears, therefore, to be positively related to the respondents' economic status.

Finally, income from these fitted secondary jobs are assigned with a random selection of income figures from the EU-SILC data (stratified according to gender and geographical area). Only secondary sources of income are used. In the case of payroll income and pensions, this imputation lowers the mean values (table 8): this is because income perceived in secondary dependent jobs is generally lower than in the principal ones. The opposite holds for self-employment income, whose average value increases after the imputation.

### **3.3 Income from self-employment**

As a second step, we deal with the misreporting behaviour of the self-employed as regards their main source of income. The adjustment procedure exploits the relation between market value of the main residence and income from work, hence modifying the traditional approach developed by Pissarides and Weber (1989), based on the relation between food expenditure and income. This relation is estimated on a validation sample and then extrapolated onto the self-employed, under the assumption that the value of the main residence is correctly

reported by all income groups while income reporting is accurate only in the validation sample. Previous research shows that house prices collected in the SHIW are quite in line with those from external sources (Cannari and Faiella, 2007). The adjustment allows for both overreporting and underreporting.

Our validation sample (346 observations) includes employees working in the public sector whose responses are deemed highly reliable by the interviewers. At the end of the interview the interviewer is in fact asked to evaluate the respondent’s reliability in income reporting and his ability to understand income questions, as well as to rate the overall climate of the interview. For the validation sample we selected respondents with the maximum score (10) in these three items.

We use the following specification:

$$E \left[ \frac{Y_i}{W_i} \mid \mathbf{X} \right] = \alpha + \mathbf{X}'\beta$$

in which the dependent variable is the ratio of individual income from labour  $Y$  to market value of main residence  $W$ . We prefer a relation at the individual rather than at the household level firstly because some of the right-hand side variables are individual (e.g. age, labour income class). Secondly, because in this way we can avoid deciding whether households composed of both self-employed and public sector employees must be included or not in the validation sample; that decision would have involved looking at the magnitudes of each income source, being in turn heavily influenced by the misreporting behaviour itself.

$\mathbf{X}$  contains three dummy variables indicating the labour income quartile the respondent belongs to, the size of the house, a dummy variable for luxury dwellings and one indicating whether the dwelling has been (totally or partially) received as a bequest or gift. Last, we include other control variables, such as age, geographical area, size of the municipality, the educational attainment of the interviewer. We also tried to account for mixed households by including dummy variables for the presence of a self-employed or for the existence of other sources of income, but no explicative power was added to the previous specification.

To make the two groups more similar to each other, we create a new set of weights aligning the distribution of the validation sample with the estimated distribution of the

self-employed by geographical area (3 classes) and household income (5 classes). This auxiliary information is obtained from the SHIW data using the method by D'Alessio and Faiella (2002) to adjust for nonresponse.

As expected, the income-to-house-value ratio increases in the upper income brackets, while it decreases in the North, for larger and valuable dwellings (table 9). Estimated coefficients are then fitted to the self-employed in order to predict their expected income from work given the value of their house and their characteristics. Moreover, a random component from the distribution of the residuals is added to preserve the observed variability.

Income from self-employment rises on average by around 36 per cent due to the adjustment, 11 percentage points more than found in Cannari and Violi (1995), who applied the standard Pissarides and Weber approach to Italy.<sup>5</sup> The adjustment is higher for large households, for people living in the South and in the Centre, for women, for the youngsters or for those with a low level of education (table 10).

### **3.4 Net income from financial assets and liabilities and property income**

Income from financial assets is not directly collected in the SHIW, but computed applying different rates of return to corresponding categories of assets. Therefore our adjustment relates to household financial wealth and is based on the approach developed by D'Aurizio *et al.* (2006). They dealt with the issue of underreporting of financial assets and liabilities using a survey conducted in 2003 by a leading Italian banking group on its customers as a supplementary source of information. Each respondent answered questions on financial assets held at the bank; then, survey data were linked to the bank databases using an exact matching procedure, hence allowing a comparison between self-reported wealth and that resulting from administrative records.<sup>6</sup>

This correction allows for both over- and underreporting. As a matter of fact, the increasing complexity of households' financial portfolios makes the respondents' task diffi-

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<sup>5</sup>As a robustness check, we have also replicated the standard method with our data and obtained an upward revision by about 30 per cent.

<sup>6</sup>See the appendix for details on the methodology.



cult. Some respondents may confuse different financial instruments, thus providing “false positive” answers. Moreover, overreporting does not increase a respondent’s burden significantly, since the only information asked is the asset value.

The average adjusted value is about 3 times the unadjusted one. The correction is higher for young respondents, the low educated and for those living in the South (table 11). The adjustment is not therefore positively related to the respondents’ economic status. The adjustment procedure also has an impact on interest paid on financial liabilities, though to a smaller extent (table 12).

Regarding property income, previous studies, in particular Cannari and D’Alessio (1990, 2008), show that while the survey estimate of the number of total dwellings used as a principal residence is in line with the macro figure, this is not the case for other dwellings. The method we borrow from Cannari and D’Alessio (1990) to adjust income from rents relies on the assumption that the empirical distribution of the number of dwellings not used as a principal residence recorded in the SHIW is a discrete Poisson distribution conditional on a set of characteristics. In the absence of more precise information, all dwellings not used as a principal residence are assumed equally likely to be declared by the owners. The probability that one of these dwellings is declared in the SHIW can then be described by a binomial distribution. This distribution can be estimated and used to impute ownership of the missing dwellings, that is the difference between the number of dwellings owned by the households (excluding the main residence) recorded in the SHIW and the corresponding “true” figure derived from the Census.<sup>7</sup> As for secondary job positions, the adjustment process does not allow for overreporting, that is held unlikely because it increases response burden significantly: in fact, respondents know that for each dwelling they report, they will be asked a further set of detailed questions.

On average, the percentage of owners increases by 2.4 percentage points. The average amount they hold increases by 11 per cent. There are no clear trends regarding the extent of the adjustment: corrections are higher for men, for those older than 64 years and for graduates (table 13).

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<sup>7</sup>The value for 2004 has been computed by inflating the figure for 2001 (the year of the latest available Census) with the net growth of the number of dwellings (see for details Banca d’Italia, 2008).

## 4 Results of the adjustment procedure

We first assess by how much the adjusted SHIW provides income aggregates which are closer to those estimated in the national accounts. The correction steps performed so far lead to an overall alignment of micro and macro figures (table 1). Major improvements are achieved for self-employment income and for entrepreneurial income and income from financial assets. Regarding the former, the SHIW now accounts for 88 per cent of the corresponding national account aggregate; it was 43 per cent before. Original SHIW data on income from financial wealth and from entrepreneurial activity accounted for only 13 per cent of the corresponding macro figure; corrected data represent 72 per cent of the same aggregate. Wages and salaries also benefit from the adjustment procedure, though to a smaller extent: originally 88 per cent of the corresponding national accounts' estimate in 2004, they now stand at 94 per cent. Pensions and financial assistance are much less affected, though a slight gain is also obtained for this source of income.

With regard to the income distribution, non-parametric estimates performed before and after the adjustment show that modifications of the shape of the distribution vary according to the income type (figure 1). As a whole, the “ex-post” distributions are slightly more dispersed than the “ex-ante”, with higher probability mass at higher income levels; this is particularly apparent for actual rents, for income from self-employment and for income from financial assets.

