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ESTIMATING SELF-EMPLOYMENT INCOME-GAPS FROM REGISTER AND SURVEY DATA: EVIDENCE FOR NEW ZEALAND

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Abstract

This paper provides estimates of the income-gap of the self-employed – defined as the proportion of undeclared to true income – in New Zealand using traces of expenditure to infer true income holdings following the approach of Pissarides and Weber (1989) and Feldman and Slemrod (2007). This uses the relationship between expenditure and income for the employed (with lower opportunities to evade) to infer the true income of the self-employed. We use a unique dataset – New Zealand's Integrated Data Infrastructure (IDI) – that matches individual data including incomes and expenditures from the Household Economic Survey with register incomes declared to the tax administration. This has several advantages in our context. Firstly, register data minimises income measurement error by employed and self-employed as it does not rely on accurate recall by survey participants. Secondly, the approach allows us to measure evasion under different incentives for misreporting. We estimate that the self-employed underreport on average around 20% of their income (with a 95% confidence interval around 10-30%), and that the income-gap varies significantly by gender and region. Our results are also found to be highly robust to a range of sensitivity tests for measurement error.

JEL classification: H26, O17, D12, E26.

Keywords: tax evasion, shadow economy, income underreporting, self-employed.

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Access to the anonymised data used in this study was provided by Statistics NZ under the security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business, or organisation, and the results in this paper have been confidentialised to protect these groups from identification and to keep their data safe. Careful consideration has been given to the privacy, security, and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the Privacy impact assessment for the Integrated Data Infrastructure available from www.stats.govt.nz.

The matching of different data sources on the IDI spine is done by Statistics NZ. These datasets are anonymised thereafter and made available to researchers. Further information on the IDI is provided in Appendix A. The results are based in part on tax data supplied by Inland Revenue to Statistics NZ under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form, or provided to Inland Revenue for administrative or regulatory purposes. Any person who has had access to the unit record data has certified that they have been shown, have read, and have understood section 81 of the Tax Administration Act 1994, which relates to secrecy. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

Non-Technical Summary

Fighting tax evasion has long featured in the agenda of most tax administrations, not only because evasion is detrimental to public finances but also because it hampers competition and creates unfairness among taxpayers. Measuring the extent of tax evasion is a natural first step in tackling the phenomenon, but a willingness to conceal the behaviour, and the difficulty of finding traces of evasion makes this quest far from straightforward.

Direct measurement of non-compliance through audits of the taxpayer brings valuable information but they are generally costly and the outcome of the audit is dependent on the ability of the auditors to fully uncover evasion. Surveys of non-compliance suffer from untruthful answers as taxpayers are wary of revealing their involvement in informal practices to avoid self-incrimination. These obvious difficulties have pushed researchers to find innovative ways of eliciting the extent of non-compliance using its traces rather than from direct observation.

In this paper we use a household's observed expenditures to infer true income. We focus on a particular group of the taxpayer population: the self-employed. This group is particularly interesting because the lack of third-party reporting and limited or no withholding of their income gives them differential opportunities to conceal their income relative to employees whose income is withheld at source through PAYE. They also represent a non-negligible fraction, around 15%, of the employed in New Zealand.

The method is based on the intuitive premise that the level of expenditure of a household is reflective of their income. The limited opportunities for employees to underreport their income means that the relationship between their expenditure level (on a range of expenditure items) and the income they report can be used to ascertain the true level of income of a comparable self-employed household in order to sustain the same level of expenditure. Given a particular level of expenditure, any differences between the income reported by the employee and the self-employed can be used to provide an estimate of the income evaded by the latter.

For this purpose, we use the Household Economic Survey (HES) that records expenditure and income for a sample of NZ households. In most countries where this method has been applied, linking administrative to survey data on incomes for tax purposes is not possible. However, New Zealand has a rich anonymised research database which holds information on survey participants matched to their tax records. This enables us to minimise issues of measurement error that plague survey data, and to obtain a cleaner measure of hidden income when incentives for misreporting are at stake. Individuals have less incentive to misreport their income to the survey, while misreporting to the tax administration results in direct tax savings. Where this is the case, measuring evasion using income reported to the survey is likely to result in a lower bound estimate of the extent of tax evasion.

