

***SELF-EMPLOYMENT INCOME GAP IN GREAT BRITAIN: HOW
MUCH AND WHO?***

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This paper utilises an expenditure survey-based data set that is rich in terms of observable characteristics to estimate the ‘income gap’ (defined to be one minus the proportion of reported to true income) of the self-employed in Great Britain. It also estimates the evasion response of the individual characteristics of the self-employed. It emerges that self-employed report, on average, around 80.4 percent of their income to the tax authority, which translates into an income-gap of 19.6 percent which varies significantly by sex, age, and region. In particular, male self-employed taxpayers underreport more than female ones, and they, in general, become more compliant as they age. Particular emphasis is paid to verifying that the income gap observed cannot be explained by other reasons than underreporting.

Keywords: Income-gap; tax compliance; tax evasion; shadow economy; self-employed.

JEL Codes: H26, O17, D12, E26

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I. INTRODUCTION

Tax noncompliance—taken to be, in its broader form, illegal tax evasion of one’s tax liabilities, either deliberate or from ignorance—undermines revenues, distorts competition (since it puts noncompliant taxpayers at an advantage) and increases inequality. Unsurprisingly, therefore, over the past few years enhancing tax compliance has been a central policy concern of governments in many countries across the world. Tackling non-compliance necessitates an understanding of the scale of the phenomenon and, importantly, its determinants. And this is the objective of this paper using a ‘traces-of-true-income’ approach.

Direct measurement of tax non-compliance is notoriously difficult and involves a substantial deployment of resources. Considering the limitations of the direct measurement of non-compliance, the literature has utilized indirect approaches that seek to reveal traces of true income and, in particular, the use of expenditure and income patterns. There are many advantages for the use of indirect methods: 1) they support a lower cost as they are typically a by-product of an existing dataset; 2) they are an independent source of data to the tax administration and thus allow the triangulation of the estimates obtained from register sources; 3) they are available to tax administrations that either do not have the technology or the resources available to measure non-compliance directly or do so in a non-random manner; 4) they are not dependent on the accuracy behind self-reported non-compliance nor on the ability of the auditors to uncover the behavior; 5) they are available on a more timely manner allowing to track non-compliance along time; 6) they count with a wider set of observables than tax records do which allows interrogating different aspects of non-compliance. Though indirect methods are not, of course, free of problems (such as, selection bias and untruthful responses) there has been recently a call for the need to increase the credibility of these methods in measuring non-compliance, Slemrod and Weber (2011).

The aim of this paper is threefold. First, we revisit the measurement of the income-gap (defined to be proportion of true income which evaded) of the self-employed in Great Britain using an extended version of the household expenditure survey (Living Costs and Food Survey–LCFS). We focus particularly on the self-employed who are of interest for two reasons: 1) the self-employed have been shown to systematically underreport their income. Self-employment income, as opposed to employment income, is not subject to third-party reporting providing them with a distinct opportunity to underreport; 2) self-employment has become an increasingly popular labour choice in Europe (and especially in the UK) in the aftermath of the financial crisis, bringing back the importance of monitoring and understanding the traits that correlate to non-compliance for this particular group.¹

The second aim of the paper is to contribute to the reliability of the expenditure-based method by critically assessing the merits of the approach in measuring non-compliance. Central to the identification strategy is whether the discrepancy observed is due to other alternative reasons more related to the heterogeneous behaviour of occupational groups and differences in preferences than to underreporting. The availability of a wide range of variables from the restricted version of the survey allows us to assess, to the extent possible, key assumptions of the model and confirm that the observed discrepancy is not driven by other alternative explanations than underreporting such as preference heterogeneity, savings, or measurement error. Whereas this framework has been previously used by others (see, for example, Schuetze (2002), Lyssiotou et al. (1993), Johansson (2005)), the link between the gap obtained and underreporting has not been fully investigated.

¹ The number of self-employed individuals were in the first quarter of 2014, 15% higher than in the same quarter of the year 2008, just at the outset of the financial crisis. However, the number of employees in 2014 Q1 was 0.34% lower than in 2008. This trend seems to maintain, in the UK, the number of self-employed increased from amounting to 12.0% of the labour force in 2001 to 15.1% in 2017 (ONS, 2018).

Unsurprisingly, over the past few years enhancing tax compliance has been a central policy concern of governments in many countries across the world due to its perverse effects (it undermines revenues and distorts competitions). Tackling non-compliance necessitates an understanding of the scale of the phenomenon and, importantly, its determinants. The third aim of this paper is to showcase that the expenditure-based method has the potential to go beyond measurement and focus on issues such as the demographics of non-compliance. This provides a useful tool for tax administrations to draw evidence on the profile of the non-compliant.

The data set used is the Secure Access version of the Living Costs and Food Survey for the period 2010—2012 which provides us with a rich set of variables. The model exploits the differing opportunity for underreporting the self-employed and the employed have. As income from employment is subject to withholding taxes there are minimal possibilities of underreporting and thus income of the employed is assumed to be accurately reported. Observing the expenditure pattern of the employed, the level of income necessary to sustain a certain level of expenditure can be ascertained and thus any discrepancies between the income reported by the self-employed and the employed at a certain level of expenditure can be used to elicit the extent of hidden income the self-employed hold. The analysis provides alternative estimates based on three different measures of expenditure and three different measures of self-employment income. The results from the three product groups are entirely consistent and the findings run in the expected direction. The main results show that, on average, the self-employed report only 80.4 percent of their true income (or to put it differently, the self-employed income-gap is 19.6 percent), which translates into a lower-bound estimate of unreported taxable income of 1.6 percent of GDP.

As is common with models of the type considered here, there might be several other explanations that challenge the underlying assumptions of the model and could be potentially biasing the results, leading to a false attribution to underreporting. The analytics show that the result is not caused by different preferences between the self-employed and the employed, nor is it caused through savings funding current consumption, or measurement error. It also emerges that using documents used to report to the revenue authority to fill in the income section of the survey leads to a higher level of underreporting being detected. Regarding the characteristics of the non-compliant taxpayers, the results suggest that males underreport more than females and that non-compliance decreases with age. We also find suggestive evidence of the geographical heterogeneity of the evasion response.

This paper contributes to the literature on measuring non-compliance using traces of true income firstly, by providing an updated estimate of the income-gap of the self-employed in the UK and, secondly, by assessing the merits of the expenditure-based method in measuring non-compliance.² We find evidence that this method does indeed perform well in uncovering hidden income. It also contributes more generally to the tax evasion literature surveyed by Andreoni, Erard and Feinstein (1998) by analysing the heterogeneity of the evasion response with the characteristics of the self-employed individual. The profiling of the non-compliant individual is of interest to tax administrations as it can inform their compliance activities. We seek with this last application to open the framework to be used in a more general context by tax administrations to investigate traits that can be of interest in understanding the determinants of non-compliance beyond those that are available for tax purposes.