With reference to inequality, we look at two standard measures - the interdecile ratio and the Gini index - applied to disposable income and separately to each income source. These measures are calculated only on individuals with a given income source; hence, any variation after the adjustment can be due either to the inclusion of an entire income source originally omitted or to the correction of a misreported amount.<sup>8</sup> Total earnings, as well as most income sources, turn out to be less equally distributed after the adjustment; for income from financial assets only we obtain opposing indications from the two indices (table 14). Inequality rises considerably for income from independent work, due to the fact that we

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<sup>8</sup>The figures relating to unadjusted income may differ from those in Banca d'Italia (2008) since we use a different method for computing capital income from financial assets (see Section 3.4).

add many recipients of this income source as a secondary activity and revalue significantly underreported amounts through the “modified” Pissarides and Weber (1989) procedure. Payroll income and pensions and financial assistance are now slightly more unequally distributed, as we impute many small incomes of this kind from secondary positions. For actual and imputed rents inequality rises, as expected, as non-reported dwellings are imputed on the basis of the probability distribution of declared houses. Overall, the distribution of disposable income widens: the decile ratio rises from 6.8 to 7.9 while the Gini index rises from 0.385 to 0.427. A similar trend occurs when equivalent income, computed using the OECD modified equivalence scale, is considered.

Finally, to test whether the results are affected by the ordering of the adjustment steps, we fit our procedure with two alternative procedures: in the first one (alternative 1) we change the order of the steps, in particular by shifting at the end the correction for self-employment income; in the second the order is left as in the baseline case, but adjusted values from previous steps are not considered (alternative 2). The results show that differences are negligible (table 15).

#### 4.1 Who are the misreporters?

As a result of the adjustment procedure each individual is characterized by a set of 14 proxy indicators of misreporting regarding all their income sources. These indicators can help to assess respondents’ misreporting behaviour in terms of both propensity and magnitude and to describe the salient characteristics of the misreporters through the framework of the item response theory. As many of these characteristics are not strictly exogenous to the event of misreporting (above all, the occupational choice) we do not give a causal interpretation to the results of these estimations; rather, we use them for descriptive purposes.

We consider two models. The first is the random intercept logistic model that is akin to the Rasch model (Rasch, 1960). This model specifies the probability of a correct response to item  $t$  ( $Y_t = 1$ ) conditional on the unobserved “ability” of subject  $i$  ( $\theta_i$ )

$$\Pr(Y_{it} = 1|\theta_i) = \frac{1}{1 + e^{[-(\theta_i - \delta_t)]}}.$$

The coefficient  $\delta_t$  is basically the proportion of errors relating to item  $t$ . Therefore, the greater the  $\delta_t$ , the more difficult the item. In our model we include a dummy indicator for each item to account for its level of difficulty. If a subject’s trait level  $\theta_i$  exceeds the difficulty of the item  $\delta_t$ , then the probability of a correct response is greater than 0.5. Since in our application we model the probability of an “incorrect answer”, signs are reversed and  $\delta_t$  can be interpreted as the easiness of the item. Thus, given the respondent’s latent trait, the easier the item the lower the probability of an “incorrect” answer.

In practice we estimate the model

$$\text{logit}[\Pr(Y_{it} = 1|\mathbf{X}, \theta_i)] = \alpha + \mathbf{X}'\beta$$

where  $Y_{it}$  is a dummy variable taking value 1 if the  $i - th$  respondent is estimated to misreport on item  $t$  ( $t = 1, \dots, 14$ ).

We construct the following 14 response dummy variables  $Y_{it}$  relating different sources of income:

| Items                                      |  |
|--|--|
| $Y_{i1}$ = Additional payroll income       | $Y_{i8}$ = Income from shares                  |
| $Y_{i2}$ = Additional self-empl. income    | $Y_{i9}$ = Income from mutual funds            |
| $Y_{i3}$ = Primary self-empl. income       | $Y_{i10}$ = Income from managed savings        |
| $Y_{i4}$ = Additional income from pensions | $Y_{i11}$ = Interests on financial liabilities |
| $Y_{i5}$ = Income from deposits            | $Y_{i12}$ = Income from actual rents           |
| $Y_{i6}$ = Income from government bonds    | $Y_{i13}$ = Income from imputed rents          |
| $Y_{i7}$ = Income from private bonds       | $Y_{i14}$ = Income from financial assistance   |

The second model exploits the information on the estimated amount of response error. Once a given answer to item  $t$  is marked as “incorrect”, not only do we impute the ownership of that source of income, but also its expected value. It is therefore possible to end up with a distribution of misreported amounts for each item. This enables us to classify the response errors into four categories, according to the quartile of the estimated misreported amount on item  $t$  they belong to. We specify the following random-intercept proportional odds model:

$$\text{logit}[\Pr(Y_{it} > s|\mathbf{X}, \theta_i)] = \alpha + \mathbf{X}'\beta$$

where  $S$  are the ordinal categories with index  $s$  ( $s = 1, 2, 3, 4$ ), based on the quartiles of the distribution of response error.

One important caveat is that we cannot assess whether the respondent has reported the “true” value of a given income source. We are only able to estimate the probability of their providing a wrong answer. The final set of outcome variables we construct are therefore proxies of response error. Each outcome can be written as  $Y_{it} = Y_{it}^* + e_{it}$  where  $Y_{it}^*$  is the true latent outcome and  $e_{it}$  is the error we may add because of the adjustment process. Our results are unbiased only if the following conditions hold:

1. the error term  $e_{it}$  and the observable characteristics used in the adjustment are not correlated, namely  $E(e_{it}|\mathbf{X}) = 0$ . This assumption does not appear to be very restrictive. It implies that all the adjustments do not produce biased results for a given set of characteristics. Indeed, this should not be the case in our application since we employ several independent sources of validation data and it is unlikely that all of them produce biased estimates of the same coefficients;
2.  $e_{it}$  is not correlated with some unobservable characteristics which are not used in the adjustment process. Unfortunately this assumption cannot be made with certainty. Nevertheless, the measures of goodness of fit of our models are satisfactory in most cases.

Turning to the covariates used in the analysis, we first include a set of indicator variables, one for each income item. Their coefficients can be interpreted as the “item difficulties”, reflecting the proportion of individuals who are estimated to provide an incorrect answer to a given item. A second group of regressors includes a set of classical controls: age and its square, education, occupational status, area of residence, household wealth. Finally we includes variables accounting for the data collection process referred to in Section 2. In particular, we include two dummies for proxy respondents and one dummy for the use of the CAPI method. Moreover, we include a variable representing the interviewer’s assessment of the respondent’s level of understanding of the questions (on a scale of 1 to 10; *comprehension*) in order to proxy for respondents’ cognitive ability. Finally, we include three dummy variables indicating whether the interviewer and the respondent match

in terms of gender, education and age. Namely, the variable *edu – inter* takes value 1 if one person between the interviewer and the respondent holds at least an upper secondary school diploma, while the other has at most a lower secondary school certificate. The variable *age – inter* takes value 1 when the difference in age is greater than ten years. These variables are meant to capture unobserved interactions between interviewer and respondent which are likely to happen during the interview influencing a respondent’s attitude towards response error.

Tables 16 and 17 summarize the results. As to the item difficulty parameters in table 16, the higher their value, the higher the percentage of response errors. The overall picture is consistent with the preliminary analysis presented in the Introduction. The items relating to financial wealth components show higher percentages of response errors. One possible explanation for this is the increasing complexity of household financial portfolios, resulting in a higher cost of information retrieval for respondents. Income from financial assistance has the lowest misreported percentage, mainly because they only refer to a marginal share of the population.

Respondents’ characteristics show a similar association with response error when considering either income sources or corresponding amounts. Misreporting is more likely among male respondents and among those living in the North. It also increases with age, probably because of the greater difficulties older people face to retrieve the necessary information to reply. It also increase with the level of educational attainment. This result is probably driven by the adjustment process we use for secondary dwellings (see Section 3.4). As expected those who are self-employed show higher response errors than employees. Not only, as confirmed by previous research, independent workers are likely to have a higher propensity towards underreporting, but their income has a higher variability and therefore implies greater recall difficulties. Finally, greater errors are to be expected among more affluent households. That result is in line with prior expectations, not least because those households have a higher number of items to report on during the interview. It is therefore likely that some errors may occur at some stage.