The matched results suggest that the self-employed underreport on average around 20% of their incomes to the tax authority, with a 95% confidence interval of approximately 10-30%. This 'central estimate' is robust to different expenditure bundles, definitions of income and 'self-employment'. As expected, we find estimates using survey reports are lower. Interestingly, the income-gap appears to vary by gender (females underreport less on average) and region (urban residents underreport more). In New Zealand an important consideration when using the above method to obtain underreporting estimates is whether the possibility of channelling income through trusts or closely-held companies leads to lower reported personal incomes especially by the self-employed. Though data available to test for such effects are limited, we nevertheless find that our 20% underreporting estimate appears to be robust to tests that distinguish between those with, and without, access to such income sources.

Comparisons with other countries should be made with caution due to differences in timing, methods, source of the data and definitions, but the proportion of true income underreported in New Zealand appears to be comparable to estimates for the UK (~19%) and Canada (11-19%) while being lower than found in countries such as United States (25-30%) and Greece (~42%). However, our evidence suggests that estimates for other countries' which are based on survey data, may be biased downwards to some degree. The estimates for other countries may be more accurately compared to a lower figure of about 12% - a value we obtain if we use household expenditure survey data only to estimate underreporting in New Zealand.

Finally, some caution is warranted in interpreting our estimates of NZ income underreporting. The data underpinning our results are from triennial household expenditure surveys over 2006 to 2012 and therefore represented an average across these three years. Because of the limited size of the HES it has not been possible to examine whether or not underreporting by the self-employed has changed over this period, which also witnessed a number of changes to tax policy settings with possible effects on reporting behaviour.

1. Introduction

Measuring unrecorded or 'hidden' income (sometimes referred to as the hidden or shadow economy) is notoriously complicated due to the willingness to conceal it. There are a variety of reasons why income may be received but not recorded, of which avoidance of tax liabilities is an important, but by no means the only, motivation. For tax compliance purposes, some taxpayers' ability to hide a part of their income results in direct measurement of non-compliance being rare and costly.[1]

Surveys of non-compliance run into the caveats of non-response, selection bias and untruthful answers. Intensive audits of tax returns on the other hand, while widely informative, are especially resource intensive. These difficulties of directly measuring non-compliance make it necessary to devise creative ways of tracking its extent such as the observation of expenditure patterns to find traces of true income as initially proposed by Pissarides and Weber (1989) applied to the UK, and more recently by Feldman and Slemrod (2007) for the US.

Pissarides and Weber (1989) used data from the UK Family Expenditure Survey to estimate the amount of non-compliance of the self-employed. The high visibility of employment income, due to the prevalence of third-party information reporting such as PAYE, significantly reduces the scope for employees to underreport their incomes.[2] Self-employment income on the other hand, being generally self-reported, offers greater opportunities for evasion. Mapping the expenditure and income patterns of employees, and inverting this relationship for the self-employed helps identify the extent of underreporting of the latter.

Using this general framework, estimates of hidden income have been produced for a number of countries largely due to the availability of surveys of family income and expenditures. Importantly however, as highlighted by Slemrod and Weber (2012), estimates of income underreporting based on survey data rely on the crucial assumption that interviewees report the same income values to the survey and to the tax authority. However, there are several reasons to believe that this might not be the case which motivates the investigation in this paper.

Firstly, incomes reported to surveys might be subject to omissions of income sources, or recall errors especially for the group of interest, the self-employed, as their income is more irregular and the accuracy of the reports declines with the length between the occurrence and the reporting. Secondly, the incentives for reporting to the survey and to the tax administration are different. Misreporting income to the tax administration translates into direct tax savings, but risks penalties and reputational damage if identified, for example by a tax audit. There are no such effects from misreporting to the survey however. This has direct implications for the estimation of income underreporting based on survey information: if survey-reported income aligns better with true income, this will result in a downward bias in estimates of income underreporting using purely survey data.