² For a review of the literature on using indirect methods to infer non-compliance see Slemrod and Weber (2011).

The organization of the paper is as follows. Section II contains a brief literature survey. Section III describes the model and Section IV presents the data and outlines briefly the empirical methodology. Section V provides and discusses the results, and, finally, Section VI summarizes and concludes.

II. BRIEF LITERATURE REVIEW

One of the first contributions exploiting the discrepancy between income and expenditure to measure the size of the black economy is that of Dilnot and Morris (1981).³ They computed excess expenditures from survey data for 7200 households in the UK and characterised as ‘black-economy households’ all those where expenditure exceeded income by 20 percent and by at least £3. They reported an upper and a lower bound distinguishing whether the discrepancy could be explained by the circumstances of the household or whether they included pensioner and unemployed households. They found that the black economy was between £3.2 and £4.2 billion representing around 2.3–3 percent of 1977 GNP. Most of the black economy households were headed by an individual working in a skilled or semiskilled occupation and 22 percent of the black economy households were headed by a self-employed individual. Dilnot and Morris (1981) calculated participation ratios for different observed characteristics. The self-employed were much more likely than other groups to be part of the black economy sample than other employees. Individuals in skilled or semiskilled manual occupations were more likely to participate in black economy activities than unskilled.

Pissarides and Weber (1989), building on the contribution by Dilnot and Morris (1981), provided a more structural framework for the estimation of underreporting of the self-

³ We keep the literature intentionally brief by focusing on contributions using the expenditure-income pattern to identify traces of true income.

employed in Great Britain. Their approach consisted in obtaining a measure of income underreporting by the self-employed through a comparison of the relationship between food expenditure and income from this group to that of the employees who are assumed to be honest reporters. Pissarides and Weber (1989) recorded that true self-employment income is on average 1.55 times the income reported by the self-employed in Great Britain using the 1982 Family Expenditure Survey, with the uplift factor, that is the scaling parameter that transforms reported to true income, being higher in blue-collar households than in white-collar households (1.65 versus 1.5). Using this estimate of underreporting, they obtained that the size of the black economy was 5.5 percent of GDP. Lyssiotou *et al.* (2004), using the same approach for 1992, estimated the uplift factor to be on average 1.28,⁴ and again higher for blue-collar households (1.39) than white-collar (1.18). In addition, using a complete demand system, they found that self-employment income should be multiplied by a factor of 2.18 for the case of blue-collar households and 1.64 for white-collar households. They estimated the size of the black economy to be 10.6 percent of GDP in 1993.

Similar studies have also been conducted in other countries. In Canada, Schuetze (2002), using the equivalent to the Family Expenditure Survey for 1969-1992, found an average underreporting factor of 1.2 (1.12 lower bound and 1.23 upper bound). More recently, Hurst *et al.* (2014) for the US found that self-employment income is underreported by 30 percent which is equivalent to what was found by Engström and Holmlund (2009) for Sweden; and comparable also to the level of 25% found in Spain (Martinez-Lopez, 2013) Johansson (2005) found that the self-employed underreport their incomes in Finland by 16.5 percent for households of one self-employed (42 percent for households of two self-employed) representing 1.3 percent (3.2 percent)

⁴ This result was obtained averaging the values of blue-collar and white-collar workers.

of GDP. Nygård et al. (2016) analysing the question of the distribution of tax evasion, addressed the estimation of the income underreported by suppliers using the expenditure-based approach. They find the scaling factor to range from 1.20 to 1.25 for Norway.

Kukk and Staehr (2014) estimated underreporting in Estonia finding the degree of underreporting to vary with the extent of reported self-employment income in household finances. They estimated that 62% of true income (reported plus misreported) is underreported for households where self-employment income represents more than 20% of total reported household income, 50.1% for those with 10-20% share of self-employment income and 35.9% for those with a share of 5-10%. This entails that the level of underreporting is still rather significant even when the proportion of reported self-employment to total reported income is small. A drawback of this approach is that selection of the percentage of underreporting is made upon reported income rather than 'true' income, making the selection endogenous. The authors also discuss a definition of underreporting based on self-reported self-employment status and share of business income finding similar results. Although the estimates are large compared to previously cited studies, it may be more comparable to those found for Russia by Kim et al. (2009) using a panel-data version of the PW approach, 41% of underreporting.

Feldman and Slemrod (2007) use the same methodology but introduce charitable contributions as their expenditure variable. As they use unaudited tax returns, their methodology allows them to identify the level of income underreporting by income source. More recently, Artavanis et al. (2016) exploit the asymmetry in the possibilities of underreporting their incomes of employed and self-employed in a similar model to Pissarides and Weber (1989) where, instead of expenditure, the level of debt acquired with the bank is used as the identifying variable.

Like these contributions, the present paper focuses on estimating the degree of income underreporting by the self-employed (income-gap). Unlike them, however, the emphasis is also on testing the assumptions of the model to ensure the correct measurement of underreporting and the identification of the *profile* of the individuals associated with noncompliance which is an issue of significant policy relevance.

III. DESCRIPTION OF THE MODEL

Our empirical approach uses the expenditure decisions of self-employed and employed households to estimate hidden income. All households make their expenditure decision based on their true income, denoted by Y^{True} , given by

$$Expenditure = f\left(Y^{True}, \text{Characteristics of the household / individual}\right). \quad (1)$$

True income is however unobservable and its magnitude is to be identified by differences between the expenditure patterns for the two groups: the self-employed and the employed. Expenditure is assumed to be measured correctly for both groups and reported income, which is the observable income variable in the survey, is allowed to be misreported by the self-employed.⁵ This follows from the observation that income reported by the employed is subject to withholding taxes and its high visibility makes underreporting extremely difficult, Slemrod and Gillitzer (2014). The absence of third party reporting of self-employment income allows the opportunity of income to be misreported and thus reported income, denoted by Y^R by the self-employed is to be scaled by a factor k_i , where households are indexed by i , that is

$$Y_i^{True} = \begin{cases} k_i Y_i^R & \text{if self-employed} \\ Y_i^R & \text{if employed} \end{cases}. \quad (2)$$

⁵ We discuss this point further in Section IV.

