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Income underreporting among the self-employed: a permanent income approach

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Abstract

The consumption based method to estimate underreporting among self-employed, introduced by Pissarides and Weber (1989), is one of the workhorses in the empirical literature on tax evasion/avoidance. We show that failure to account for transitory income fluctuations in current income may overestimate the degree of underreporting by around 40 percent. Previous studies typically use instrumental variable methods to address the issue. In contrast, our access to registry based longitudinal income measures allows a direct approach based on more permanent income measures. This also allows us to evaluate the performance of a list of instruments widely used in the previous literature. Our analysis shows that capital income is the most suitable instrument in our application, while education and housing related measures do not seem to satisfy the exclusion restrictions.

Keywords: Income underreporting, tax evasion, self-employment, Engel curves, permanent income

JEL classification: D12, H24, H25, H26.

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1 Introduction

Recent years have seen an increase in the application of indirect measures of tax evasion. Slemrod and Weber (2012) even describe it as an "explosion in empirical research on tax evasion", and entreat researchers on tax evasion to enlist in the "credibility revolution" (Angrist and Pischke, 2010) in empirical econometrics.

One of the modern workhorses in empirical research on tax evasion is the Pissarides and Weber (1989) method (henceforth PW). It is a clever indirect method of estimating the degree of income underreporting by self-employed individuals, who arguably have much better opportunities to evade taxes than wage earners do. In a nutshell, the method is based on using excess food consumption among self-employed as smoking gun evidence of income underreporting. Based on survey data on consumption (and income, if the researchers do not have access to registry based income measures), the consumption and income relations (Engel curves) may shed light on the true incomes of self-employed.

In this paper, we address one of the key methodological problems of the PW method: researchers typically only have access to current income measures, while theory suggests that a more permanent measure of the household's consumption potential may be more relevant. We remain agnostic to which income measure that is the most empirically relevant. It seems unlikely that current consumption would only be related to total lifetime income. Theory would only suggest this when we abstract from credit restrictions, uncertainty and other realistic features. However, it is also unlikely that consumption would only be related to current income. Our presumption is that the truth lies somewhere in between these two extremes – i.e. we presume that the most relevant income measure is not yearly (current) income but a more permanent measure, which we, for expositional convenience, simply denote permanent income.

It is hard to account for the fact that current income is a noisy measure of permanent income, without access to permanent income. Transitory income fluctuations attenuate the estimate of the income elasticity of food consumption which in turn may lead to overestimation of underreporting among the self-employed. Previous studies acknowledge the importance of using more permanent income measures when modeling food consumption, but given the typical cross-sectional design of survey data, it has proven difficult to come up with a good measure of permanent income. Pissarides and Weber (1989) try to account for this through instrumental variable (IV) techniques, which has subsequently become the standard way of approaching the problem. However, the IV solution relies on somewhat arbitrary exclusion restrictions; it is very hard to find variables that are closely correlated with permanent income but have no independent association with consumption.

We try to solve this problem in a more direct way by using a unique feature of our consumption data. By merging the survey data on consumption to rich panel data from

official tax and income registers, we can move towards a measure of permanent income by averaging household income both forwards and backwards in time. We then investigate how the estimate of underreporting is affected as we extend the time window over which we aggregate income. Specifically, does the PW method overestimate underreporting due to transitory income fluctuations, and if so, by how much?

Our approach is closely related to the analysis in Hurst et al. (2014) who exploit the panel dimension of the Panel Study of Income Dynamics to mitigate the effects of transitory income fluctuations. In line with a potential story of reduced attenuation bias, they document an increase in the food income elasticity as they move from current income to a three-year average income measure. The increased income elasticity, however, does not carry over to a lower estimate of underreporting. Having access to longer panel data, we take a more systematic approach to investigate this issue. We isolate the effects of transitory income fluctuations on the estimate of underreporting by keeping the sample of households intact across all income definitions.

Our results are highly consistent with a substantial degree of attenuation bias. The estimated food income elasticity increases by more than 40 percent as we move from current income to a 7-year average measure of household income. As a result, the estimated degree of underreporting falls by more than one-third.

The second part of our paper addresses the usual way to deal with transitory income fluctuations, namely IV estimation.[1] Most previous studies in the literature have used IV (Engström and Holmlund, 2009, Schuetze, 2002, Kim et al., 2009, Pissarides and Weber, 1989, Kukk and Staehr, 2014, Johansson et al., 2005).[2] Given the difficulty to find instruments that satisfy the exclusion restriction, we believe that finding a relevant measure of permanent income is a better way to deal with transitory income fluctuations than IV. However, in cases where data limitations rule out the former strategy, the researcher must decide on the most suitable set of instruments. So far, we know very little about the relative performance of different instruments.

Since we have access to a good measure of permanent income, we are in a unique position to evaluate the performance of different sets of instruments that have been used in the literature. To our knowledge, this is the first paper that systematically does so. Our results show that capital income appears to be the best available instrument in terms of satisfying the exclusion restriction and producing estimates of the food income elasticity and income underreporting that are close to the "true" estimates using OLS and multiple-year averages of household income. Variables related to education and housing yield unreasonably large income elasticities and seem to belong both in the income and

[1] Due to the high quality of our registry based income data, we assume that the transitory fluctuations can be fully attributed to true transitory variation in household income, and not to classical measurement error in reported income.

[2] Lyssiotou et al. (2004) develop a related demand system approach, extending the basic PW model, that also relies on an instrumental variable approach.

food equations.

The remaining of the paper is organized as follows. Section 2 explains how we account for transitory income fluctuations in the PW method. Section 3 describes the data and the key variables that relate to food consumption, income and self-employment. Section 4 discusses the OLS and IV results. Section 5 provides some robustness checks and section 6 concludes.