It is worth stressing that the results of the models are strongly driven by the results of the adjustment procedure described in Section 3. In a sense, these models can be seen

as tools that summarize and show the final results of the adjustment process. The within-subject correlation among the outcomes of the 14 items is affected by the sign and the magnitudes of the observable characteristics used in the analysis. For instance, if for each adjustment a positive association between self-employment and response error is found, this will result in a higher probability of finding “incorrect responses” along all the 14 items.

The use of the CAPI data collection technique reduces the chance of response error with respect to the paper-and-pencil interviewing (PAPI) method. On the contrary, the probability of misreporting increases in the case of proxy respondents or when respondents’ cognitive ability of understanding questions are judged unsatisfactory by the interviewer.

Finally, all proxies for the existence of significant demographic differences between respondent and interviewer suggest that those differences increase the probability of response errors. As anticipated in Section 2, the respondent might feel more at ease with an interviewer whose social status more closely mirrors their own and the resulting climate might be more confidential; overreporting arising from the respondent wanting to make a positive impress on the interviewer will be then less likely. On the contrary, wealthy respondents might be tempted to underreport their income in the presence of an interviewer coming from a lower social class. Similar mechanisms may be at work when there are sizeable age differences or when they are of opposite gender.

Table 18 shows the distribution of respondents according to their expected number of reporting errors along the 14 items. Each respondent is classified as a “misreporter” in a given item if his or her estimated probability exceeds the average probability computed for that same item. These indicators of misreporting behaviour are then summed at the respondents’ level to provide a synthetic indicator of their behaviour.

Our findings suggest that respondents can be grouped into three clusters on the basis of their latent trait  $\theta_i$ . Some 27 per cent of them can be deemed highly reliable, their expected probability of misreporting being close to zero. At the opposite side of the distribution, about 15 per cent of respondents are likely to misreport on at least four items.

The average amount of response error is estimated to be about € 4,000 per year (table 19). The distribution looks highly concentrated with a Gini index of 0.799. Around 10 per cent of respondents are estimated to have an average response error of about € 46,000 and

they are responsible for two thirds of total misreporting.

Robustness checks involving the use of synthetic indicators - the number of misreported items and the average value of the adjustment - and the estimation of several specifications provide a consistent picture.<sup>9</sup>

## 5 Conclusions

In this paper we investigate misreporting behaviour in survey data on personal income. Data from the Bank of Italy's 2004 SHIW have been checked against external sources in order to assess if, and to what extent, information provided by respondents was correctly reported. Our main results may be summarized as follows.

First, we estimate response error to be on average €4,000 per year, about 12 per cent of reported household income. Underreporting issues emerged as particularly serious with regard to income from financial assets and from self-employment: respectively the bias is estimated to be as much as 3 and 1.4 times the reported amounts.

Second, we found that the estimated response error has a significant influence on income distribution. The Gini index increases for most of the income sources, but not for income from financial assets. The inequality level of total disposable income distribution is higher for adjusted than for unadjusted data.

Third, our findings suggest that respondents are predisposed to provide either accurate answers or poor data; around 15 per cent of respondents are likely to be highly unreliable. Moreover, the distribution of the magnitude of response error is highly concentrated. Some 10 per cent of respondents are estimated to account for two thirds of the total amount of response error.

These results are useful on two levels. First, they allow the researchers who use SHIW micro-data to take data quality fully into account when conducting their studies. Second, our results may help data producers to improve data quality, since similar surveys are likely to be affected, at least partly, by the same issues. Surveys are generally designed to minimize sampling error. In the SHIW the relative standard error of average household

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<sup>9</sup>Estimates, not reported for the sake of brevity, are available upon request.



income is about 1.2 per cent, ten times lower compared with the estimated response error. Improvements in sample design are therefore needed to reduce such error. Our results show that one important source of error comes from the interaction between respondents and interviewers. The more similar they are, the lower the response error. Realistically, this does not imply that interviewers should be selected on the basis of similarity to respondents, however, more resources could be allocated in their training, stressing the importance of their behaviour/attitude when interviewing a respondent very different from themselves.

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## 7 Methodological appendix

### 7.1 Income and jobs: a comparison between the SHIW and the NA

In order to assess the degree of accuracy of microeconomic data on income collected by the SHIW we compare them with corresponding macro figures from the National Accounts. We only consider the year 2004; comparisons referred to previous years can be found in Brandolini (1999), in Coromaldi and Guerrera (2006) and in Cannari and D'Alessio (2008).

The two sources have been matched according to the following criteria. Payroll income includes net wages and salaries and fringe benefits. Pensions and net transfers include pensions, arrears and wage supplementation. The item "Income from self-employment in economic producing units with 5 dependents or less and actual rents" compares with the Italian NA item "Mixed income share transferred from productive to consumer households" not featuring in the ESA95 framework, where income from activity in producing households (unincorporated enterprises) is classified. The item "Income from self-employment in economic producing units with more than 5 dependents" compares with the NA item "Withdrawals from income of quasi-corporations". The item "Imputed rents" is contrasted with the NA item "Gross operating surplus" since it is essentially (by more than 80 per cent; Agostinelli, 2003) represented by imputed rents from owner-occupied dwellings, with the residual part being domestic services, agricultural production for own use and maintenance made by the owner. The item "Entrepreneurial income and income from financial assets" includes three NA items, "Dividends" "Other distributed income of corporations" (not featuring in the ESA95 manual) and "Net interest". Social contributions paid by dependent and independent workers have been subtracted from aggregates in the NA. Taxes on income have been assigned pro quota to the different income categories excluding imputed rents (as in Brandolini, 1999). Depreciation is taken into account for the items "Income from self-employment in economic producing units with 5 dependents or less and actual rents" and for "Imputed rents". Further details on NA definitions can be found in Agostinelli (2003) and in Agostinelli and Di Veroli (2003).

A number of caveats must be introduced as the comparison, while necessary, is inherently limited in scope: the reference population is different in the two sources (residents net of institutionalized persons in the SHIW versus residents and non-residents in the NA); the SHIW suffers from the typical problems of sample surveys on households (lack of representativeness of some categories of income recipients, reticence, missing responses that were not randomly distributed); NA aggregates are subject to frequent revisions as new information becomes available, and include explicit adjustments to cope with undeclared work, which is likely to be only partly captured by the survey; income definitions sometimes do not match perfectly in the two sources. On this point, the SHIW asks for data on income net of taxes and social contributions, while the NA are built on a gross basis. The assignment of taxes and social contributions to each separate income category in the NA is an unavoidable source of measurement error. For all these reasons, although the NA are the best available benchmark, it is worth stressing that our adjustment procedure does not aim at aligning microdata to them exactly.

Table 1 shows that in 2004 the micro estimates of payroll income and of income from pensions and net transfers were lower than the corresponding macro figures by 12 and 31

per cent, respectively. In addition, the SHIW estimate of income from self-employment was about 43 per cent of the corresponding macro figure, mainly because of income generated in the largest units (29 per cent). Entrepreneurial income and income from financial assets fared even worse (13 per cent of the corresponding NA aggregate). By contrast, we detected a sizeable overestimation of the imputed rents, presumably reflecting the estimation procedure that Istat adopts to meet specific requirements of the ESA95 (Istat, 2004). In particular, imputed rents are estimated not by relying on subjective evaluations collected through the Survey on Consumption Expenditure (which provides an estimate of the imputed rents that is broadly comparable with the SHIW estimate), but using the value of actual rents for similar dwellings.

## **7.2 The adjustment procedure for financial assets: methodological details**

In order to improve upon data comparability, the design and implementation of the survey conducted by the banking group were planned to be as similar as possible to those of the SHIW. The reference population was made up of customers who authorized the disclosure of their data for research purposes, as required under Italian law. The population was stratified according to its geographical area of residence, municipality size and, most importantly, to the financial wealth held in the bank. The survey collected data on 1,834 households. Assuming that respondents were representative of customers of other banks, this information can be extrapolated to the SHIW data. In order to strengthen that assumption the sampling weights were post-stratified to reproduce the distribution of the Italian population of banks' customers (e.g. geographical area).