Combining equation (1) and (2), and assuming a log-linear relationship between expenditure and income, it is the case that

$$\ln Expenditure_i = \beta \ln Y_i^R + \beta \ln k_i + CHAR_i \alpha, \quad (3)$$

where the term $\ln k_i$ is the term that differs between the employed and the self-employed. Note that equation (4) is a standard Engel curve where permanent income (unobservable) which is the desired income variable to investigate consumption decisions is imperfectly replaced by reported income (observable). This will require an estimation strategy that accounts for the measurement error in the income variable. Defining SE_i as a dummy variable that identifies self-employed households, equation (3) can be written in estimation form as

$$\ln Expenditure_i = \beta \ln Y_i^R + \gamma SE_i + X_i \alpha + \varepsilon_i, \quad (4)$$

where β identifies the elasticity of consumption with respect to income, X_i is a vector of covariates including characteristics relevant to the individual and the household, ε_i is a white noise error, and γ identifies the extended amount of expenditure declared by the self-employed given a certain level of income.⁶ An estimation of the average income-gap $\bar{\kappa}$ and the scaling factor \bar{k} can be obtained using γ and β as,

$$\bar{\kappa} = 1 - \frac{1}{\bar{k}} \text{ where } \bar{k} = \exp\left(\frac{\gamma}{\beta}\right). \quad (5)$$

However, income from self-employment is more volatile than income from employment and a correction for this differing volatility is added which is captured by a difference in the variance of

⁶ For the derivations we refer the interested reader to Pissarides and Weber (1989).

their reported income.⁷ In this case, a point estimate is no longer attainable and the upper and lower bound of the scaling factor and its income-gap can be identified as,

$$\bar{k} \equiv 1 - \frac{Y^R}{Y^{True}} = 1 - \frac{1}{\bar{k}} \quad \text{where} \quad \bar{k} = \exp\left(\frac{\gamma}{\beta} \pm \frac{1}{2}(\sigma_{Y_S}^2 - \sigma_{Y_E}^2)\right). \quad (6)$$

The results report the income-gap with no volatility correction as in equation (5) and for brevity the midpoint of the upper and lower bound obtained from equation (6).

Lastly, and importantly, we investigate the heterogeneity of the income-gap to inform the profile of the non-compliant by allowing different characteristics of the self-employed to interact with the self-employment variable. This creates different estimations of the income-gap for each category n of characteristic N .⁸ Equation (4) can be rewritten as:

$$\ln Expenditure_i = \beta \ln Y_i^R + \gamma_n SE_i * N_n + X_i \alpha + \varepsilon_i. \quad (7)$$

Similarly, the income gap can be estimated for the different categories n using the estimated γ_n from equation (7) in equations (5) and (6), for the specification of the income-gap without and with volatility, respectively.

IV. DESCRIPTION OF THE DATA

A. Living Costs and Food Survey

The data comes from the Secure Access version of the Living Costs and Food Survey (LCFS) and cover the years 2010-12.⁹ The LCFS uses as unit of survey the household and it

⁷ Ideally one would like to use permanent income as the measure of income that affects consumption. However, permanent income is unobserved as well as true income. Self-employment income can be subject to more volatility than employed income, therefore one can relate permanent income and true income using a random variable that is log-normally distributed and has a mean equal for both groups but that has different variances for the two groups. This allows the approximation of the difference in volatility of these unobservables by an estimable difference in the volatility of reported incomes obtained independently for each group from the first-stage regression of income on the instrumental variables (educational attainment) and the covariates that relates to the household.

⁸ As an example, say N is gender, and $n=(male, female)$.

⁹ Office for National Statistics, Department for Environment, Food and Rural Affairs. (2014). Living Costs and Food Survey, 2006-2012: Secure Access. [data collection]. 4th Edition. UK Data Service. SN: 7047. The original

captures expenditure decisions and income earned from all the individuals within a household. For consistent comparison across households, and to avoid concerns arising from differences in non-compliance due to the composition of the household, the sample is restricted to households of two adults,¹⁰ either cohabitees, married or civil partners who live in Great Britain and the Household Reference Person (HRP) is either employed or self-employed. HRP is the householder who: either owns the household accommodation, or 1) is legally responsible for the rent of the accommodation; or 2) has the household accommodation as an emolument or perquisite; or 3) has the household accommodation by virtue of some relationship to the owner who is not a member of the household. If there are joint householders, HRP is the one with the higher income. If the income is the same, then the eldest householder is taken. The age of HRP is also restricted to be less than 60 in order to leave out different expenditure behaviour after retirement, Aguiar and Hurst (2005).

To obtain a reasonable sample size the 2010 to 2012 waves are pooled. They are also deflated using the consumer price index base of 2010. Income reported has also been adjusted in order to account for the fact that income reported by the self-employed dates back to the last available record which could well have been obtained a year before and consequently, not to the date of the interview. Failing to correct this time lag could lead to spurious results. Self-employment income reported is updated to the time of the interview using the monthly rate of inflation calculated from the amount of self-employment income per self-employed worker drawn from the Blue Book for the corresponding years.

data creators, depositors or copyright holders, the funders of the Data Collection (if different) and the UK Data Archive bear no responsibility for the analysis hereby presented.

¹⁰ Household composition is controlled for in the specification using the number of children.

A self-employed household is defined to be one that draws more than 25 percent of their income from labour income from self-employment. This threshold is imposed in order to avoid households that have a substantial amount of self-employment income (e.g. from a subsidiary source) may classify themselves as employees. For robustness, alternative specifications of the self-employment dummy variable have also been considered as will be discussed in Section V.A.

B. Measuring income

In the LCFS, self-employed individuals were asked about the profit from their activity and about how much their drawings amount to both for business and non-business purposes or personal use. In the event that the individuals were not able to respond to any of these questions they were asked for an estimate of how much their income was once expenses were deducted. To capture all income the self-employed take into consideration, it is assumed that their consumption decision is based on their total earnings which include both labour earnings and those reinvested back into the business (a form, perhaps, of precautionary savings). But it is conceivable that income for the self-employed is better proxied by other sources of income. To obtain a comprehensive picture (and also being agnostic of which form of income approximates true income better) use is, therefore, made of three different measures of self-employment income: a *comprehensive measure*, *profits*, and *drawings*.

The *comprehensive measure* of income takes into account as much data on income as possible, avoiding missing values in the answers, and is computed as follows. The profit figure (transformed into a weekly amount) is taken if reported. If the individual reported a loss (or zero profit) or is not able to report a profit figure, then the estimate of the weekly drawings is taken. If none of the former are available, then the weekly equivalent of the

estimation of income minus expenses is taken. The second and third measures consider, respectively, only *profits* and *drawings* as the measure of self-employment income.