[1] An example where direct measurement has been attempted is the Taxpayer Compliance Measurement Programme (TCMP) in the US; See Feldman and Slemrod (2007) for discussion. Non-tax motivations for hiding some incomes include where the income earning activity is illegal (e.g. drugs) or where there are moral/cultural barriers to acknowledging or recording some income sources (e.g. prostitution, even if legal).

[2] Below we use the terms employee/self-employed rather than employment/self-employment. Employees are those who are hired by a *third*-party. The self-employed are those employed on their own account. They might also receive a shareholder salary but they still retain discretion over the amount payed (to themselves). The main distinction for our purpose is that self-employment income is not third-party reported and there is discretion over the income declared as opposed to employees where withholding makes income visible.

In this paper we address the criticality of this survey reporting assumption by using a unique dataset that links survey participants in the Household Economic Survey in New Zealand to their tax records for a series of years.[3] This allows us to investigate the consequences of assuming consistent reporting between income sources for estimates of income underreporting in New Zealand. To do so, we use different specifications of survey and 'register' income (reported to Inland Revenue), and analyse the validity of income reported to the survey by both employees and the self-employed. While the survey reports for third-party employed map closely to their tax register information, this is not the case for the self-employed.

We find self-employment income is reported with more error than employee income and comparing survey versus register data shows that income underreporting estimates obtained purely from survey data result in a downward bias, in part due to a higher average income reported to the survey than to the register by the self-employed. Substantially higher underreporting is uncovered when using the more reliable income measure from the register.

Another advantage of our approach is that it combines the richness of survey information that cannot be obtained from a data register perspective with the accuracy and reliability of income from administrative sources. This also allows us to investigate the heterogeneity of evasion responses by the self-employed according to different individual and household characteristics. Knowing the heterogeneity of hidden income across demographic groups, for example, yields interesting insights to identify the compliance propensities of individual taxpayers which is essential for policy design. The characteristics we focus on in this paper are the gender, age, regional location and the legal form of the self-employed.

In addition to survey-based analyses, asymmetry in the underreporting of earnings by the self-employed and the employed has been observed directly by a number of countries' tax administrations using individual taxpayer records. For the US, for example, based on administrative data the IRS reports underreporting of non-farm incomes by as much as 63% in 2008-10. For the UK, HMRC report a tax-gap around 14% in 2014-15 from self-employed sources (HMRC, 2016, p.50). There is no equivalent evidence to date of the extent of evasion responses for this group in New Zealand using either survey-based or register data.[4] A primary contribution of this paper is, therefore, to produce evidence of the extent of the self-employment income-gap in New Zealand. We find that the self-employed underreport around 20% of their incomes to Inland Revenue and that this estimate is robust to alternative income and expenditure specifications and self-employment definitions.[5] It is however distinctly larger than would be obtained if relying solely on consumer survey methods.

In terms of identifying the non-compliant, our results suggest that underreporting does not seem to vary with age but males underreport significantly more than females. This is consistent with the tax evasion literature and previous findings using this method for the UK; see Cabral et al. (2016). Underreporting also varies by region, being typically more concentrated in more densely populated (urban) regions with a higher concentration of economic activity in New Zealand, particularly Auckland, Wellington and

[3] The Household Economic Survey is the equivalent in New Zealand to the Living Costs and Food Survey in the UK and the Family Expenditure Survey in the US.

[4] Macro-based estimates put the level of tax evasion in New Zealand between 7% and 11% of GDP (Giles, 1999) and 12% for the period 1999-2006 (Schneider, 2010). However, those macro approaches are known for giving inflated estimates and their use has been widely criticised in the literature (ISWGNA, 2006; Breusch, 2005).

[5] The income-gap estimated here could result from both deliberate and inadvertent non-compliance; it measures the *average* level of underreporting across the population.