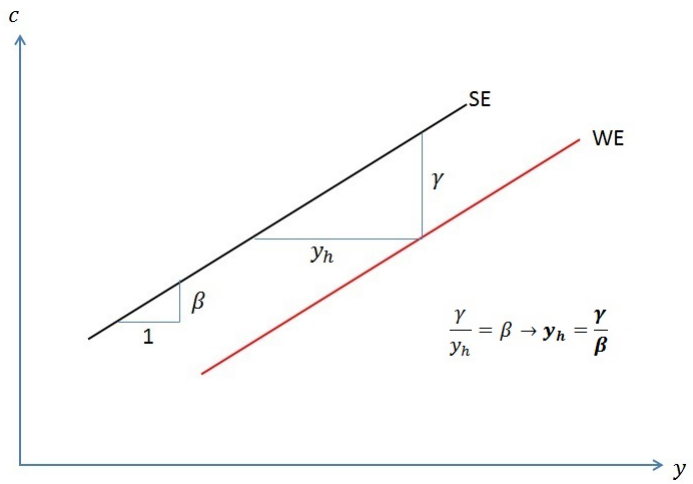
2 Estimating Underreporting of Income of the Self-employed

This section briefly describes the expenditure-based estimation approach, originally developed by Pissarides and Weber (1989). We then show how we account for the effects of transitory income fluctuations by using panel data on household income. We borrow notation from Engström and Holmlund (2009).

2.1 The basic model

The PW approach is illustrated by figure 1. Let c denote log food consumption, $c = \ln C^F$, and y log disposable income, $y = \ln Y^D$. The figure shows two log-linear Engel curves, one for self-employed households and one for wage earners. The intercept difference, γ, between these two curves reflect the degree of income underreporting among the self-employed.

Figure 1: Engel curves for wage earners (WE) and self-employed (SE)



Four central assumptions underlie this interpretation.[3] First, the elasticity of consumption with respect to income, β, is equal for the two groups. This is illustrated by the curves having the same slope. Second, there is no systematic misreporting of expenditures on food consumption between the two groups. The item of expenditure that most likely fulfills this assumption is food. There is little reason to lie about food consumption and it is also easy to report. Third, self-employed households systematically underreport their income by a constant factor, whereas wage earners are assumed to report their true incomes. If wage earners also underreport their income, the PW method will only provide a lower bound estimate. Finally, the researcher needs to assume that individuals who misreport their income in surveys misreport their income in the same way to the tax authorities. This is not a concern in our study since we collect information on household income from registry based data.

Pooling the data for self-employed households and wage earners, we can estimate the degree of underreporting among the self-employed by estimating an equation of the following form:

$$c_{it} = \mathbf{X}_i\alpha + \beta y_{it} + \gamma SE_{it} + \epsilon_{it} \tag{1}$$

where subscript i denotes household i, subscript t denotes year t, $\mathbf{X_i}$ is a vector of variables affecting consumption, SE_{it} is a dummy variable for self-employed households and ϵ_{it} is a random error term. The parameter, γ, captures the intercept difference between the two Engel curves. The fraction of true income reported by the self-employed, κ, is identified as $\exp(-\gamma/\beta)$ and we form the estimate $\hat{\kappa}$ as $\exp(-\hat{\gamma}/\hat{\beta})$ using the estimated coefficients from Eq. 1. Following Hurst et al. (2014), we express our results in terms of the amount that the self-employed underreport their income, which is given by $1-\kappa$.

The derivation follows directly from figure 1. The degree of underreporting, or hidden income y_h, is given by $y_h = y_T - y_r$, where y_T is the log of true disposable income and y_r is the log of reported disposable income. The figure shows that $y_h = \gamma/\beta$, which implies that $y_T = \gamma/\beta + y_r$. In "un-logged" form the relation can be written $Y_T = e^{\gamma/\beta}Y_r$ which gives $Y_r/Y_T = e^{-\gamma/\beta} \equiv \kappa$, where Y_r and Y_T denote reported and true incomes, respectively. It follows directly that $Y_h/Y_T = 1-\kappa$, since $Y_T \equiv Y_h + Y_r$, where Y_h denotes hidden disposable income.

2.2 Accounting for transitory income

According to the permanent income hypothesis, the relevant income measure to include in the estimated equation is permanent income as opposed to current income. This causes a problem since measures of permanent income are less often available. Most studies have instead relied on current income measures. This may result in overestimation of the

[3]Since the primary focus of this paper is the distinction between current and permanent income, we will not provide a thorough examination of the validity of all these assumptions.

income underreporting by self-employed. The reason for this can be derived as follows.

Suppose that permanent income y_{it}^p is what matters for consumption in the Engel curve above (Eq. 1), and that current income is just a "noisy" version of permanent income, so that $y_{it} = y_{it}^p + \omega_{it}$. Further, assume that $\mathrm{E}(\omega_{it} = 0)$, $\mathrm{Var}(\omega_{it}) = \sigma_\omega^2$ and that ω_{it} is uncorrelated with y_{it}^p and ϵ_{it}. Then we can re-write Eq. 1 as:

$$c_{it} = \mathbf{X}_i\alpha + \beta y_{it} + \gamma SE_{it} + v_{it} \tag{2}$$

where $v_{it} = -\beta\omega_{it} + \epsilon_{it}$. Transitory income fluctuations introduce attenuation bias in our estimates of β because $\mathrm{Cov}(y_{it}v_{it}) = -\beta\sigma_\omega^2 \neq 0$. Since the estimated degree of underreporting decreases in β, the attenuation bias will lead to overestimation of the true underreporting by self-employed.

Since measures of permanent income are rare, this causes a serious practical problem when applying the PW method. Several studies have used instrumental variable techniques to mitigate the effects of transitory income and measurement error. However, finding instruments that affect consumption only through permanent income is difficult, and it is impossible to directly test the exclusion restriction without access to permanent income.

We use a unique feature of our consumption data to solve this problem. By merging the consumption data to rich panel data from official tax and income registers, we can observe past and future income streams for each household that participates in the the household survey. Specifically, we move towards a measure of permanent income by averaging household income both forwards and backwards in time. If current income is a noisy proxy for permanent income, we expect to see an increase in the size of $\hat{\beta}$ and a corresponding decline in our estimate of the degree of underreporting, $1-\hat{\kappa}$, as we extend the time window over which we average income. Our access to a measure of permanent income also makes it possible to directly evaluate the performance of a set of instruments widely used in the previous literature.