C. Measuring Expenditure

The correct reporting of expenditure by both groups, self-employed and employed is one of the assumptions in the model. However, there are significant reasons to believe that food is an item of expenditure that can be considered as being reported with a high degree of accuracy. Firstly, food is one of the items of expenditure that is better captured on the LCFS. Brewer and O’Dea (2012), through a comparison of the National Accounts with the LCFS, find that food together with household fuel and the running costs associated with motoring appear as the categories of expenditure where coverage is higher. Food had a coverage rate above 80 percent for each year in the period 1974-2009. This is consistent with the patterns found in the US by Meyer and Sullivan (2009) who, comparing the Personal Consumption Expenditure and the Consumption Expenditure, have found a good coverage for food eaten in of 85 percent while the coverage of food eaten away from home has been declining over time. Secondly, food, being a necessity,¹¹ is not an expenditure that can be altered by transitory shocks, its consumption cannot be postponed to future periods and zeros for infrequency of purchase are not present.¹² Thirdly, food does not represent an item of expenditure that can generally be claimed as a business expense.

¹¹ For a discussion on this see Attanasio *et al.* (2004) who also present some evidence that for very poor households (defined as having their income or consumption below 60 percent of median consumption or income) this might not hold. The fraction of such households, however, in the general population is, in general, very small to significantly change the results.

¹² This is one of the reasons why durable goods were not taken into account in the measure of expenditure. Ways to mitigate problems with infrequency of purchases have been proposed but there are limitations too, Meghir and Robin (1992). Lyssiotou *et al.* (2004) estimated underreporting using a demand system in which they included durable goods, but problems with infrequency of purchase still remain. Additionally, Brewer and O’Dea (2012) find that durable goods (household and personal services, vehicle purchases and other durable leisure goods) are an item of expenditure with very volatile coverage ratio in the LCFS (previously named as the Family Expenditure Survey) ranging between 55-80 percent.

The UK tax authority (HMRC) establishes that some of the costs the self-employed face can be claimed as allowable expenses. These include: office costs, travel costs, clothing, staff costs, resell of goods, financial costs, and cost related to of business premises and advertising or marketing. Food expenses do not feature in the list of allowable expenses, but there is an exception in that food expenses can be claimed if it is in the case of overnight business travel. Other food costs such as those derived from entertaining clients, suppliers and customers or those related to event hospitality cannot be claimed, HMRC (2015). In fact, none of the individuals in the sample mentions food as a business expense. Besides, food is expected to be correctly reported as there is no social stigma associated to it. It is well documented that other items of expenditure such as tobacco or alcohol are usually misreported on surveys, particularly in the LCFS the coverage ratio is 40 percent (Brewer and O’Dea, 2012). Food does not represent an item that can be suspected of showing a certain lifestyle as opposed to expenditure on holidays or newly bought cars, and therefore the interest in misreporting is minimal. Lastly, food expenditures are recorded using a diary during a two-week period by all individuals over 16 years of age and children between 7 and 15 are offered a simplified version. Other items of regular expenditure, such as the mortgage, are captured in the household questionnaire.¹³

¹³ The Living Costs and Food Survey uses diaries instead of interviews to collect food expenditure data. Recall data has been long recognised to suffer from different problems: quantities are difficult to remember (Gray, 1955), memory declines with the length of the recall period which Deaton (1997) refers to as ‘progressive amnesia’ (see Sudman *et al.* (1996) and Scott and Amenuvegbe (1991)) and telescoping errors (Neter and Waksberg, 1964). Diaries minimize these problems as respondents are asked to record their expenditure on the day it occurs. However, as Browning *et al.* (2003) and Battistin (2003) recognise diary methods are also known to suffer from problems of ‘diary fatigue’ due to the high burden they pose on the respondents. If diaries are only required to be kept for a short period of time then problems of infrequency of purchase arises. As Deaton (2005) puts it there is a trade-off between memory and match between consumption and purchases. Ahmed *et al.* (2006) exploiting a database with both interview (recall) and diary data find that none of the sources are free of errors but that recall measures of expenditure were substantially underrecorded. There is an inclination to mix both techniques in order to minimise their challenges (Gibson, 2002; Battistin, 2003). The Consumer Expenditure Survey in the US and the LCFS in the UK combine recall and diary data with the intention to capture more infrequently purchased items of expenditure with the former. Browning *et al.* (2003) comparing recall and diary expenditure on food at home for the US recognise that individuals do a ‘remarkably good

The analysis considers two other measures of expenditure apart from *food*, expenditure on *utilities* and a *basket of nondurable goods*. Expenditure on utilities was chosen as it is an item of expenditure that could be easily recalled due to the regular payments. However, it raises concerns as it represents an item typically claimed as a business expense by the self-employed. The higher level of consumption could be masquerading the differing nature of the self-employment activity and its particular fiscal treatment. Therefore, estimates although presented for comparison should, in principle, be taken with caution. The third measure of expenditure that is considered, is a composite measure of expenditure that considers a basket of nondurable goods.¹⁴ This measure of expenditure is added to test for the robustness of the results when considering a broader basket of goods to which expenditure can be diverted. It offers a sound robustness check for the preferred item of expenditure which is food consumption.

Table 1: Main Summary Statistics

	Employed			Self-Employed		
	N	Mean	S.D.	N	Mean	S.D.
Disposable Labour Income (ln)	4034	6.528	0.504	738	6.473	0.695
Food (ln)	4026	4.35	0.558	738	4.432	0.579
Utilities (ln)	4021	3.222	0.565	736	3.314	0.585
Non-Durables (ln)	4036	5.734	0.524	739	5.81	0.552

Table 1 reports the summary statistics for the expenditure measures and disposable income for the two groups. Table 1 shows, interestingly, and across all expenditure measures, the self-

job' when recording food at home as opposed to total expenditure. As food expenditure is a frequent item of expenditure, diaries appear to be the appropriate way of recording it.

¹⁴ The basket of non-durable goods comprises expenditure on food, alcohol and tobacco, clothing, utilities, non-durable expenditure on recreation, non-durable expenditure on transportation and communication, health, education and other miscellaneous nondurable expenditures. These other items of expenditure have a varying degree of coverage in the survey. As analysed by Brewer and O'Dea (2012) for the case of the UK, the coverage of clothing in later years reaches 60 percent while the coverage of transportation reaches 40 percent. This variable can therefore be affected by a higher measurement error and therefore it is reported for the purpose of providing robustness to the results and testing the model under a wider basket of goods.

employed exhibit higher levels of expenditure whereas their reported income is lower than that of the employed.¹⁵

V. ESTIMATION AND RESULTS

In order to explain consumption, theory suggests that the measure that relates to consumption decision is permanent income (Friedman, 1987). However, since permanent income is unobserved, current reported income from the survey is used its place. The existence of transitory variations around the permanent measure of income leads to an attenuation of the estimated elasticities of income with respect to consumption when current income is used. Therefore, in order to address the measurement error in the independent variable resulting from the use of current income as a noisy proxy for permanent income, income is instrumented in equation (4). The instruments to be used are: educational attainment (whether the household reference person and spouse had higher education) and whether the household reference person is in a white-collar or blue-collar occupation.¹⁶ A summary of the main results of the estimation, these are the income-gaps, are available within the text. Full estimation results are available as an online supplement to the paper in the journal's website.¹⁷

A. Self-Employment Income-Gap

Estimation of the income-gap for the self-employed as evidenced in equations (6) and (7) requires four key parameters: the estimation of the residual income variance for the two

¹⁵ The difference in means is statistically significant. Summary statistics of the covariates are provided in Appendix A.