The econometric framework is based on the hurdle models (Wooldridge, 2003). The first step estimates the non-reporting of ownership: the response variable, obtained from the administrative records, is a dummy for the actual holding of an asset. The probability of non-reporting is estimated by including among the covariates a dummy for the declared asset ownership in the interview. The analysis is carried out separately for six financial assets (deposits and repos, government bonds, private bonds, quoted shares, mutual funds and managed savings) and for financial liabilities. The second step models the underreporting of the amount held, defined as the ratio between the actual and the reported amount for each class of assets. This ratio is computed at the individual level and is assumed to be a proxy for reticence at the household level. The log of the ratio is regressed on the household declared amount, its square, and a set of sociodemographic characteristics. The third step fits the preceding estimates to the SHIW data. For each financial instrument, the estimated probability of holding a given asset is fitted at the household level. A random experiment is then used to impute ownership to households which are likely to possess an asset, whether they declare it or not. We reconstruct for every asset the amount owned by the households to whom the experiment attributes ownership, even if they did not declare it. Finally, the estimated coefficients of misreporting on amounts are fitted to SHIW data to obtain an inflation factor (less often a deflation factor) for the declared amount.

## 8 Tables and figures

*Table 1. National Accounts and SHIW income estimates*

| Source of income                              | NA                        | SHIW(1) | SHIW(2) | SHIW(1)/NA        | SHIW(2)/NA |
|---|---------------------------|---------|---------|-------------------|------------|
|   | Millions of euro          |         |         | Percentages       |            |
| Payroll income                                | 303,466                   | 267,962 | 285,656 | 88.3              | 94.1       |
| Imputed rents                                 | 57,278                    | 125,733 | 164,575 | 219.5             | 287.3      |
| Income from self-employment in units          |                           |         |         |                   |            |
| with up to 5 employees and actual rents       | 167,406                   | 79,440  | 162,689 | 47.5              | 97.2       |
| with more than 5 employees                    | 52,418                    | 15,447  | 30,297  | 29.5              | 57.8       |
| Entrepren. income, income from financ. assets | 111,877                   | 14,951  | 80,553  | 13.4              | 72.0       |
| Pensions and net transfers                    | 222,754                   | 153,969 | 158,831 | 69.1              | 71.3       |
|   | NA                        | SHIW(1) | SHIW(2) | SHIW(1)-NA        | SHIW(2)-NA |
|   | Share of total income (%) |         |         | Percentage points |            |
| Payroll income                                | 33.2                      | 40.8    | 32.4    | 7.6               | -0.8       |
| Imputed rents                                 | 6.3                       | 19.1    | 18.6    | 12.8              | 12.3       |
| Income from self-employment in units          |                           |         |         |                   |            |
| with up to 5 employees and actual rents       | 18.3                      | 12.1    | 18.4    | -6.2              | 0.1        |
| with more than 5 employees                    | 5.7                       | 2.3     | 3.4     | -3.4              | -2.3       |
| Entrepren. income, income from financ. assets | 12.2                      | 2.3     | 9.1     | -9.9              | -3.1       |
| Pensions and net transfers                    | 24.3                      | 23.4    | 18.0    | -0.9              | -6.3       |

SHIW(1) = unadjusted figures; SHIW(2) = adjusted figures.

*Table 2. Workers by main income source*

| Main source of income | LFS*       | NA         | SHIW       | SHIW/LFS | NA/LFS |
|-----------------------|------------|------------|------------|----------|--------|
| From employment       | 16,117,254 | 18,029,080 | 16,115,090 | 100.0    | 89.4   |
| From self-employment  | 6,287,176  | 6,226,750  | 6,008,486  | 95.6     | 96.5   |
| Total                 | 22,404,430 | 24,255,830 | 22,123,576 | 98.7     | 91.2   |

\* Labour force survey (yearly average).

*Table 3. Jobs held*

|               | NA         | SHIW       | SHIW/NA |
|---------------|------------|------------|---------|
| Employees     | 20,055,000 | 16,633,430 | 82.9    |
| Self-employed | 10,976,300 | 6,292,250  | 57.3    |
| Total         | 31,031,300 | 22,925,680 | 73.9    |

Table 4. Effect of the new weighting scheme

| Source of income            | Recipients (%) |       | Mean values ( € ) |        | Coeff. of variation |       |
|-----------------------------|----------------|-------|-------------------|--------|---------------------|-------|
|                             | Initial        | Final | Initial           | Final  | Initial             | Final |
| Payroll income              | 30.9           | 32.6  | 14,458            | 15,080 | 1.2%                | 1.2%  |
| Income from self-employment | 8.4            | 11.8  | 20,436            | 20,929 | 5.3%                | 4.1%  |
| Pensions                    | 24.3           | 25.6  | 10,417            | 10,825 | 1.1%                | 0.9%  |
| Property income             | 65.0           | 70.6  | 4,283             | 3,993  | 2.4%                | 2.0%  |
| Financial assistance        | 3.9            | 5.1   | 1,562             | 1,605  | 13.1%               | 13.5% |

Table 5. Probability of a secondary source of income by main source

| Main source                        | Payroll income |          |          |          |                    |          | Self -empl. |          |
|------------------------------------|----------------|----------|----------|----------|--------------------|----------|-------------|----------|
| Secondary source                   | Self-empl.     |          | Pensions |          | Financ. assistance |          | Pensions    |          |
|                                    | Coeff.         | St. err. | Coeff.   | St. err. | Coeff.             | St. err. | Coeff.      | St. err. |
| Geogr. area (base: South/ Islands) |                |          |          |          |                    |          |             |          |
| North                              | 0.018          | 0.001    | -0.153   | 0.002    | -0.118             | 0.002    | 0.317       | 0.002    |
| Center                             | 0.080          | 0.001    | 0.033    | 0.002    | -0.306             | 0.002    | 0.145       | 0.003    |
| Education (base: $\geq$ degree)    |                |          |          |          |                    |          |             |          |
| None/primary                       | -0.558         | 0.003    | 0.292    | 0.003    | 0.834              | 0.002    | 0.663       | 0.003    |
| Secondary school                   | -0.360         | 0.002    | 0.180    | 0.002    | 0.013              | 0.002    | 0.074       | 0.003    |
| Age class (base: > 64)             |                |          |          |          |                    |          |             |          |
| < 25                               | -0.612         | 0.004    | -1.998   | 0.007    | -0.134             | 0.012    | -2.484      | 0.020    |
| 25 - 44                            | -0.006         | 0.003    | -1.183   | 0.003    | 1.071              | 0.011    | -1.680      | 0.008    |
| 45 - 64                            | -0.112         | 0.003    | 0.515    | 0.003    | 0.704              | 0.011    | 0.711       | 0.007    |
| Household size (base: > 4)         |                |          |          |          |                    |          |             |          |
| 1 member                           | 0.126          | 0.002    | 0.072    | 0.003    | -0.334             | 0.003    | 0.300       | 0.004    |
| 2 members                          | -0.095         | 0.002    | 0.439    | 0.002    | 0.135              | 0.002    | 0.508       | 0.003    |
| 3 members                          | -0.085         | 0.002    | 0.164    | 0.002    | -0.040             | 0.002    | 0.156       | 0.003    |
| 4 members                          | 0.013          | 0.002    | -0.545   | 0.003    | 0.199              | 0.002    | -0.448      | 0.004    |
| Gender                             |                |          |          |          |                    |          |             |          |
| Male                               | 0.158          | 0.001    | 0.052    | 0.001    | -0.190             | 0.001    | 0.143       | 0.002    |
| Intercept                          | -2.395         | 0.003    | -3.186   | 0.003    | -4.044             | 0.011    | -2.747      | 0.007    |
| Observations                       | 17,908         |          |          |          |                    |          | 5,714       |          |