The discussion above abstracts from a highly related problem addressed in Pissarides and Weber (1989). Pissarides and Weber (1989) recognize that current income may be a better approximation for permanent income for wage earners compared to self-employed. Self-employed typically have higher income fluctuations from year to year. They account for this by scaling (down) the estimate of underreporting by a factor that incorporates the relative income volatility between these two groups. However, this method does not address the fact that current income might be a bad proxy for permanent income for *both* groups, which is the focus of our study. By applying the correction procedure suggested by Pissarides and Weber (1989) we find that the higher volatility of self-employed income is a problem of second order compared to the problem of using current instead of permanent income. Table 12 in the appendix show that moving from current towards

permanent income has a much larger effect on the underreporting estimate than what controlling for between-group differences in income volatility has.

3 Data

3.1 Consumption survey (HUT)

The consumption data comes from the Swedish Household Budget Survey (Hushållensutgifter, HUT). The household data is presented annually by Statistics Sweden. Around 4,000 randomly selected households are approached each year, of which slightly more than half participate in the survey. We use data from 2003–2009 with a total number of households of 15,044. The HUT data contain no panel elements.[4]

The participating households are asked to report their consumption expenditures during randomly selected two-week periods using a detailed expense manager. The expenditures are then multiplied by 26 to represent annual consumption. The households should also note whether the expenditures are associated with a certain household member. Various other questions are asked as to get information on household characteristics, including employment status, age, occupation, type of housing and number of children.

3.2 Income data (LINDA)

To calculate household income, we use the register based longitudinal database LINDA, constructed to be cross-sectionally representative of the Swedish population each year.[5] The data set is large; it contains 3.35% of the Swedish population each year corresponding to over 300,000 individuals. Information about individuals' incomes come from official tax reports, so that the income variables are free from measurement errors that are common in survey data. Swedish register data on income are of very high quality because they are automatically third party reported (for wage earners) and are reported separately for different types of income.

We use LINDA from 2000–2012, which means that we can observe both past and future income streams of the households in the consumption survey. An additional advantage of using register data for incomes, is that we may directly interpret the results in terms of tax evasion/avoidance. Most studies using the PW method relies on survey data instead of register data. It is not obvious, however plausible, that a tax evading self-employed individual also underreport incomes in surveys. See Hurst et al. (2014) for an in depth discussion on this matter.

Because LINDA is at the individual level, we aggregate income for the members of a

[4]The design and main results of the HUT studies are presented in reports from Statistics Sweden (2003, 2004,... 2009).

[5](Edin and Fredriksson, 2000) provide a detailed account of the data collection process for LINDA.

given household to get household income. By construction of the HUT survey, one household member, referred to as the "sampled individual", is always part of LINDA. However, since LINDA and HUT use different household definitions, the remaining household members are not always part of LINDA. HUT households are self-reported and consist of individuals who share residence and have a common household budget. In LINDA, individuals must share residence and be registered as partners, or have children, in order to form a household. We will restrict the sample to households whose members are all part of LINDA.

3.3 Key variables and sample restrictions

The two key variables are annual food consumption and annual disposable income. Our main measure of food consumption is reported in the data as "food and alcohol purchases plus meals out". There are several reasons why food consumption is a suitable measure when applying the expenditure based approach. First, it is assumed to be mundane enough for individuals not to be afraid of reporting truthfully. An attractive feature is also that food needs to be bought often – yearly food expenditure is most likely better approximated by two weeks purchases than what e.g. yearly clothes expenditure is. Finally, it is less likely to be registered as a business expense, in which case it would be unclear how the expense was reported to the HUT survey, than most other expenditure categories.

Our main measure of household income is disposable income. Current income is defined as the household's disposable income for the relevant HUT year. Disposable income is based on all types of (register based) income, including transfers, income from labor and self-employment and capital income. Taxes are deducted from gross income to get household disposable income.[6] We use past and future income records to create multiple-year average measures of income. This approach has been used by many others in the literature to construct measures of permanent income (Solon, 1992, Gottschalk et al., 1994, Hurst et al., 2014). For each household in year t, we compute income measures that average income between $t - i$ and $t + i$ where i ranges from 0 to 3. The effect of moving from current income to permanent income is illustrated by extending the time window from $i = 0$ (no lag) to $i = 3$ (7-year average). For this to work, we restrict the sample to "stable" households that exist in LINDA in all 7 years between $t-3$ and $t+3$.[7]

[6]Transfers consist of both taxable transfers, such as sick pay and unemployment benefits, and tax-free transfers, such as child allowances and social assistance payments. Capital income refers to interest income, dividends and net capital gains.

[7]There are three potential reasons why households do not exist in LINDA in all 7 years. First, a household is removed from LINDA if the sampled household member dies or emigrates. Second, the household of a sampled person is removed if the adult members of the household no longer share residence or are no longer registered as partners. Third, new individuals are added to LINDA each year to ensure that each cross-section of LINDA is representative for the whole population (Edin and Fredriksson, 2000).

3,052 households are dropped as a result.

We impose that household income must be positive not only for the current year, but also for all measures of permanent income. We also exclude households with income from farming. Households with negative income or zero reported food expenditures are also dropped from the sample. We restrict the sample to households where the household head is between 18 and 67 years old. As a result of these sample restrictions, 1,705 households are dropped. As mentioned in section 3.2, we restrict the sample to households that are the same in HUT and LINDA. 1,119 households are dropped as a result.[8] We are then left with 9,164 households.

Self-employment status of the household is based on information in LINDA. We define self-employed households as being a household where at least one of the adult members either report positive active business income or are considered as being connected to a closely held corporation (CHC).[9] As a robustness check, we employ two alternative definitions of self-employment that have been used in the literature. First, we define self-employment based on self-reported employment status in the HUT survey. Second, we define self-employed households as households with reported income from self-employment of at least 25 percent of total reported income.

As a first step, a household is classified as self-employed if the household is classified as self-employed in year t. We refer to this as the "unrestricted" definition of self-employment as households might transition from self-employment to employment (or vice versa) during the other years. To account for such transitions, our second definition is more restrictive, requiring that households are consistently classified as self-employed in all seven years. Dropping households that transition between self-employment and employment, we are ultimately left with 7,728 households, of which 811 are self-employed. We refer to the resulting sample as the "restricted" sample. Since the empirical relevance of this distinction is not known a priori, we report estimation results for both samples.