¹⁶ In a cross-section setting, instrumental variables have been the preferred estimation method (Pissarides and Weber, 1989; Hurst et al., 2014 for the Consumer Expenditure sample). The difficulty in addressing the measurement error of the income variable in a cross-section setting concentrates on the choice of the instrumental set that satisfies the exclusion restrictions. When panel data on current income is available, average measures of income over time are used in order form a more 'permanent' measure of income (Engström and Hagen, 2017). We find as in the case of Hurst et al. (2014) the educational attainment variables to be suitable instruments for income and the relevant assessment of the quality of the instrumental variables is provided in an online appendix.

¹⁷ The online appendix is available in the authors' website. It contains the full estimation of the income-gap including the main results from the regression necessary to estimate the income-gaps, the relevant bounds of the estimate and the quality of the instrumental variables.

employment groups (self-employed and employed) that can be estimated independently from the first-stage regressions ($\sigma_{Y_S}^2$ and $\sigma_{Y_E}^2$);¹⁸ the elasticity of consumption (given by β), and the coefficient of the self-employment dummy variable (γ) from the second-stage regressions.

Table 2 displays the estimation of the income-gap of the self-employed including firstly the specification in which the volatility correction of income is not taken into account, this is $\sigma_{Y_S}^2 = \sigma_{Y_E}^2$, as in equation (5); and the specification that accounts for the differing volatility in incomes, this is equation (6). As equation (6) results on a bounded estimation, that is an upper and lower bound of the income-gaps is obtained, we present and focus the discussion for the sake of brevity around the midpoint of the interval, relegating full estimation results to the online appendix. Table 2 reports on the main estimation results and is organised as follows: (1) Panel A considers the robustness of the results to alternative specifications of the dependent variable of expenditure, (2) Panel B tests for the robustness of different specifications of the self-employment income variable, and (3) Panel C, compares the sensitivity of the results to alternative specifications of the definition of a self-employed household.

Panel A in Table 2 shows that, with *food expenditure* as a dependent variable, the self-employed income-gap is 19.6 percent which translates into a midpoint multiplier of $\bar{k} = 1.24$, implying that income reported by the self-employed should be multiplied by a factor of 1.24 to obtain true income.¹⁹ This value is similar to that obtained for countries such as Sweden or Canada (Engstrom and Holmlund, 2009; Schuetze, 2002). Panel A also reports the estimation using two alternative measures of expenditure: expenditure in *utilities* and a *nondurable basket of goods*. The concern with using expenditure in utilities, despite being an item of expenditure

¹⁸ The cross-section nature of the data does not allow the calculation of the variance of income over time for each household and therefore these variances are calculated for each group.

¹⁹ The appropriate standard errors are computed using the delta method.

one may expect to be easily recalled, is that it can be claimed as a business expense. This may act as an incentive to the self-employed to carry some of their activity at home and claim the expense on utilities. Thereby we could observe a higher level of expenditure on utilities for a certain level of income that would not be due to underreporting but that it is only a feature of the self-employed activity and the fiscal treatment. The degree of underreporting revealed using utilities is only slightly larger: 22.3 percent. The basket of all non-durable goods as a proxy for expenditure gives a similar degree of underreporting as using food expenditure, 19.9 percent which highlights the robustness of our results to different specifications of the dependent variable.²⁰

Panel B in Table 2 shows that using alternative measures of our main independent variable of interest self-employment income, the level of underreporting estimated using the comprehensive measure of self-employment income and profit is identical. Both of these measures highlight the importance of capturing the possibility that the self-employed make their consumption decision based on their available and retained earnings. The use of drawings from the business as the measure of income for the self-employed results in a substantial decrease on the sample size as not many individuals report taking drawings from their business or report missing answers. Using drawings as the income variable for the self-employed translates into more significant income underreporting. This result may be overestimating the amount of underreporting as it might be failing to consider the influence of retained earnings in shaping consumption decisions.

²⁰ Arguably, estimation should also consider housing as a measure of expenditure. The problem with this, however, is that it would require imputed rent for individuals who own their house something for which data are not available and, more importantly, not easily computed

The definition of a self-employed household (being those who derive more than 25 percent of their income from self-employment) might be of concern in the sense that it relies on reported income—which may be misreported—to classify households into employment categories. Using a proportion of reported rather than true income can lead to the misclassification of households into employment rather than self-employment. The aim of this 25-rule definition was to circumvent the use of self-reported employment status in order to avoid the selection of households into employment when their main source of income is self-employment.²¹ We test the robustness of the results to the alternative definitions of self-employed household in Panel C. We show that the income-gap estimated is robust to the definition of the self-employed household be it based on income (25-rule) or defined from self-reports. Two alternative definitions are utilised for the latter: the first uses *self-reported employment status* of the HRP in their main or subsidiary jobs (*Self-Employed Head* in Panel C), while the second relates to the *opportunity* a self-employed household has to underreport income whenever there any of the household members report having a self-employment income source (*Any Self-Employed* in Panel C).²² For comparison purposes Panel C again reports the income-gap using the 25 percent income rule (which is equivalent to the first row *Food* in Panel A).

²¹ Pissarides and Weber (1989) to overcome the endogeneity of the income definition also instrument for the self-employment dummy variable. However, the bias that can result in the estimates due to weak instruments could outweigh the effect of failing to instrument and accepting the bias introduced by considering that some households that behave as self-employed are classified in our sample as employed. Our approach is to use alternative definitions of a self-employed household in order to assess the impact of definition on the estimation of underreporting using definitions of self-employment that are not a function of the proportions of self-employment to total reported income.

²² For clarification purposes, the second definition using self-reports (*Any Self-Employed*) defines a household as self-employed if any self-employment income source is available to them. This definition neither accounts for the importance nor amount of self-employment income: only the opportunity to underreport income matters. This definition is more general than the first definition using self-reports (*Self-Employed Head*) that classifies a household into self-employment regarding the reported status of the HRP. This classification is made solely only the head of the household whereas the previous one considered any income sources of the household irrespective of who earns it.