Table 6. Probability of a secondary source of income by main source

| Main source                        | Pensions       |          |                |          | Capital income |          |                |          |
|------------------------------------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|
| Secondary source                   | Payroll income |          | Self-emp. inc. |          | Payroll income |          | Self-emp. inc. |          |
|                                    | Coef.          | St. err. | Coef.          | St. err. | Coef.          | St. err. | Coef.          | St. err. |
| Geogr. area (base: South/ Islands) |                |          |                |          |                |          |                |          |
| North                              | -0.083         | 0.002    | 0.204          | 0.002    | 0.343          | 0.002    | 0.360          | 0.002    |
| Center                             | 0.205          | 0.002    | 0.091          | 0.002    | 0.147          | 0.002    | 0.206          | 0.002    |
| Education (base: $\geq$ degree)    |                |          |                |          |                |          |                |          |
| None/primary                       | -0.564         | 0.003    | -0.745         | 0.002    | -0.760         | 0.003    | -0.524         | 0.002    |
| Secondary school                   | 0.110          | 0.002    | -0.209         | 0.002    | -0.019         | 0.002    | -0.137         | 0.002    |
| Age class (base: $> 64$ )          |                |          |                |          |                |          |                |          |
| < 25                               | 0.266          | 0.007    | -0.414         | 0.014    | 1.103          | 0.005    | -0.055         | 0.005    |
| 25 - 44                            | 0.685          | 0.005    | -0.156         | 0.010    | 1.245          | 0.004    | 0.598          | 0.003    |
| 45 - 64                            | 0.594          | 0.003    | 0.497          | 0.006    | 0.577          | 0.004    | 0.130          | 0.002    |
| Household size (base: $> 4$ )      |                |          |                |          |                |          |                |          |
| 1 member                           | -0.202         | 0.004    | -0.427         | 0.004    | 0.507          | 0.003    | -0.031         | 0.003    |
| 2 members                          | -0.263         | 0.003    | 0.010          | 0.003    | 0.003          | 0.003    | 0.058          | 0.003    |
| 3 members                          | 0.069          | 0.003    | 0.329          | 0.003    | -0.069         | 0.003    | 0.053          | 0.003    |
| 4 members                          | 0.608          | 0.003    | 0.296          | 0.004    | -0.174         | 0.003    | 0.071          | 0.003    |
| Gender                             |                |          |                |          |                |          |                |          |
| Male                               | 0.277          | 0.002    | 0.480          | 0.002    | 0.208          | 0.002    | 0.858          | 0.001    |
| Intercept                          | -2.552         | 0.004    | -3.206         | 0.006    | -2.417         | 0.004    | -1.629         | 0.002    |
| Observations                       | 12, 832        |          |                |          | 5, 256         |          |                |          |

Table 7. Income recipients by source (percentages)

| Characteristics          | Payroll     |             | Self-empl.  |             | Pensions    |             | Fin. assistance |            |
|--------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-----------------|------------|
|                          | Initial     | Final       | Initial     | Final       | Initial     | Final       | Initial         | Final      |
| <b>Gender</b>            |             |             |             |             |             |             |                 |            |
| Male                     | 38.4        | 41.5        | 15.3        | 19.8        | 23.9        | 25.4        | 5.7             | 5.9        |
| Female                   | 27.1        | 29.2        | 8.5         | 11.9        | 27.2        | 28.0        | 4.6             | 4.8        |
| <b>Age class</b>         |             |             |             |             |             |             |                 |            |
| <25                      | 14.8        | 15.6        | 2.9         | 4.3         | 0.5         | 0.5         | 4.5             | 4.5        |
| 25-44                    | 61.4        | 63.1        | 20.0        | 25.3        | 1.5         | 1.8         | 6.4             | 7.0        |
| 45-64                    | 39.3        | 43.9        | 17.9        | 22.8        | 27.9        | 32.1        | 5.8             | 6.0        |
| >64                      | 0.4         | 4.3         | 2.1         | 5.7         | 93.2        | 93.2        | 3.1             | 3.1        |
| <b>Education</b>         |             |             |             |             |             |             |                 |            |
| None/primary school      | 6.9         | 9.0         | 3.5         | 5.5         | 47.7        | 48.4        | 3.8             | 3.9        |
| Secondary school         | 44.9        | 47.7        | 14.8        | 19.6        | 14.5        | 15.8        | 5.6             | 5.9        |
| University degree        | 53.0        | 56.1        | 26.8        | 31.9        | 13.1        | 14.6        | 7.4             | 7.9        |
| <b>Household size</b>    |             |             |             |             |             |             |                 |            |
| 1 member                 | 29.8        | 33.3        | 14.3        | 20.1        | 53.7        | 54.7        | 10.7            | 10.7       |
| 2 members                | 29.5        | 33.1        | 9.9         | 14.7        | 49.1        | 50.7        | 5.0             | 5.4        |
| 3 members                | 37.1        | 40.2        | 13.2        | 17.3        | 19.0        | 20.4        | 5.0             | 5.2        |
| 4 members                | 34.9        | 36.3        | 12.4        | 15.4        | 7.6         | 8.3         | 3.6             | 4.0        |
| 5 or more members        | 26.8        | 28.1        | 8.6         | 10.7        | 7.9         | 8.7         | 3.3             | 3.5        |
| <b>Geographical area</b> |             |             |             |             |             |             |                 |            |
| North                    | 37.3        | 40.2        | 13.1        | 17.2        | 26.2        | 27.6        | 4.8             | 5.1        |
| Center                   | 35.7        | 38.6        | 12.9        | 19.1        | 27.5        | 28.5        | 6.4             | 6.5        |
| South and Islands        | 25.0        | 27.1        | 9.6         | 12.1        | 23.8        | 24.7        | 4.8             | 5.1        |
| <b>Total</b>             | <b>32.6</b> | <b>35.2</b> | <b>11.8</b> | <b>15.7</b> | <b>25.6</b> | <b>26.8</b> | <b>5.1</b>      | <b>5.4</b> |

Table 8. Individual income by source (€)

| Characteristics          | Payroll       |               | Self-empl.    |               | Pensions      |              | Fin. assistance |              |
|--------------------------|---------------|---------------|---------------|---------------|---------------|--------------|-----------------|--------------|
|                          | Initial       | Final         | Initial       | Final         | Initial       | Final        | Initial         | Final        |
| <b>Gender</b>            |               |               |               |               |               |              |                 |              |
| Male                     | 15,648        | 15,007        | 23,530        | 23,352        | 12,523        | 11,813       | 561             | 2,323        |
| Female                   | 12,868        | 12,392        | 15,101        | 18,850        | 8,675         | 8,434        | 2,715           | 2,925        |
| <b>Age class</b>         |               |               |               |               |               |              |                 |              |
| <25                      | 9,160         | 8,885         | 8,408         | 16,011        | 4,082         | 4,082        | 1,997           | 2,020        |
| 25-44                    | 14,370        | 14,221        | 20,855        | 20,488        | 6,120         | 5,233        | 1,660           | 2,582        |
| 45-64                    | 16,563        | 15,504        | 20,876        | 26,280        | 11,708        | 10,238       | 1,259           | 3,102        |
| >64                      | 14,584        | 7,458         | 29,440        | 10,162        | 10,060        | 10,060       | 1,176           | 2,503        |
| <b>Education</b>         |               |               |               |               |               |              |                 |              |
| None/primary school      | 11,549        | 10,281        | 14,290        | 21,889        | 8,663         | 8,550        | 1,988           | 2,586        |
| Secondary school         | 13,806        | 13,392        | 18,524        | 23,021        | 12,582        | 11,546       | 1,639           | 2,456        |
| University degree        | 20,670        | 19,984        | 32,504        | 14,320        | 20,731        | 18,525       | 68              | 3,536        |
| <b>Household size</b>    |               |               |               |               |               |              |                 |              |
| 1 member                 | 16,688        | 15,540        | 26,133        | 19,650        | 10,300        | 10,115       | -931            | 1,762        |
| 2 members                | 14,908        | 14,039        | 23,995        | 19,030        | 10,218        | 9,894        | 1,459           | 2,575        |
| 3 members                | 14,390        | 13,743        | 15,649        | 17,128        | 10,693        | 9,971        | 2,697           | 2,959        |
| 4 members                | 13,928        | 13,649        | 20,545        | 28,154        | 11,328        | 10,407       | 3,214           | 3,286        |
| 5 or more members        | 12,735        | 12,646        | 17,196        | 24,608        | 10,173        | 9,387        | 2,433           | 2,449        |
| <b>Geographical area</b> |               |               |               |               |               |              |                 |              |
| North                    | 15,137        | 14,558        | 23,806        | 19,823        | 11,138        | 10,607       | 1,623           | 2,867        |
| Center                   | 15,523        | 14,958        | 20,113        | 27,550        | 11,000        | 10,601       | 717             | 2,134        |
| South and Islands        | 12,360        | 11,813        | 14,796        | 19,742        | 9,053         | 8,742        | 2,091           | 2,597        |
| <b>Total</b>             | <b>14,458</b> | <b>13,888</b> | <b>20,412</b> | <b>21,601</b> | <b>10,417</b> | <b>9,991</b> | <b>1,562</b>    | <b>2,603</b> |