3.4 Differences between wage earners and the self-employed

Table 1 reports descriptive statistics for the self-employed and the wage earners in the unrestricted sample (columns (1) and (2)) and in the restricted sample (columns (3) and (4)). On average, self-employed in the restricted sample are somewhat older, have marginally higher incomes and have larger houses than the self-employed in the unre-

[8] Cohabiting couples without common children should be overrepresented in this group. We therefore expect these households to be younger and smaller in size. We also expect their incomes to be lower as we aggregate income over an incomplete set of household members. Table 11 in the appendix confirm these observations. Koijen et al. (2014) also note that HUT and LINDA use different household definitions. Using HUT data from 2007, they find that 85% of the households have the same number of adults in LINDA, which comes very close to what we find.

[9] The relevant variables are nakte ("inkomst av aktiv enskild näringsverksamhet"), nakthb ("inkomst av aktiv näringsverksamhet för delägare i handelsbolag") and *bfoab* ("kod för samgranskning med fåmansföretag"). This definition is used by Bastani and Selin (2014).

Table 1: Descriptive statistics

	Unrestricted sample		Restricted sample	
	(1)	(2)	(3)	(4)
	Self-employed	Wage earners	Self-employed	Wage earners
Food expenditure	11.01	10.83	11.03	10.82
	(0.600)	(0.622)	(0.590)	(0.625)
Current disposable income	12.97	12.86	12.97	12.85
	(0.584)	(0.522)	(0.589)	(0.514)
Disposable income 3-year average	12.99	12.86	12.99	12.85
	(0.549)	(0.496)	(0.535)	(0.493)
Disposable income 5-year average	13.00	12.86	13.01	12.85
	(0.534)	(0.490)	(0.530)	(0.489)
Disposable income 7-year average	13.00	12.86	13.01	12.85
	(0.520)	(0.485)	(0.513)	(0.484)
Age	47.94	46.76	49.32	46.75
	(10.08)	(11.02)	(9.575)	(11.05)
Household size	3.330	3.001	3.309	2.969
	(1.367)	(1.417)	(1.360)	(1.419)
High school	0.459	0.454	0.480	0.456
	(0.499)	(0.498)	(0.500)	(0.498)
College	0.383	0.399	0.334	0.396
	(0.486)	(0.490)	(0.472)	(0.489)
Single family house	0.662	0.582	0.671	0.573
	(0.473)	(0.493)	(0.470)	(0.495)
Size of house (m2)	138.1	116.3	140.4	114.6
	(52.47)	(47.54)	(51.86)	(46.63)
Property tax	7.162	5.675	7.462	5.544
	(3.559)	(4.147)	(3.323)	(4.179)
Capital income	6.444	4.783	6.733	4.663
	(4.422)	(4.179)	(4.454)	(4.147)
Observations	1454	7710	811	6917

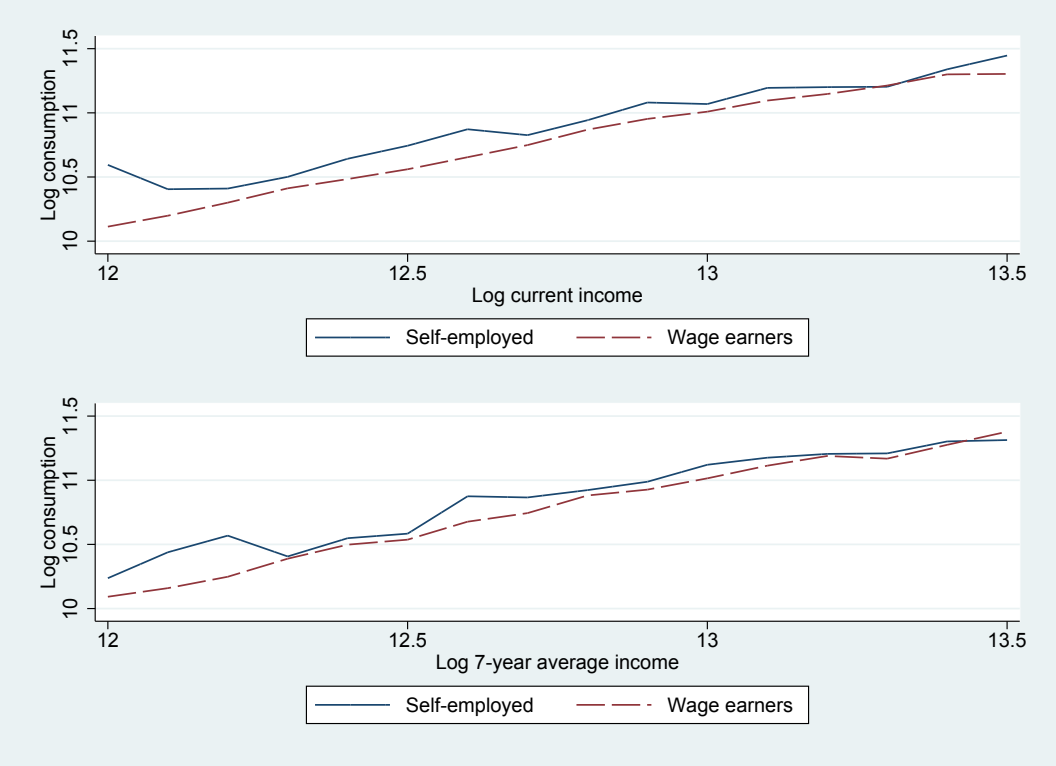
Note: This table reports summary statistics for self-employed and wage earners. All numerical variables are converted to constant 2013 Swedish Crowns (SEK; 1 USD = 6.5 SEK in 2013) and are reported in logged form. For capital income and property taxes, we add one before taking logs. In the unrestricted sample, a households is classified as self-employed if the household is classified as self-employed in year t. The restricted sample consists of households that are consistently classified as either self-employed or wage earners in all 7 years between $t-3$ and $t+3$.

stricted sample. Wage earners, on the other hand, do not differ much across the two samples.