Table 2: Estimation of the Income-Gap

	No Volatility Correction	Volatility Correction
	Point Estimate	Midpoint
<i>Panel A: Expenditure</i>		
Food	0.187*** (0.043)	0.196*** (0.042)
Utilities	0.214*** (0.045)	0.223*** (0.045)
Non-Durables	0.190*** (0.031)	0.199*** (0.03)
<i>Panel B: Income</i>		
Profit	0.180*** (0.066)	0.196*** (0.065)
Drawings	0.368*** (0.099)	0.391*** (0.095)
Proxy	0.187*** (0.043)	0.196*** (0.042)
<i>Panel C: Alternative SE definitions</i>		
Self-Employed Head	0.215*** (0.038)	0.221*** (0.037)
Any Self-Employed	0.215*** (0.037)	0.221*** (0.036)
SE (25% rule)	0.187*** (0.043)	0.196*** (0.042)

Notes: 2SLS regressions based on equation (4) and income-gaps estimated as in (5) and (6). Robust standard errors in parentheses. The stars indicate significance at the following levels: *p < 0.10, ** p < 0.05, *** p < 0.01. Survey data pooled for waves 2010-2012. The dependent variable in Panel A are (1) Food Expenditure, (2) Utilities and (3) Non-Durables. The dependent variable is food expenditure in Panel B and C. Independent variable of interest is household disposable labour income instrumented using the level of education and the type of occupation (white or blue collar, defining white-collar as those individuals who are employers in small or large organisations, or hold a higher managerial, higher professional, lower professional and higher technical, lower managerial and higher supervisory and intermediate position) and the self-employment dummy variable. All specifications include year and quarter fixed effects and controls for household and personal characteristics (age and number of children in a non-quadratic fashion, number of cars and rooms, type of tenure, availability of drier and central heating). All dependent and independent variables are in logs and deflated accordingly. The sample is restricted to individuals aged less than 60 years of age. All specifications are weighted using sample weights. The income-gap presented in this table are the IV estimated income-gaps. First stage F-statistics, tests on the quality of the instrument, sample sizes and the OLS specification and estimation are provided in an online appendix.

B. Is it underreporting?

A concern with the analysis so far (and the results obtained) might be whether the estimates obtained can indeed be attributed to underreporting or whether they are a feature of the assumptions posed to obtain the estimate. It is precisely this issue that the analysis now turns to, paying particular attention to three aspects: heterogeneous preferences for food consumption, heterogeneous spending behaviour, and measurement error in the survey.

1. Preference Heterogeneity

It has been assumed (see equation (4)) that both taxpayer groups (self-employed and employed) have the same preferences over consumption and, therefore, the same income elasticity of consumption. One, however, can certainly think of a more structural model where occupational choice is driven by sector-specific skills and different preferences over consumption. To test this assumption, the consumption functions of the two occupational groups have been estimated separately showing that the income elasticities for both occupational groups are statistically indistinguishable from each other.

The data on food expenditure allows us to distinguish between food eaten in the house and eaten out of the house. Since food eaten out is typically more expensive, a difference in the pattern of consumption between the two groups could explain the gap obtained if there was a higher preference by the self-employed for dining out. We have, therefore, tested whether there is a different preference between food eaten in and out between the occupational groups. Estimating the share of food eaten in with respect to total food expenditure, we find that there is no significant difference between the two groups. Therefore, the higher level of expenditure observed for the self-employed cannot be justified

by a higher expenditure on food outside from home nor by a different elasticity of consumption.

2. Heterogeneous Spending Behaviour: Financial Constraints

Another reason why we might observe a discrepancy between expenditure and income may be a different level of financial stability for the self-employed. What we know, and is controlled for in the model, is that income for the self-employed is more volatile than income for the employed. However, it could still be the case that in the years observed, 2010-12, the level of expenditure of the self-employed is not funded by current income only but also by past savings. If this was the case the model would be misleadingly attributing to underreporting the fact that some current consumption is not funded by current income but by past income. Using variables from the Secure Access data, we are able to filter out those individuals who claim to be financially constrained: by this is meant individuals who find their current income not sufficient to fund their current consumption and need to recourse to other alternative sources such as loans, savings, or money from relatives. We have created a smaller data set of individuals not financially constrained and we rerun the analysis and we are still able to find a substantial income-gap of 22.9 percent, Panel A in Table 3, which cannot be explained through the use of past incomes for this type of households.

The main category of expenditure analysed in this paper is food expenditure for the reasons discussed in Section V.C. However, in Table 2 we also present estimates using utilities as an expenditure category. One of the main concerns that utilities raise is that it is one of the main categories claimed by the self-employed as a business expense. Therefore, a higher level of expenditure on utilities relative to income may not be a sign of underreporting but the result of a differential fiscal treatment for the self-employed. We have sieved out of the estimation all those

self-employed that claim any utilities bill as a business expense. Using utilities as the expenditure category on those self-employed individuals who do not claim any business expenses, we still observe a very similar level of underreporting (21.9 percent)—see Panel B in Table 3.

Table 3: Estimation of the Income-gap: Alternative explanations of the gap

	No Volatility Correction	Volatility Correction
	Point Estimate	Midpoint
<i>Panel A:</i>		
No Financial Constraints	0.218*** (0.083)	0.229*** (0.082)
<i>Panel B:</i>		
No business expenses claim	0.212*** (0.05)	0.219*** (0.049)
<i>Panel C: Income Measurement Error</i>		
Any Documents	0.206** (0.081)	0.218*** (0.08)
HMRC Documents	0.310** (0.127)	0.320** (0.125)

Notes: 2SLS regressions are based on equation (4) and income-gaps estimated as in equation (5) and (6). Robust standard errors in parentheses. The stars indicate significance at the following levels: *p < 0.10, ** p < 0.05, *** p < 0.01. The dependent variable in Panel B is utilities. The dependent variable is food expenditure for Panel A and C and is the default expenditure variable unless specified otherwise. Independent variable of interest is household disposable labour income instrumented using the level of education and the type of occupation (white or blue collar, defining white-collar as those individuals who are employers in small or large organisations, or hold a higher managerial, higher professional, lower professional and higher technical, lower managerial and higher supervisory and intermediate position) and the self-employment dummy variable. All specifications include year and quarter fixed effects and controls for household and personal characteristics (age and number of children in a non-quadratic fashion, number of cars and rooms, type of tenure, availability of drier and central heating). All dependent and independent variables are in logs and deflated accordingly. The sample is restricted to individuals aged less than 60 years of age. All specifications are weighted using sample weights. The income-gap estimations presented in this table are the IV estimated income-gaps as in equation (6). First stage F-statistics, tests on the quality of the instrument and the OLS specification are provided in an online appendix.

Therefore, there is evidence that neither the role of savings in funding current consumption nor the possibility of claiming of business expenses from some expenditure categories are the driver of the results obtained.