Canterbury. We fail to find robust evidence of a significant effect of the legal form of the self-employed (sole trader, director/shareholder, partnership, scheduler payments) where different forms may have differing opportunities to underreport, as outlined by Kleven et al. (2011). We therefore cannot confidently reject the hypothesis that, on average, the proportion of income underreported is similar across all self-employed forms, though caution is warranted in interpreting this result due to the possibility of missing income for some self-employed forms (e.g. income held in trusts) and relatively small sub-sample sizes.

In summary, the present paper contributes to the tax non-compliance literature that uses traces of true income from expenditure surveys in three respects. First, we assess the relevance of the key assumption in much of the literature that households declare consistently to the survey and to the register. Unlike previous research using the expenditure-based approach, we correct for measurement error on the income side by introducing administrative records for each individual. This enables us to relax the assumption of accurate reporting in the survey, and obtain a more reliable estimate of the income-gap by comparing estimated true income to reported income where reporting incentives differ.

Secondly, by assessing how closely income declared to the survey maps to income declared to the tax authority by both employees and the self-employed, we contribute to the literature on measurement error. New Zealand is one of the few laboratories where measurement error can be analysed in this way. Previous evidence on measurement error for income reports by, for example, Bound et al. (1994) and Kreiner et al. (2014), has focussed on *employees* with the self-employed typically eliminated from the analysis. Assessing the extent of measurement error of self-employment income, we find this to be a primary reason behind the lower estimates of underreporting when those are obtained from survey data alone. If this feature arises in other countries, it implies that survey-based estimates are likely to correspond to a lower bound of true income underreporting.

Finally, we contribute to the tax evasion literature more generally by exploring how far observable individual and household characteristics correlate with income underreporting.

The remainder of the paper is organised as follows. Section 2 briefly reviews the literature on the measurement of income underreporting. Section 3 outlines the methodology used in the current paper and its identifying assumptions. Section 4 presents the data and the main variables that feature in the estimation. Section 5 outlines the main results, presents the robustness checks and discusses the role of measurement error in the estimation of non-compliance using survey as opposed to register data, and section 6 concludes.

2. Previous Literature

The literature measuring the shadow economy can be broadly divided into two categories: direct methods that use the individual taxpayer as the compliance decision unit, and indirect, typically more macro-level methods that use proxy relationships to infer the extent of non-compliance. Here we focus on the former *micro* approach; Slemrod and Weber (2012), Gemmell and Hasseldine (2012, 2014) and Feige (2016) provide broader reviews and summaries of alternative methods. In this section we summarise previous studies that aim to identify traces of non-compliance from taxpayer data.

Slemrod and Weber (2012) argue that methods that rely on directly measuring traces of non-compliance, including income-expenditure discrepancies, represent a fruitful approach for measurement. One of the first contributions exploiting this discrepancy to measure the size of the black

economy in the UK is Dilnot and Morris (1981). They computed excess expenditures from survey data for 7,200 households and characterised as 'black-economy households' all those where expenditure exceeded income by 20% and by at least £3. They found that the black economy was between £3.2 and £4.2 billion representing around 2.3-3% of 1977 GNP. Most of the black economy households were headed by an individual working in a skilled or semi-skilled occupation with 22% of households headed by a self-employed individual. Similarly, the self-employed were much more likely than employees to be part of the black economy, and individuals in skilled or semi-skilled manual occupations were more likely than the unskilled to participate in black economy activities.

Building on Dilnot and Morris (1981), Pissarides and Weber (1989) provided a more structured framework for the estimation of underreporting of the self-employed in the UK. 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 employees who are assumed to be honest reporters. Pissarides and Weber (1989) estimated that true self-employment income was on average 1.55 times the income reported by the self-employed in the UK using the 1982 Family Expenditure Survey which translates into an income-gap of 36%. They found underreporting to be higher in blue-collar households than in white-collar households (1.65 versus 1.5).