Focusing on between-group differences, spending on food is higher among the self-employed. The self-employed also have higher incomes, but they consume more relative to their income than wage earners. The difference amounts to around 1 percentage point, which is similar to what Hurst et al. (2014) find. As expected, the self-employed have more volatile income than wage earners. They are also slightly older, more likely house owners and have larger households. They have the same education level as wage earners, on average.

Figure 2 plots the relationship between food consumption and disposable income for

Figure 2: Relationship between food consumption and income (bins)



wage earners and self-employed, respectively. Specifically, we plot the average of log food consumption for equally spaced income bins for households with incomes between the 5th and 95th percentiles. The upper panel uses current income and the lower panel uses our 7-year average income measure. First we see that the Engel curve for the self-employed lies above the Engel curve for the wage earners over essentially the entire income range. In other words, for a given amount of income, self-employed spend more on food than wage earners. Second, the Engel curves converge at lower income levels when me move from current income to 7-year average income. This is consistent with a potential story that the reduction in attenuation bias that follows from taking out transitory income fluctuations is most important at the lower end of the income distribution. Third, from visual inspection the central assumption of equal slopes seem to hold. We formally test this by adding an interaction term between the self-employment dummy and the relevant income measure to Eq. 2. As seen in Table 13 in the appendix, the estimates of the interaction term are insignificant across all income measures.

4 Estimation results

In this section, we present the results from estimating Eq. 2. That is, we regress log food consumption on log disposable income and a set of control variables. The latter include age, age squared, number of children, a house owner dummy, six dummies for H-region and year dummies. The OLS regressions also control for the set of variables that are used as instruments in the IV analysis, including two dummies for high school and college (the reference category is elementary school), single family house, size of house (square meters), log property taxes and log capital income. We report four sets of estimates of both β and γ and the corresponding estimated amount of underreporting $1 - \kappa$, one for each income measure.

We begin by discussing the results from the unrestricted specification, that is, we define self-employed households as households in which at least one member was self-employed in year t. The results are reported in Table 2. The estimates of γ are positive and significant in all four specifications. The interpretation is that self-employed spend around 7 percent more on food relative to wage earners with the same reported income. The γ estimates are roughly stable when moving towards permanent income.

We also see that the estimates of β increase substantially as the time window used to construct the income measure is extended. Column (1) shows that the food income elasticity amounts to 0.26 when we use current income, while the 7 year permanent income measure gives a β estimate of 0.40. Furthermore, the β estimate increases substantially when moving from current income to the 3-year measure of permanent income. When subsequently moving to the 5 and 7-year measures the additional increases in the β estimate become smaller and smaller, indicating that the estimate has more or less stabilized when using the 7-year measure.

The estimates of underreported income, $1 - \kappa$, mirror the pattern seen for the β estimates; we see a large initial drop from 0.25 to 0.19 when moving from current income to 3-year average, followed by increasingly smaller drops as we extend the time window over which income is aggregated.

The overall results are highly consistent with a substantial degree of attenuation bias in the β estimate based on current income. The attenuation bias is remedied when moving towards a measure of permanent income – the β estimate increases and the estimate of underreported income decreases. Due to the covariance between estimates from the different specifications, it is not straightforward to determine whether the drop in estimated underreporting is statistically significant. When disregarding the potential covariance, we get a t-value of 2.95 when comparing the estimated income elasticity between current income and the 7-year average income measure. However, since the covariance is likely positive, this is a conservative estimate that probably underestimates the statistical difference in the β estimates.

Table 2: Estimation results, unrestricted sample

	(1) Current income	(2) 3-year average	(3) 5-year average	(4) 7-year average
β	0.259***	0.345***	0.368***	0.398***
	(0.0358)	(0.0318)	(0.0337)	(0.0306)
γ	0.0728***	0.0726***	0.0672***	0.0678***
	(0.0226)	(0.0227)	(0.0227)	(0.0226)
1-κ	.245	.19	.167	.157
se $1-\kappa$	.069	.054	.052	.049
R2	0.408	0.417	0.420	0.423
No of SE	1454	1454	1454	1454
Obs	9164	9164	9164	9164

Note: This table shows the OLS estimates of the log-linear Engel curve from Eq. 2. The income elasticity is denoted as β and the coefficient on the self-employment dummy is denoted γ. We estimate the regression for different measures of household income (indicated across the columns). $1-\kappa$ is the estimated amount of underreporting of the self-employed, using the estimates of β and γ. The standard list of controls include age, age squared, number of children, number of adults, six dummies for H-region and year dummies. In addition, all OLS regressions control for the set of variables that are used as instruments in the IV analysis, including two dummies for high school and college, a dummy for single family house, size of house, log property taxes and log capital income. Robust standard errors in parentheses. We use the delta method to calculate standard errors (se) for the degree of underreporting $1-\kappa$. Sample weights are used in all estimations.

The panel dimension of the data, and the ambition to think in terms of permanent measures as opposed to current measures, highlight a general problem with the PW method. The method generally relies only on current self-employment status. If this status is a bad proxy for permanent status the possibilities to underreport income may change dramatically over years. As an extreme example we can imagine a household that has wage earner status all years except the HUT year, in which it has self-employment status and reports much lower income than the true income. When adding past and future incomes for such a household, we are adding the true incomes. The estimate of underreporting may therefore be attenuated when not controlling for passed and future employment status. In the next subsection we will therefore restrict the sample to households that remain self-employed or wage earners for the whole period, i.e. from 3 year before the HUT year until 3 years after the HUT year.

4.1 Persistence in self-employment status

In this subsection we will address the problem that self-employment status is not permanent. As seen from Table 3 there is rather high persistence in the employment status. The results from the table can be summarized as: if a household is self-employed in period t, the chance that it is self-employed in t+1 or t-1 is roughly 85 percent. The persistence

in status is thus high but still far from permanent.

Table 3: Persistence of self-employment status

	t-3	t-2	t-1	t	t+1	t+2	t+3
Fraction self-employed	0.693	0 .762	0.872	1	0.848	0.734	0.657

Note: Fraction of households self-employed in HUT-year that were also self-employed in year $t - i$.