3. *Measurement Error*

As noted earlier, one of the caveats of using surveys relates to the accuracy of the information reported. The nature of the survey makes it likely that expenditure is more accurately reported than income since the survey makes available instruments for making expenditure as accurate as possible. For example, in the case of food a diary is filled by each member of the family. In the case of utilities, being a recurrent expense, it is easy to recall (Bee et al., 2015). For income, however, underreporting may not be the only reason behind the discrepancy found. Individuals are asked about their current income. Employees are usually paid on a monthly basis, so their claim of income earned should not deviate in excess of what they actually earn. That is, it should be free from recall error. For the self-employed, however, this is not the case. Recalling their last profit of their businesses may not be such an easy task. Therefore, it may be true that the discrepancy found might stem from measurement error due to recall, that is, the self-employed might be supplying approximate figures for their income that have little to do with their true levels.²³ There is substantive evidence that the length of the recall period, that is the lapse between occurrence and report, influences the accuracy of the report. Scott and Amenuvegbe (1991) find that average daily expenditures reported fall by almost three percent for every day added to the recall period being frequently purchased items the most affected. Deaton (1997) coined the tendency to forget earlier transactions ‘progressive amnesia’.²⁴ For income, Withney (1954) interviewed participants about

²³ Two scenarios can arise from the income reported by the self-employed. If the income reported by the self-employed is uncorrelated with their true income or reported income to the tax authority, then this is simply noise and can be direction of the bias is unclear. It could also happen that when reporting to the survey, the self-employed give a measure of income that lines up better with their true income than it does with the reported income to the tax authority. If this was the case, the estimate of underreporting obtained from this method using survey data on incomes might be underestimating the extent of non-compliance.

²⁴ Evidence is mixed, though. The Indian National Sample Survey which surveys households experimented with different recall periods for different groups of goods. They found that decreasing the recall period increased reported expenditure on food by 30 percent and total expenditure by 17 percent (Deaton, 2005). But this is not always the case. The NSSO Expert Group on Sampling Errors (2003), however, have noted that for certain foods a longer recall period was better than a shorter one (30 days versus 7 days) (cited in Wodon, 2007).

their current income in one year, and then re-interviewing the participants one year later asking them about the past income, only 61 percent of the cases reported the same income in their current and retrospective reports. Converse evidence is also found on the literature, Marquis and Moore (1990) only found that increasing underreporting linked to an increase in the recall period for one of the eight programmes analysed in the Survey of Income and Programme Participation (SIPP).

In order to assess whether the discrepancy stems from simple measurement error, we have carried out two checks. In the first, we have selected those individuals who consulted any documents in order to report their profit figures to the survey.²⁵ These documents could be either a Notice of Tax Assessment (form 300), their Annual Accounts (or the summary), their Tax Return or any other documents. Estimates are reported in Panel C of Table 3 which show that the level of underreporting is larger than in the case when no document is consulted (21.8 percent versus 19.6 percent). The second check looks at the estimate in the presence of administrative data. One of the differences between filling out a survey and reporting to the revenue service is the incentive to report the true income. In the survey, individuals may report their true income more accurately than they do to the revenue service as there is no gain from misreporting to the survey while misreporting to the tax authority translates into tax savings. However, one may also argue that some of the individuals who are afraid of their data being linked to their tax records despite reassurance of the anonymity of their responses, will provide

²⁵ The nudge to consult documents is a strategy from the interviewers to reduce recall errors. This procedure has proven efficient as documented by Maynes (1968) who found less errors in reports of individuals who were prompted to look at the records of the amount held in their savings accounts than in those who were not. Same results were found by Grondin and Michaud (1994) and Moore *et al.*, (1996) who found a reduction of errors in reporting of income when using tax forms (cited in Moore *et al.* 2000). Instructions were given in the LCFS for interviewers to prompt the use of documents.

the same answer to the survey as they did to the revenue service for the sake of consistency and to avoid self-incrimination.

To disentangle whether these effects are biasing the results, we repeat the estimation only for individuals who have made use of documents that have already been used for tax purposes or that are from the revenue service: The Notice of Tax Assessment and the Tax Return. Using only individuals who have looked at these documents we find a larger value of underreporting of 32 percent, Panel C in Table 3. However, we need to take these results with care as the sample size of self-employed using these documents is significantly reduced. Even so, this highlights the potential advantages of using administrative and survey data together and it outlines that even when using documents to better report income, the income gap is still visible.

C. Heterogeneity in the Income-gap

This section constructs a *profile* of the noncompliant self-employed.²⁶ A summary of the results including the income-gaps is contained in Table 4, full estimation and tests of the adequacy of the instruments are available in an online appendix.

1. Non-Compliance: Age

To assess the impact of age on self-employment underreporting, we introduce the interaction of the self-employment dummy variable and different age categories as in equation (7). We have analysed this taking into account the age of the HRP and also the age of the self-employed individual (if different). The results in Panel A of Table 4 show that as individuals age, they

²⁶ Other characteristics aside from age, gender and region were tested but non-compliance did not vary in a statistically significant way between groups. These characteristics were their legal form (whether a partnership or sole trader),

become more compliant. This is, in households where the HRP is less than 35 years old, income is underreported by on average 37.5 percent; if between 35 and 45, 18.2 percent and between 45 and 60 by 13.6 percent. The finding that the income-gap decreases as age increases is consistent with the findings in the literature on tax audits in the US using TCMP (Clotfelter, 1983; Feinstein, 1991).²⁷

2. *Non-Compliance: Gender*

Gender is another characteristic generally observed by the revenue service. We find that men underreport significantly more than women. Panel B in Table 4 shows that households of two self-employed (*Both* in Table 4) underreport more than households of one self-employed. This result is in line with intuition. A self-employed individual has higher chances of underreporting their income than an employee due to the absence of third-party reporting. A household of two self-employed has even more opportunities to underreport than a household of a single self-employed individual. These results are in line with those found by Johansson (2005) for Finland but run against those found by Schuetze (2002) for Canada. However, in households of one self-employed, the self-employment dummy variable is not significant when the self-employed is the wife but income-gap is higher in households where the self-employed is male. Our result is in line with what has been found in studies using surveys and experiments analysing tax compliance (Tittle, 1980; Torgler and Schneider, 2006; Spicer and Becker, 1980; Baldry, 1987; Kleven et al., 2011).

²⁷ Criminology studies provide evidence of this same finding for crimes in general. It seems that for all types of criminals and crimes there exists a common distribution for age which shows to be invariant to social and cultural conditions so that crime is negatively correlated with age. Though the theories for why this happen vary as discussed in Tittle, 1980; Brown and Miller, 1988.

Vogel (1974), using a survey in Sweden, found that men think of themselves as having better illegal opportunities than women. Torgler and Valev (2010) using data from eight Western European countries from the World Values Survey and the European Values Survey that span the period from 1981 to 1999 also find that in the case of bribes men are more frequently asked for bribes by government officials than women. They find in general women are more willing to comply.²⁸ Opposite results can also be found in the literature such as Baldini *et al.* (2009) who use the discrepancy between the income reported to the fiscal authorities and the income reported to the Survey of Household Income and Wealth in Italy for the region of Modena as a measure of income tax evasion. Using a probit model they find females are more likely to underreport than men. However, their study refers only to a particular region of Italy and the results of the study cannot be generalized to the whole population. Schuetze (2002), however, finds that the sex of the individual yields no difference in compliance behaviour.