*Table 9. Labour income and market value of main residence*

| Dep. variable: ratio of labour income to market value of main residence |        |         |
|---|--------|---------|
|   | Coeff. | P-value |
| Geogr. area (base: South and Islands)                                   |        |         |
| North   | -0.050 | 0.00    |
| Center  | 0.040  | 0.01    |
| Municipality size (base: medium)  |        |         |
| Small municipalities  | -0.048 | 0.58    |
| Large municipalities  | 0.063  | < .0001 |
| Male  | -0.008 | 0.48    |
| Education (base: secondary school)                                      |        |         |
| Primary   | -0.066 | 0.25    |
| Tertiary  | -0.006 | 0.86    |
| Labour income quartile (base: First)                                    |        |         |
| Second  | 0.037  | 0.32    |
| Third   | 0.093  | 0.01    |
| Fourth  | 0.182  | < .0001 |
| Age class (base: <30)   |        |         |
| 30-40   | 0.041  | 0.11    |
| 40-50   | -0.039 | 0.01    |
| >50   | 0.037  | 0.00    |
| Luxury dwelling   | -0.072 | < .0001 |
| Logarithm of house surface  | -0.099 | < .0001 |
| Low-rate dwelling   | 0.125  | 0.07    |
| Interviewer's characteristics   |        |         |
| free-lance  | 0.021  | 0.20    |
| graduate  | -0.208 | < .0001 |
| main job as interviewer   | 0.017  | 0.25    |
| Inheritance/gift  | -0.050 | < .0001 |
| Intercept   | 0.662  | < .0001 |
| Observations  | 346    |         |
| Adj R-square  | 0.72   |         |

Table 10. Adjustment of income from self-employment

| Characteristics               | Mean values   |               | Variation   |
|-------------------------------|---------------|---------------|-------------|
|                               | Initial       | Final         | %           |
| <b>Gender</b>                 |               |               |             |
| Male                          | 26,600        | 32,858        | 23.5        |
| Female                        | 17,770        | 30,201        | 70.0        |
| <b>Age class</b>              |               |               |             |
| <30                           | 9,485         | 23,794        | 150.9       |
| 30-40                         | 23,244        | 29,265        | 25.9        |
| >50                           | 25,880        | 36,872        | 42.5        |
| <b>Education</b>              |               |               |             |
| None/primary school           | 16,870        | 34,333        | 103.5       |
| Secondary and tertiary school | 24,132        | 31,650        | 31.2        |
| <b>Household size</b>         |               |               |             |
| 1 member                      | 30,950        | 32,445        | 4.8         |
| 2 members                     | 28,848        | 29,887        | 3.6         |
| 3 members                     | 18,340        | 26,112        | 42.4        |
| > 3 members                   | 21,710        | 36,366        | 67.5        |
| <b>Geographical area</b>      |               |               |             |
| North                         | 28,069        | 28,754        | 2.4         |
| Center                        | 23,049        | 47,943        | 108.0       |
| South and Islands             | 16,446        | 25,911        | 57.6        |
| <b>Total</b>                  | <b>23,438</b> | <b>31,907</b> | <b>36.1</b> |

Table 11. Adjustment of income from financial assets

| Characteristics          | Percent. of owners |             | Mean values (€) |              |
|--------------------------|--------------------|-------------|-----------------|--------------|
|                          | Initial            | Final       | Initial         | Final        |
| <b>Gender</b>            |                    |             |                 |              |
| Male                     | 65.3               | 66.5        | 550             | 1,514        |
| Female                   | 52.5               | 53.4        | 472             | 1,577        |
| <b>Age class</b>         |                    |             |                 |              |
| <25                      | 15.3               | 15.5        | 162             | 1,380        |
| 25-44                    | 72.8               | 74.1        | 443             | 1,141        |
| 45-64                    | 71.9               | 73.4        | 592             | 1,635        |
| >64                      | 74.3               | 75.6        | 618             | 2,098        |
| <b>Education</b>         |                    |             |                 |              |
| None/primary school      | 42.4               | 43.4        | 244             | 1,439        |
| Secondary school         | 64.9               | 65.9        | 481             | 1,427        |
| University degree        | 84.9               | 86.1        | 1,347           | 2,506        |
| <b>Household size</b>    |                    |             |                 |              |
| 1 member                 | 75.9               | 77.2        | 654             | 2,419        |
| 2 members                | 73.6               | 74.8        | 571             | 1,726        |
| 3 members                | 59.6               | 60.3        | 572             | 1,447        |
| 4 members                | 48.9               | 49.8        | 350             | 989          |
| 5 or more members        | 34                 | 35.2        | 304             | 988          |
| <b>Geographical area</b> |                    |             |                 |              |
| North                    | 72                 | 72.4        | 644             | 1,660        |
| Center                   | 64.1               | 65          | 484             | 1,760        |
| South and Islands        | 39.1               | 41.1        | 239             | 1,098        |
| <b>Total</b>             | <b>58.7</b>        | <b>59.8</b> | <b>514</b>      | <b>1,543</b> |

Table 12. Adjustment of interest on financial liabilities

| Characteristics          | Percent. of owners |             | Mean values (€) |              |
|--------------------------|--------------------|-------------|-----------------|--------------|
|                          | Initial            | Final       | Initial         | Final        |
| <b>Gender</b>            |                    |             |                 |              |
| Male                     | 22.6               | 26.4        | 1,165           | 1,246        |
| Female                   | 15.1               | 18.2        | 1,104           | 1,239        |
| <b>Age class</b>         |                    |             |                 |              |
| <25                      | 6.2                | 7.6         | 827             | 958          |
| 25-44                    | 31.1               | 35.5        | 1,426           | 1,581        |
| 45-64                    | 24.8               | 29.8        | 921             | 1,000        |
| >64                      | 6.8                | 9.7         | 466             | 531          |
| <b>Education</b>         |                    |             |                 |              |
| None/primary school      | 7.2                | 9.3         | 556             | 646          |
| Secondary school         | 23.9               | 27.9        | 1,178           | 1,234        |
| University degree        | 30.2               | 36          | 1,545           | 2,013        |
| <b>Household size</b>    |                    |             |                 |              |
| 1 member                 | 12.7               | 15.9        | 1,372           | 1,683        |
| 2 members                | 17.1               | 21.3        | 1,535           | 1,490        |
| 3 members                | 21.3               | 25.6        | 812             | 1,008        |
| 4 members                | 22.1               | 24.7        | 1,156           | 1,235        |
| 5 or more members        | 14.6               | 17.6        | 976             | 982          |
| <b>Geographical area</b> |                    |             |                 |              |
| North                    | 22.4               | 26          | 1,380           | 1,472        |
| Center                   | 18.9               | 24          | 936             | 1,104        |
| South and Islands        | 13.9               | 16.4        | 799             | 894          |
| <b>Total</b>             | <b>18.7</b>        | <b>22.2</b> | <b>1,140</b>    | <b>1,243</b> |