We therefore restrict the sample to households that are categorized as self-employed or wage earners throughout the whole 7-year period, and reestimate the specifications in Table 2. The results are reported in Table 4. Using the restricted sample yields higher estimates of γ. For example, column (1) shows that self-employed now spend 11 percent more on food relative to wage earners with the same reported current income. This is what we would expect when we switch from a noisy indicator of self-employment to a more stable measure. As a result, the estimates of $1 - \kappa$ estimates are somewhat larger than the corresponding estimates in Table 2. However, the pattern seen in Table 2 when moving towards a measure of permanent income is perfectly reproduced in Table 4 – the β estimate increases and the estimate of underreported income decreases.

Table 4: Estimation results, restricted sample

	(1) Current income	(2) 3-year average	(3) 5-year average	(4) 7-year average
β	0.291***	0.365***	0.384***	0.418***
	(0.0354)	(0.0390)	(0.0407)	(0.0364)
γ	0.110***	0.108***	0.101***	0.102***
	(0.0262)	(0.0264)	(0.0260)	(0.0260)
1-κ	.316	.257	.232	.217
se $1 - \kappa$	.064	.056	.054	.05
R2	0.418	0.425	0.428	0.431
No of SE	811	811	811	811
Obs	7728	7728	7728	7728

Note: This table shows the OLS estimates of the log-linear Engel curve from Eq. 2. The income elasticity is denoted as β and the coefficient on the self-employment dummy is denoted γ. We estimate the regression for different measures of household income (indicated across the columns). $1 - \kappa$ is the estimated amount of underreporting of the self-employed, using the estimates of β and γ. Same control variables as in Table 2. Robust standard errors in parentheses. We use the delta method to calculate standard errors (se) for the degree of underreporting $1 - \kappa$.

Thus, using a more persistent measure of self-employment instead of current self-employment status is empirically irrelevant for the magnitude of the decline in underreporting that is due to reduced attenuation bias. However, because the estimated *level* of

underreporting depends on this definition, we will use the more restrictive definition in the remaining analyses of this paper.

4.2 IV results

The usual way of dealing with the attenuation bias in the estimate of β is through instrumental variable methods. The list of instruments used in the literature is very long: housing related variables, education, employment of the spouse, nationality and gender of the household head, and measures of capital income. As always when using IV methods, the suitability of the chosen instruments hinges on the exclusion restriction. The instruments are often somewhat arbitrarily excluded from the list of covariates and elevated to instrument variable status. To our knowledge, no study has systematically evaluated the performance of different sets of instruments.[10] We are in a unique position to do so. Since we have access to a good proxy for permanent income, we are able to evaluate the performance of different sets of instruments and explicitly test the exclusion restriction. We focus on three commonly used sets of potentially valid instruments: education, housing related variables and capital income.

In Table 5 we treat the estimates from Table 4 above as "the truth". Column (1) of Table 5 replicates the OLS estimates of column (4) in Table 4. We then compare the performance of the three separate families of instruments that are most frequently used in the previous literature. The instruments are separated into three categories: housing, education and capital income. The housing category includes log property taxes[11], house size and a dummy for single family house; the education category is captured by two dummies for high school and college, respectively; and the capital income measure is defined as log taxable capital income.[12] The estimation results from these IV specifications are reported in columns (3), (5) and (7). As before, we use the estimates of β and γ to construct estimates of $1-\kappa$. We also report first-stage F-statistics and p-values from the Sargan test of overidentifying restrictions.

Because the instruments we use are part of the usual set of controls, the set of controls will be different across the IV specifications. The IV controls will also be different from those used in the previous OLS analysis. To facilitate comparison, columns (2), (4) and (6) report the OLS estimates that are based on the same set of controls used in the IV

[10] Hurst et al. (2014) evaluate the performance of educational attainment as an instrument for household income. They do this by comparing the IV estimate of the food income elasticity for current income to the OLS estimate using a three-year average income measure. They find that the IV and OLS specifications produce similar estimates of β, which they interpret as evidence of instrument validity.

[11] The property tax amount to approximately 1 percent of the assessed value of the house. The property tax was replaced by a (fixed) property fee in 2008. The relevant variables in LINDA are sfast ("fastighetsskatt") and sfavg ("fastighetsavgift"). Around 66 percent of the households pay property tax.

[12] The relevant variable is kkaps ("statlig taxerad inkomst av kapital"). This variable is restricted to be positive. Around 62 percent of the households have positive taxable income from capital.

Table 5: IV estimation results, restricted sample

	Ref.	Education		Housing		Capital income	
	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) IV	(6) OLS	(7) IV
β	0.418	0.445	1.281	0.441	0.657	0.421	0.399
γ	0.102	0.096	0.218	0.110	0.146	0.105	0.122
$1-\kappa$	0.217	0.194	0.156	0.220	0.199	0.221	0.263
se $1-\kappa$	0.050	0.048	0.028	0.048	0.038	0.050	0.065
First stage F-stat	.	.	47.724	.	98.956	.	83.227
Sargan p-value	.	.	0.655	.	0.001	.	.

Note: This table shows the IV estimates of the log-linear Engel curve from Eq. 2 for different instruments. The instruments used in columns (3),(5) and (7), respectively, are education (two dummies for high school and college), housing (log property taxes, house owner and square meters) and log capital income with the corresponding OLS estimates given in columns (2), (4) and (6). Each specification includes the complete set of controls (see Table 2) minus the relevant instruments. Column (1) reproduces column (4) of Table 2, our main OLS specification using the 7-year average income measure. The last row reports the p-value from the Sargan test for over-identification (only for multiple instruments).

specifications of columns (3), (5) and (7), respectively. As seen from the table, the exact choice of controls only has a marginal effect on the OLS estimates.

The results show that the estimates of the food income elasticity vary substantially across the IV specifications. The education instrument yields an estimate of β greater than one compared to 0.66 for housing. Using capital income as instrument yields a β estimate of 0.40, which comes very close to the "true" estimate of 0.42 given in column (6). It is also consistent with many empirical studies that find that food is a relative necessity.