Lyssiotou et al. (2004), using the same approach for 1992, estimated an income-gap of 22% on average, also higher for blue-collar households (28%) than white-collar (15%). However, using a complete demand system, they found significantly higher estimates of underreporting, with self-employed blue-collar households underreporting their incomes on average by 54% and white-collar households by 34%. They estimated the size of the black economy to be 10.6% of GDP in 1993. Recent evidence for the UK, from Cabral et al (2016), using the same framework applied to survey data, finds underreporting of around 19% by the self-employed.

Similar studies have been conducted in other countries but care needs to be exercised when directly comparing estimates as the techniques and datasets vary. 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) which corresponds to an income-gap between 11%-19%. More recently, Hurst *et al.* (2014) for the US found that self-employment income was underreported in surveys by 25-30% which is similar to estimates by Engström and Holmlund (2009) for Sweden. Johansson (2005) found that the self-employed underreport their incomes in Finland by 16.5% for households of one self-employed individual (42% for households of two self-employed) representing 1.3% (3.2%) of GDP.

The essence of the methodology – using incomes and specific expenditures – has been applied more widely. Feldman and Slemrod (2007) assume that the relationship between true income and charitable contributions are independent of labour market choices, and estimate the level of underreporting associated with the different sources of income. They found income from self-employment in the US to be underreported by an average of 35%.[6] More recently Artavanis *et al.* (2016), in the same spirit as Pissarides and Weber (1989), use a unique dataset for a large bank in Greece that contains the universe of applications for consumer credit products and mortgages. They invert the relationship between debt

[6] Note that this survey-based estimate is much lower than the 63% IRS underreporting estimate quoted above for the US. It is unclear how far this is due to the different methods to the different methods and data used but, as discussed further below, it could be related to a tendency for survey-based estimates to be biased downwards relative to register-based estimates.

and income to estimate income underreporting by the self-employed, finding an underreporting average of 42%-45%.

Our paper most closely follows that of Pissarides and Weber (1989) and Cabral et al (2016), based on food expenditure-income relationships for employees and the self-employed, which we extend to examine a variety of expenditure categories. As noted earlier, our use of matched register data for several years also allows us to examine the robustness of the more common survey-based estimates of underreporting.

3. Methodology

3.1 The Pissarides-Weber approach

Our approach uses the expenditure capacity for a given level of income of employees and the self-employed to estimate hidden income, based on inferring true income for the self-employed from their expenditure capacity. The model recognises two types of households – self-employed and employed – that despite being similar in terms of expenditure, differ in their opportunity to underreport incomes.

Let Y^R be reported income and Y^T true income, then for employee households:

$$Y_E^T = Y_E^R \tag{1}$$

Self-employment income, on the other hand, not being subject to third-party reporting, provides the self-employed with the *opportunity* of misreporting their earnings, which we specify as:

$$Y_{SE}^T = kY_{SE}^R \tag{2}$$

where k is a scaling factor by which reported self-employment income needs to be multiplied to obtain *true* income. The scaling factor k is the coefficient we are interested in estimating. This scaling factor, can be translated into an income-gap, κ, defined as the proportion of income that is underreported:

$$\kappa = 1 - \frac{1}{k} \tag{3}$$

Clearly, both variables – the scaling factor and the income-gap – convey the same information expressed in different ways; we focus on income-gap results in Section 5 but report both in Appendix C.

Observing the level of expenditure and income of employees gives an indication of the level of income necessary to sustain a particular level of expenditure. That is, for a given level of expenditure, the difference between the incomes reported by the employed and by the self-employed give us an estimation of income underreporting.