3. *Non-compliance: Region*

Knowing how noncompliance is distributed geographically can provide evidence on which regions are less compliant and therefore may want to be more targeted with the audits by the tax authority.²⁹ Panel C in Table 4, reports the results, with the most noncompliant regions in the UK being Greater London followed by the East of England, the North and the South.

²⁸ Gender differences in delinquency have been largely investigated in criminology and many theories have been proposed. The fact that this difference in behaviour was due to the inequitable role in society of women and men was discarded since entrance in the labour market of women did not affect crime rates. The most accepted theory to support this difference points at self-control and opportunities to commit crimes as the drivers. Delinquent men are found to be more exposed to delinquent companions that can influence their behaviour through imitation (Mears *et al.* 1998).

²⁹ We have tried considering all the regions of England as well as Scotland and Wales. Restrictions on the sample size due to the Secure Access nature of the data used led to the pooling of certain regions together in order to achieve a sufficient sample size that ensured anonymity.

Table 4: Estimation of the Income-gap: Profiles of Non-Compliance

	No correction for volatility	Correction for volatility
	Point Estimate	Midpoint
<i>Panel A: Age</i>		
<35	0.375*** (0.093)	0.375*** (0.093)
35-45	0.172*** (0.063)	0.182*** (0.063)
>45	0.136** (0.066)	0.149** (0.065)
<i>Panel B: Gender</i>		
Wife	-0.051 (0.132)	-0.043 (0.131)
Husband	0.188*** (0.049)	0.196*** (0.048)
Both	0.309*** (0.089)	0.331*** (0.086)
<i>Panel C: Region</i>		
North	0.179* (0.106)	0.188* (0.104)
Yorkshire & The Humber	-0.224 (0.261)	-0.166 (0.249)
Midlands	0.122 (0.118)	0.137 (0.116)
East	0.315*** (0.08)	0.316*** (0.08)
Greater London	0.418*** (0.09)	0.429*** (0.089)
South	0.148* (0.076)	0.156** (0.075)
Wales & Scotland	0.067 (0.149)	0.069 (0.149)

Notes: 2SLS regressions based on equation (7) and the income-gaps obtained as in equation (5) and (6). Robust standard errors in parentheses. The stars indicate significance at the following levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Survey data pooled for waves 2010-2012. The dependent variable is food expenditure. Independent variable of interest is household disposable labour income instrumented using the level of education and the type of occupation (white or blue collar, defining white-collar as those individuals who are employers in small or large organisations, or hold a higher managerial, higher professional, lower professional and higher technical, lower managerial and higher supervisory and intermediate position). The self-employed dummy variable is interacted with the characteristic N in question as in equation (7). All specifications include year and quarter fixed effects and controls for household and personal characteristics (age and number of children in a non-quadratic fashion, number of cars and rooms, type of tenure, availability of drier and central heating). All dependent and independent variables are in logs and deflated accordingly. The sample is restricted to individuals aged less than 60 years of age. All specifications are weighted using sample weights. The income-gap presented in this table are the IV estimated income-gaps. First stage F-statistics, tests on the quality of the instrument and the OLS specification are provided in an online appendix.

VI. CONCLUDING REMARKS

This paper has revisited the use of expenditure and income as one of the methods that rely on traces of true income to identify non-compliance. Using an extended version of the household expenditure survey in Great Britain, we find that the self-employed underreport on average around 80.4 percent of their true income (or equivalently, their income-gap is 19.6 percent). Given that self-employment income in the UK for the period of study, 2010—2012, represented 5.5 percent of GDP, this translates into an estimate of unreported taxable income during this period of 1.6 percent of GDP. The magnitude of the income-gap has been shown to be robust to the expenditure and income variables used which praises the robustness of the results.

Methods that rely on traces of true income have some desirable advantages: they are less costly as they are typically a by-product of an existing survey; they do not rely on the detection rate of auditors or on self-reported non-compliance; they are available on a timelier manner; and lastly, they can offer a wider range of observable characteristics for the individual than those available on tax records. However, as non-compliance is ascertained through the relationship between other variables, it is fundamental in this type of exercises to investigate how closely the gap obtained can be linked to non-compliance. We have done this by identifying other possible explanations of the discrepancy and ruling them out as the main drivers of our findings. Our results identify that the income-gap obtained is neither driven by preference heterogeneity nor by the possibility of households being financially constrained and using their savings to fund current consumption, nor can it be attributable to measurement error.

We showcase also that these indirect methods have an extra advantage: they can be extended not only to measurement but to understanding the traits that relate to non-compliance. This is particularly possible because of the richness in observables that survey data introduces that

goes far beyond those available on tax records and can enable tax administrations to understand the characteristics that most correlate to non-compliance to better design their compliance activities. We have identified men to be less compliant than women and taxpayers to become more-compliant as they age. The income-gap is also found to vary by regions. Other characteristics such as the legal form of self-employment were not identified to correlate in a statistically significant manner.

This paper acknowledges, as Slemrod and Weber (2011) highlight, the difficulty in providing evidence of the unobservable and recognises the need to build trust in the use of indirect approaches to the measurement and understanding of non-compliance. We aimed at contributing to this ‘credibility revolution’ by showcasing the strength of the results obtained using the expenditure-based method to uncover traces of non-compliance and testing that indeed the income-gap observed links to non-compliance. Indirect methods should not be treated as substitutes of direct methods but rather complements in that they are able to answer questions that cannot be answered using solely administrative sources.

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APPENDIX A

Table A1
Summary Statistics of the covariates

	N	Mean	S.D.
<i>Panel A: Employed</i>			
Age	4045	40.053	10.02
Number of children	4045	0.833	0.941
Local Authority Tenant	4045	0.03	0.169
Other rented	4045	0.122	0.327
Owner with Mortgage	4045	0.617	0.486
Number of Cars	4045	1.322	0.711
Central Heating	4045	0.968	0.176
Drier	4045	0.628	0.483
Number of Rooms	4045	5.836	1.78
<i>Panel B: Self-Employed</i>			
Age	733	42.175	9.663
Number of children	733	0.956	0.984
Local Authority Tenant	733	0.027	0.161
Other rented	733	0.112	0.316
Owner with Mortgage	733	0.606	0.489
Number of Cars	733	1.294	0.758
Central Heating	733	0.969	0.173
Drier	733	0.669	0.471
Number of Rooms	733	6.218	1.898