The estimates of underreported income, $1-\kappa$, again mirror the pattern seen for the β estimates. The estimated underreporting is 15.6 percent and 19.9 percent for the education and housing estimates, respectively, which is lower than the corresponding OLS estimates. The negative effect of higher β on the estimated underreporting is partially offset by higher estimates of γ. The estimated underreporting for the capital income specification is 26.3 percent.

The fact that the β estimates are very different across instruments raise concern about the validity of the instruments. It is clear from the F-statistics that the instruments are relevant, i.e. have an impact on log disposable income. Capital income and housing related variables are most strongly correlated with income with F-statistics of 83.2 and 99.0, respectively. However, it is less clear that the exclusion restrictions hold for all the instruments. In general, it is impossible to test the exclusion restriction. However, since we have a good measure of permanent income we can provide an explicit test of the exclusion restrictions, under the assumption that our 7-year average captures the relevant

relation between income and consumption. We do this by estimating Engel curves based on the 7-year average income measure and the three different sets of instruments. If the exclusion restriction holds, the instruments should be statistically insignificant. We perform F-tests of joint significance of the separate sets of instruments. The results are reported in Table 6.

Table 6: Testing the exclusion restriction

	(1)
Disposable income 7-year average	0.418***
	(0.0364)
Education	
High school	0.0548**
	(0.0236)
College	0.142***
	(0.0253)
Housing	
Single family house	0.0183
	(0.0260)
Size of house (m2)	-0.000180
	(0.000281)
Property tax	0.00823**
	(0.00340)
Capital income	
Capital income	0.00192
	(0.00197)
F-test education	18.871
p-value	0.000
F-test housing	6.502
p-value	0.000
F-test capital	0.953
p-value	0.329
R2	0.431
Obs	7728

Note: This table reports estimates from regressing log food consumption on our 7-year average income measure and each set of instruments used in Table 5. We also include the standard list of controls (see table 2).

We first note that education has a significant effect on food consumption. The F-test rejects the null hypothesis that the two education dummies are jointly equal to zero. The corresponding F-test for the housing variables is also statistically significant with a p-value close to 0. Capital income, on the other hand, does not have a direct effect on

food consumption when controlling for permanent income. The p-value of the F-test is equal to 0.33.

The housing and education variables appear to be directly related to food expenditure, in addition to their relation to income, and they also produce unreasonably large income elasticities. If they belong in the estimated model, they should be used as controls rather than instruments. Capital income appears to be the best available instrument in terms of satisfying the exclusion restriction and producing income elasticities that are close to the "true" elasticity.

5 Robustness

Some studies, including this one, define self-employment based on reported business income (e.g. Pissarides and Weber (1989), Schuetze (2002), Kukk and Staehr (2014)). An alternative approach is to use self-reported employment status to determine whether a household is self-employed or not (e.g. Engström and Holmlund (2009), Hurst et al. (2014), Johansson et al. (2005), Kim et al. (2009)). As an alternative to the income-based definition, we define self-employed households as households where at least one of the adult members consider themselves as being self-employed.[13] Even though self-reported employment status is only available for the current HUT year, this definition is more likely to capture persistent self-employment than our unrestricted, income-based definition of self-employment. This is confirmed by Table 7, which reports the fraction of self-employed households for each self-employment definition and across all sample restrictions. The fraction of self-employed households using the income-based definition is consistently higher across all sample restrictions but the last.

Table 7: Self-employment shares across sample restrictions

	Obs	Share SE (income-based def.)	Share SE (self-reported def.)
Original sample	15044	0.142	0.110
Stable households	11992	0.150	0.115
General restrictions	10287	0.154	0.130
HUT $\subset$ LINDA (unrestr)	9164	0.159	0.130
Persistent SE status (restr)	7728	0.105	0.102

Note: Column (1) describes the restrictions we impose to the original sample, column (2) reports the share of self-employed households according to our main definition of self-employment and column (3) reports the share of self-employed households according to self-reported self-employment status.

[13]The survey asks individuals to report their main occupation. The alternatives include: employed, self-employed in unincorporated company ("enskild näringsidkare"), self-employed in an incorporated company ("aktiebolag"), farmer, student, unemployed, retired and "other".

We reestimate the specifications in Table 4 on the restricted sample and use self-reports to define self-employment. The results are presented in Table 8. All β and γ estimates are remarkably close to the corresponding estimates in Table 4. Again we see that the estimated underreporting decreases by more than 30 percent when we move from current to permanent income.

Table 8: Self-reported self-employment status

	(1) Current income	(2) 3-year average	(3) 5-year average	(4) 7-year average
β	0.291***	0.365***	0.385***	0.418***
	(0.0355)	(0.0390)	(0.0407)	(0.0364)
γ	0.115***	0.116***	0.109***	0.108***
	(0.0280)	(0.0282)	(0.0281)	(0.0280)
1-κ	.326	.272	.248	.228
se $1-\kappa$	.068	.059	.058	.054
R2	0.418	0.425	0.428	0.432
No of SE	788	788	788	788
Obs	7728	7728	7728	7728

Note: Same as Table 4 except that we use self-reported employment status to define self-employed households. Restricted sample.

We also reestimate the IV specifications in Table 5 to check whether the IV results are robust to using self-reported self-employment status. Table 9 reports the results. It turns out that the estimates are very similar to the previous IV estimates, which strengthens the conclusion that capital income is preferable to the other two sets of instruments.

Table 9: IV estimation results, self-reported SE status

	Ref.	Education		Housing		Capital income	
	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) IV	(6) OLS	(7) IV
β	0.418	0.445	1.322	0.441	0.654	0.421	0.393
γ	0.108	0.093	0.218	0.116	0.147	0.111	0.125
$1-\kappa$	0.228	0.189	0.152	0.232	0.201	0.232	0.272
se $1-\kappa$	0.054	0.052	0.027	0.051	0.039	0.053	0.070
First stage F-stat	.	.	47.724	.	98.956	.	83.227
Sargan p-value	.	.	0.595	.	0.001	.	.

Note: The same as Table 9 except that we use self-reported employment status to define self-employed households.