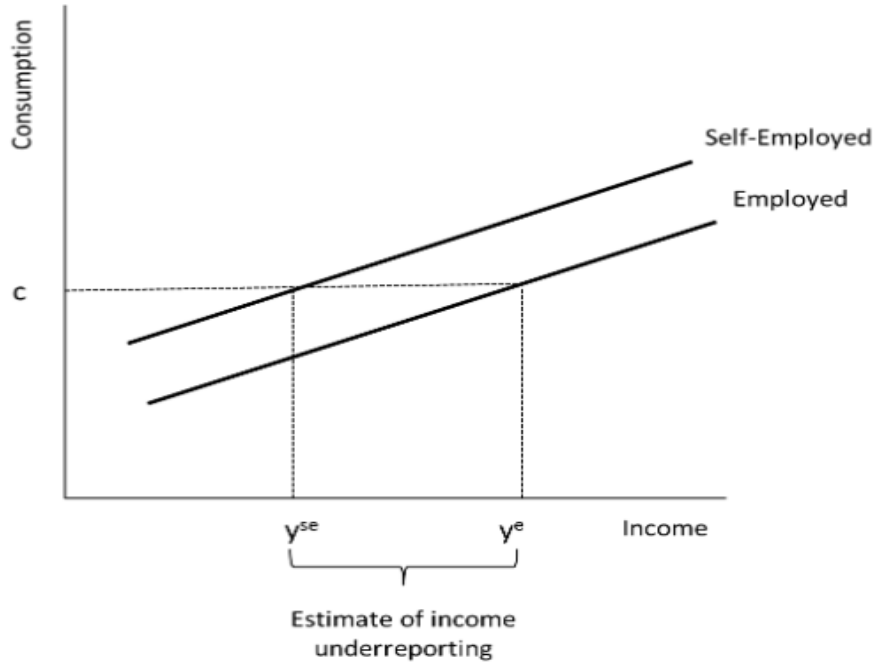
Graphically, Figure 1 represents this relationship – the Engel curve – for the employed and self-employed. The observed Engel curve of the self-employed can be seen to lie above that of the employed. Given a certain level of expenditure c in Figure 1, the self-employed report an income level, y^{se}, while the employed report income of y^e for the same level of expenditure. The difference between y^{se} and y^e provides an estimate of income underreporting.
Empirically this can be translated into an estimating equation as follows:

$$\ln Expenditure_i = \beta_o + \beta_1 \ln Income_i + \gamma SE_i + Demographics_i * \Theta + Wealth_i * \Lambda + \varepsilon \tag{4}$$

where β_1 represents the elasticity of income with respect to expenditure (the slope of the Engel curve), γ is the coefficient on a shift dummy variable (=1 if self-employed; 0 otherwise) that represents the

shift from the employed Engel curve, and Θ are the coefficients of a vector of household characteristics. Effects of household wealth on expenditures are captured by the parameter, Λ.

Figure 1



To capture other important determinants of expenditure levels (4) includes a vector of household and individual demographic characteristics (number of children, marital status, age and gender) as well as variables that proxy for household wealth. Since wealth measures are not directly observable in our datasets (partly due to the non-taxation of wealth in New Zealand), we seek to capture wealth-related effects on expenditure using two sets of wealth-related or permanent income-related variables, whilst recognising that these are imperfect proxies.

Firstly, we include 'soft' survey-reported variables related to housing (type of tenure of the dwelling, number of rooms, the number of stories, type of dwelling, the local housing benefit (Accommodation Supplement) area where the house is located,[7] and the region). Secondly, two variables from the register are used that indicate (i) the annual variability of household income (as a measure of income risk), and (ii) its average growth rate, over three years to proxy the stability of household finances. We also conduct extensive sensitivity tests in section 5 for alternative wealth proxies and capital income measures.

An estimate of the scaling factor can be obtained using the estimated parameters γ and β_1 as:

$$k = \exp\left(\frac{\gamma}{\beta_1}\right) \tag{5}$$

with the corresponding income-gap computed using equation (3).

[7] The accommodation supplement is a transfer from the government to assist people with limited income and cash assets to sustain their accommodation costs. The amount to be received is affected by the area the household is in within the region with higher compensations being received for the North and Central Auckland region. Maximum entitlement rates are only received subject to household circumstances and to an income and asset tests.

A further consideration regarding the estimation of equation (4) is that the measure of income that is expected to influence expenditure decisions is permanent income. However, permanent income is unobservable, and the measure of income we observe is only recorded income (either from the survey or the register). As a result, permanent income is measured with error by both sources. We therefore instrument for recorded income using educational attainment variables and the occupation of the household head: whether they are 'white-collar' or 'blue-collar'.[8] Equation (4) is therefore estimated using two-stages least squares with OLS equivalents are reported in Appendix C.