Table 13. Adjustment of income from rents

| Characteristics          | Percent. of owners |             | Mean values (€) |              |
|--------------------------|--------------------|-------------|-----------------|--------------|
|                          | Initial            | Final       | Initial         | Final        |
| <b>Gender</b>            |                    |             |                 |              |
| Male                     | 47.8               | 50.3        | 6,131           | 6,904        |
| Female                   | 48.3               | 50.7        | 5,226           | 5,745        |
| <b>Age class</b>         |                    |             |                 |              |
| <25                      | 4.5                | 5.1         | 5,676           | 5,309        |
| 25-44                    | 45.8               | 49.2        | 5,326           | 5,979        |
| 45-64                    | 72.5               | 75.9        | 5,926           | 6,549        |
| >64                      | 75.1               | 77.2        | 5,657           | 6,405        |
| <b>Education</b>         |                    |             |                 |              |
| None/primary school      | 45.8               | 47.3        | 4,227           | 4,751        |
| Secondary school         | 47.8               | 50.6        | 5,976           | 6,552        |
| University degree        | 60.9               | 64.6        | 8,690           | 10,027       |
| <b>Household size</b>    |                    |             |                 |              |
| 1 member                 | 75.9               | 77.6        | 6,959           | 7,693        |
| 2 members                | 63.9               | 67.9        | 5,537           | 6,309        |
| 3 members                | 46                 | 48          | 5,302           | 6,007        |
| 4 members                | 35.2               | 37.6        | 5,381           | 5,812        |
| 5 or more members        | 23.4               | 24.6        | 4,366           | 4,660        |
| <b>Geographical area</b> |                    |             |                 |              |
| North                    | 50.3               | 53.4        | 6,480           | 7,220        |
| Center                   | 52.4               | 54.7        | 6,874           | 7,795        |
| South and Islands        | 42.9               | 44.6        | 3,655           | 3,936        |
| <b>Total</b>             | <b>48.1</b>        | <b>50.5</b> | <b>5,663</b>    | <b>6,305</b> |

Table 14. Interdecile ratio (IDR) and the Gini index

| Source of income                        | Unadjusted IDR | Adjusted IDR | Unadjusted Gini | Adjusted Gini |
|---|----------------|--------------|-----------------|---------------|
| Payroll income                          | 3.49           | 4.40         | 0.262           | 0.291         |
| Income from self-employment             | 9.50           | 39.75        | 0.493           | 0.564         |
| Pensions and financial assistance       | 4.15           | 5.20         | 0.317           | 0.330         |
| Actual rents                            | 17.07          | 54.54        | 0.553           | 0.601         |
| Imputed rents                           | 7.75           | 9.17         | 0.418           | 0.471         |
| Net income from financial assets        | 100.76         | 153.42       | 0.857           | 0.727         |
| Disposable personal income              | 6.85           | 7.95         | 0.385           | 0.427         |
| Equivalent income (OECD modified scale) | 4.42           | 5.18         | 0.341           | 0.364         |



Table 15. Results with alternative models of adjustment

| Source of income                                 | Baseline*                  | Alternative 1** | Alternative 2*** |
|--|----------------------------|-----------------|------------------|
|  | Mean values (€, millions ) |                 |                  |
| Payroll income                                   | 285,656                    | 285,656         | 283,546          |
| Imputed rents                                    | 164,575                    | 165,021         | 165,073          |
| Income from self-employment in units             |                            |                 |                  |
| with up to 5 employees and actual rents          | 162,689                    | 163,217         | 158,404          |
| with more than 5 employees                       | 30,297                     | 31,146          | 31,147           |
| Entrepren. income and income from financ. assets | 80,553                     | 80,645          | 79,931           |
| Pensions and net transfers                       | 158,831                    | 158,831         | 158,831          |

\* Order as indicated in the paper. Adj. values at each step are used in the following steps.

\*\* Income from self-empl. as the final step of the process. Adj. values at each step are used in the following steps.

\*\*\* Order as indicated in the paper. Adj. values at each step are not used in the following steps.

Table 16. Probability of misreporting: random intercept logistic model

| Variables  | Coef.   | P> z  | 95% Conf. Interval |         |
|--|---------|-------|--------------------|---------|
| Item   |         |       |                    |         |
| Additional payroll income                          | -8.424  | 0.000 | -8.690             | -8.157  |
| Additional self-empl. income                       | -8.053  | 0.000 | -8.315             | -7.791  |
| Primary self-empl. income                          | -7.209  | 0.000 | -7.464             | -6.953  |
| Additional income from pension                     | -9.062  | 0.000 | -9.341             | -8.782  |
| Income from deposits                               | -3.715  | 0.000 | -3.960             | -3.471  |
| Income from government bonds                       | -6.976  | 0.000 | -7.230             | -6.722  |
| Income from private bonds                          | -5.882  | 0.000 | -6.132             | -5.632  |
| Income from shares                                 | -6.575  | 0.000 | -6.827             | -6.323  |
| Income from mutual funds                           | -5.696  | 0.000 | -5.946             | -5.447  |
| Income from managed savings                        | -7.947  | 0.000 | -8.208             | -7.687  |
| Interests on financial liabilities                 | -5.753  | 0.000 | -6.003             | -5.503  |
| Income from actual rents                           | -7.558  | 0.000 | -7.815             | -7.301  |
| Income from imputed rents                          | -7.243  | 0.000 | -7.498             | -6.988  |
| Income from financial assistance                   | -10.617 | 0.000 | -10.981            | -10.252 |
| Age  | 0.081   | 0.000 | 0.074              | 0.088   |
| Age squared  | 0.000   | 0.000 | 0.000              | 0.000   |
| Educational qualification (base: none)             |         |       |                    |         |
| Primary school certificate                         | 0.276   | 0.000 | 0.173              | 0.380   |
| Lower secondary school certificate                 | 1.098   | 0.000 | 0.961              | 1.235   |
| Upper secondary school diploma                     | 1.381   | 0.000 | 1.241              | 1.521   |
| University degree                                  | 1.503   | 0.000 | 1.354              | 1.652   |
| Geographical area (base: North)                    |         |       |                    |         |
| Center   | -0.215  | 0.000 | -0.263             | -0.168  |
| South and Islands                                  | -0.956  | 0.000 | -1.004             | -0.907  |
| Gender Female (base: male)                         | -0.277  | 0.000 | -0.317             | -0.236  |
| Work status (base: payroll employee)               |         |       |                    |         |
| Self-employed                                      | 0.567   | 0.000 | 0.498              | 0.636   |
| Not employed                                       | -1.340  | 0.000 | -1.399             | -1.281  |
| Quintiles of household wealth (base: 1st quintile) |         |       |                    |         |
| 2nd quintile                                       | 0.290   | 0.000 | 0.198              | 0.382   |
| 3rd quintile                                       | 0.339   | 0.000 | 0.261              | 0.417   |
| 4th quintile                                       | 0.394   | 0.000 | 0.331              | 0.457   |
| 5th quintile                                       | 0.603   | 0.000 | 0.544              | 0.663   |
| Proxy respondent on payroll income                 | 0.751   | 0.000 | 0.681              | 0.822   |
| Proxy respondent on self-employment income         | 0.672   | 0.000 | 0.529              | 0.814   |
| CAPI   | -0.081  | 0.000 | -0.125             | -0.038  |
| Edu-inter  | 0.798   | 0.000 | 0.699              | 0.897   |
| Sex-inter  | 0.323   | 0.000 | 0.279              | 0.366   |
| Age-inter  | 0.201   | 0.000 | 0.152              | 0.251   |
| Comprehension                                      | 0.077   | 0.000 | 0.064              | 0.089   |
| Standard error. random intercept                   | 0.5325  |       |                    |         |