Finally, we test whether the results are robust to defining households as self-employed if they report having business income above a certain share of total income. The advantage of this definition is that we capture households that have a sizable part of their income from self-employment. Specifically, we follow Pissarides and Weber (1989) and define self-employment as consisting of all households with reported income from self-employment of at least 25 percent of total income from labor. The results from reestimating Table 4 using the share of business income to define self-employment are reported in Table 10. The sample of self-employed households is restricted to households that are consistently classified as self-employed in all 7 years. The sample of wage earners include households with zero reported income from self-employment in all 7 years. As expected, using a less generous definition of self-employment, the share of self-employed households drops. Out of 7,481 households, 565 are now defined as self-employed. The results are consistent with our previous results.

Table 10: Defining self-employment based on the share of business income to total income

	(1) Current income	(2) 3-year average	(3) 5-year average	(4) 7-year average
β	0.292***	0.367***	0.382***	0.415***
	(0.0374)	(0.0410)	(0.0422)	(0.0377)
γ	0.0932***	0.0952***	0.0866***	0.0884***
	(0.0312)	(0.0315)	(0.0315)	(0.0315)
1-κ	.273	.228	.203	.192
se $1-\kappa$	.08	.068	.068	.062
R2	0.415	0.423	0.425	0.428
No of SE	565	565	565	565
Obs	7481	7481	7481	7481

Note: Same as Table 4 except that we define self-employed households as households with at least 25 percent of total reported income from labor being self-employment income in all 7 years. Wage earners include households with zero reported income from self-employment in all years. For CHC-owners, self-employment income is defined as the sum of income from self-employment, dividend payments and wage income.

6 Conclusions

In this paper, we analyze to what extent the Pissarides and Weber (1989) expenditure-based approach to tax evasion overestimates income underreporting among the self-employed due to transitory income fluctuations. A unique feature of our data allows us to merge the survey data on consumption to rich panel data from official tax and income registers. Transitory income fluctuations may cause an attenuation bias in the estimate of the food income elasticity. We mitigate this bias by moving towards a measure of permanent income by averaging household income both forwards an backwards

in time.

Our results are highly consistent with a substantial degree of attenuation bias. The estimated food income elasticity increases by more than 40 percent as we move from current income to a 7-year average measure of household income. As a result, the estimated degree of underreporting falls by more than one-third. The results are robust to various definitions of self-employment.

Previous studies try to account for transitory income fluctuations through instrumental variable techniques. Since we have access to a good measure of permanent income, we evaluate the performance of different sets of instruments that have been used in the literature. Our results show that capital income appears to be the best available instrument in terms of satisfying the exclusion restriction and producing estimates of the food income elasticity and income underreporting that are close to the "true" estimates using OLS and multiple-year averages of household income. Variables related to education and housing yield unreasonably large income elasticities and seem to belong both in the income and food equations.

We conclude that it is empirically relevant to account for transitory income fluctuations when applying the PW method. The preferred way of doing this is by constructing relevant measures of permanent income. However, when lacking panel data, our analysis also show that capital income performs well as an instrument for permanent income, while education and housing related variables does not satisfy the exclusion restriction in our application. The latter conclusion contrasts Hurst et al. (2014), who find, in a similar analysis using US data, that education measures performs well as instruments of permanent income.

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Appendix

Table 11: Descriptive statistics matched and non-matched households

	(1) Not matched	(2) Matched
Self-employed	0.123	0.159
	(0.328)	(0.365)
Food expenditure	10.90	10.86
	(0.544)	(0.622)
Current disposable income	12.40	12.88
	(0.673)	(0.533)
Disposable income 3-year average	12.44	12.88
	(0.633)	(0.507)
Disposable income 5-year average	12.46	12.88
	(0.612)	(0.500)
Disposable income 7-year average	12.47	12.88
	(0.609)	(0.493)
Age	44.28	46.95
	(12.59)	(10.88)
Household size	2.820	3.053
	(1.239)	(1.415)
High school	0.465	0.455
	(0.499)	(0.498)
College	0.397	0.396
	(0.490)	(0.489)
Single family house	0.455	0.595
	(0.498)	(0.491)
Size of house (m2)	110.6	119.7
	(56.03)	(49.00)
Property tax	4.017	5.911
	(4.155)	(4.095)
Capital income	3.539	5.047
	(4.391)	(4.262)
Observations	1123	9164

Note: This table compares households that did not have the same composition in HUT and LINDA (not matched) to those that had (matched).

Table 12: Alternative estimates of $1-\kappa$ with PW income volatility adjustment

	(1) Current income	(2) 3-year average	(3) 5-year average	(4) 7-year average
β	0.291***	0.365***	0.384***	0.418***
	(0.0354)	(0.0390)	(0.0407)	(0.0364)
γ	0.110***	0.108***	0.101***	0.102***
	(0.0262)	(0.0264)	(0.0260)	(0.0260)
1-κ	.316	.257	.232	.217
se $1-\kappa$	.064	.056	.054	.05
$\hat{\sigma}^2_{yS} - \hat{\sigma}^2_{yW}$	0.128	0.092	0.092	0.083
PW $1-\kappa$	0.270	0.222	0.195	0.184
R2	0.418	0.425	0.428	0.431
No of SE	811	811	811	811
Obs	7728	7728	7728	7728

Note: This table shows the OLS estimates of the log-linear Engel curve from Eq. 2. This table is a replica of Table 2 and adds the estimates of $1-\kappa$ using the PW income volatility adjustment as outlined by Hurst et al. (2014) (online appendix).

Table 13: Equality of slopes

	(1) Current income	(2) 3-year average	(3) 5-year average	(4) 7-year average
β	0.299***	0.377***	0.396***	0.431***
	(0.0397)	(0.0429)	(0.0449)	(0.0396)
$\beta * \gamma$	-0.0451	-0.0765	-0.0718	-0.0806
	(0.0536)	(0.0590)	(0.0604)	(0.0590)
t-test slope (p-value)	0.400	0.195	0.234	0.172
R2	0.418	0.426	0.428	0.432
No of SE	811	811	811	811
Obs	7728	7728	7728	7728

Note: This table reports the OLS estimate of the log-linear Engel curve from Eq. 2 after adding an interaction term between the self-employment dummy and the relevant income variable. The estimates of the interaction term reflect whether the assumption of equal slopes between self-employed and wage earners holds or not under each income measure.

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