Table 17. Probability of misreporting: random intercept ordinal logistic model

| Variables  | Coef.  | P> z  | 95% Conf. Interval |        |
|--|--------|-------|--------------------|--------|
| Item   |        |       |                    |        |
| Additional payroll income                          | 2.194  | 0.000 | 1.912              | 2.475  |
| Additional self-empl. income                       | 2.561  | 0.000 | 2.284              | 2.839  |
| Primary self-empl. income                          | 3.432  | 0.000 | 3.161              | 3.704  |
| Additional income from pension                     | 1.528  | 0.000 | 1.235              | 1.822  |
| Income from deposits                               | 6.421  | 0.000 | 6.154              | 6.689  |
| Income from government bonds                       | 3.653  | 0.000 | 3.382              | 3.923  |
| Income from private bonds                          | 4.714  | 0.000 | 4.445              | 4.982  |
| Income from shares                                 | 4.031  | 0.000 | 3.761              | 4.301  |
| Income from mutual funds                           | 4.869  | 0.000 | 4.600              | 5.137  |
| Income from managed savings                        | 2.667  | 0.000 | 2.391              | 2.944  |
| Interests on financial liabilities                 | 4.839  | 0.000 | 4.571              | 5.107  |
| Income from actual rents                           | 3.066  | 0.000 | 2.793              | 3.340  |
| Income from imputed rents                          | 3.370  | 0.000 | 3.098              | 3.641  |
| Age  | 0.072  | 0.000 | 0.066              | 0.079  |
| Age squared  | 0.000  | 0.000 | 0.000              | 0.000  |
| Educational qualification (base: none)             |        |       |                    |        |
| Primary school certificate                         | 0.286  | 0.000 | 0.190              | 0.381  |
| Lower secondary school certificate                 | 1.058  | 0.000 | 0.931              | 1.185  |
| Upper secondary school diploma                     | 1.332  | 0.000 | 1.202              | 1.461  |
| University degree                                  | 1.471  | 0.000 | 1.333              | 1.609  |
| Geographical area (base: North)                    |        |       |                    |        |
| Center   | -0.189 | 0.000 | -0.233             | -0.146 |
| South and Islands                                  | -0.766 | 0.000 | -0.811             | -0.722 |
| Gender Female (base: male)                         | -0.259 | 0.000 | -0.297             | -0.222 |
| Work status (base: payroll employee)               |        |       |                    |        |
| Self-employed                                      | 0.636  | 0.000 | 0.573              | 0.698  |
| Not employed                                       | -1.172 | 0.000 | -1.226             | -1.118 |
| Quintiles of household wealth (base: 1st quintile) |        |       |                    |        |
| 2nd quintile                                       | 0.304  | 0.000 | 0.219              | 0.389  |
| 3rd quintile                                       | 0.388  | 0.000 | 0.316              | 0.460  |
| 4th quintile                                       | 0.443  | 0.000 | 0.385              | 0.501  |
| 5th quintile                                       | 0.649  | 0.000 | 0.594              | 0.704  |
| Proxy respondent on payroll income                 | 0.617  | 0.000 | 0.552              | 0.681  |
| Proxy respondent on self-employment income         | 0.469  | 0.000 | 0.340              | 0.599  |
| CAPI   | -0.072 | 0.000 | -0.113             | -0.032 |
| Edu-inter  | 0.710  | 0.000 | 0.619              | 0.802  |
| Sex-inter  | 0.297  | 0.000 | 0.257              | 0.337  |
| Age-inter  | 0.192  | 0.000 | 0.147              | 0.237  |
| Comprehension                                      | 0.046  | 0.000 | 0.035              | 0.057  |

(1) Income from financial transfers is omitted for multicollinearity. (2) Cut-offs and their standard errors are not displayed.

*Table 18.* Distribution of respondents according to the estimated number of response errors

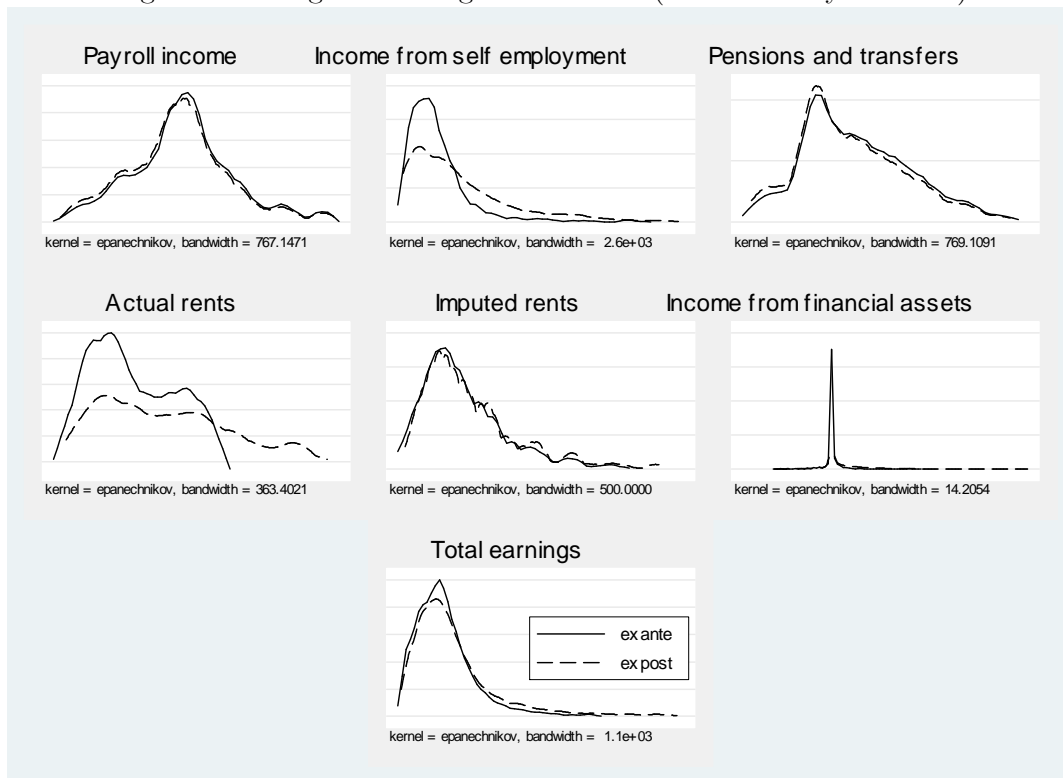
| Number of response errors | percent. | cum. percent. |
|---------------------------|----------|---------------|
| 0                         | 27.5     | 27.5          |
| 1                         | 18.4     | 45.9          |
| 2                         | 21.2     | 70.1          |
| 3                         | 17.4     | 84.5          |
| 4                         | 8.8      | 93.3          |
| 5                         | 3.8      | 97.1          |
| > 5                       | 2.9      | 100.0         |

*Table 19.* Response error by household tenths

| Household tenths       | percent. share of response error | mean (€) response error |
|------------------------|----------------------------------|-------------------------|
| up to 1st decile       | 0.0                              | 10                      |
| from 1st to 2nd decile | 0.1                              | 40                      |
| from 2nd to 3rd decile | 0.3                              | 192                     |
| from 3rd to 4th decile | 0.6                              | 430                     |
| from 4th to 5th decile | 1.2                              | 843                     |
| from 5th to 6th decile | 2.2                              | 1,523                   |
| from 6th to 7th decile | 4.0                              | 2,720                   |
| from 7th to 8th decile | 7.7                              | 5,265                   |
| from 8th to 9th decile | 16.7                             | 11,392                  |
| over the 9th decile    | 67.2                             | 45,815                  |

Average response error=4,013; Gini = 0.799.

Figure 1: Change in earnings distribution (kernel density estimate)



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