3.2 An extension

The estimating equation can be also modified to allow investigation of the heterogeneity of the income-gap with respect to characteristics of interest that can help tax administrations to profile non-compliant individuals. This identifies both the traits that correlate with tax evasion and the types of households most likely to be non-compliant. For each of the characteristics we allow the intercept to vary across employees and self-employed with the same characteristics, allowing identification of the 'pure' effects associated with self-employment status rather than from heterogeneity in the characteristic itself.

For example, when investigating whether gender affects evasion behaviour we include intercepts for male and female employees *and* male and female self-employed. This allows us to identify separate coefficients of underreporting for self-employed males and females. We then test whether gender differences in the estimated income-gaps are significantly different and, if so, the characteristic of interest can be signalled as relevant in terms of profiling non-compliance characteristics.[9]

Specifically, we re-write equation (5) as:

$$\ln Expenditure_i = \beta_o + \beta_1 \ln Income_i + \sum_{n=1}^{N} \gamma_n^{SE} SE_i I_n + \gamma_n^{E} (1 - SE_i) \mathrm{I}_n + Demographics_i * \Theta + Wealth_i * \Lambda + \varepsilon_i \quad (6)$$

where I is an indicator for the characteristic of interest (such as age or gender), that has categories $n = 1, \ldots, N$. The differing intercepts for the self-employed and employed associated with characteristic I ($N*2$) can be used to estimate the income-gap as:

$$\kappa_n = 1 - \frac{1}{\exp\left(\frac{(\gamma_n^{SE} - \gamma_n^{E})}{\beta_1}\right)} \qquad n \epsilon N. \quad (7)$$

A Wald test of the equality of the income-gaps for the different categories of the variable can ascertain whether characteristic I signals that underreporting significantly varies across the characteristic and thus identifying non-compliers.

[8] Individuals are classified into white-collar if they occupy the positions of managers or supervisors and blue-collar otherwise.

[9] Ideally, we would like to combine as many characteristics as possible to ascertain which combination of characteristics is differentially found to underreport. However, the low number of observations for self-employed households means that dividing them into smaller cells for each defining characteristic results in very low observations per cell making results unrepresentative and/or large regression standard errors.

Identifying Assumptions

Before considering results from applying the above approach it is important to be aware of the identifying assumptions on which it relies and possible associated caveats. There are four key assumptions in particular:

(i) Expenditure is correctly reported by all households on average (but does not preclude the possibility of random measurement error);
(ii) Employees do not underreport their income;
(iii) The (constant) elasticity of expenditure to true income is the same for the self-employed and employed once we control for any confounding factors;
(iv) The elasticity of expenditure is the same for reported and hidden income.

We discuss each in turn.

(i) Expenditure is correctly reported by all households.

Expenditure is the key measure relied on to assess the income capacity of the household and is available only from (HES) survey reports by households. To maximise accuracy, the HES collects expenditure data based on two types of techniques: diary recording and recall questions, with each technique applied to different expenditure items. Recall data has been recognised to suffer from inaccuracy due to some quantities being difficult to remember (Gray, 1955), telescoping errors (Neter and Waksberg, 1964), and progressive amnesia – declining memory with the length of the recall period – (Sudman and Bradburn, 1973; Scott and Amenuvegbe, 1991).

Despite this, recall questions are particularly helpful when the expenditure items of interest are infrequently purchased such as durables; e.g. furniture, household appliances. For more frequent purchases, diaries seek to address accuracy issues by recording respondents' expenditure on the day it is incurred. In the HES, items such as food expenditure, alcohol, clothing and footwear are recorded in a diary that is kept by members of the household for a period of two weeks.[10]

In the New Zealand case, we have reasons to believe that food and our non-durables basket are reasonably accurately reported. First, because diaries are held only for a limited period of two weeks, this makes 'diary fatigue' less of a concern. And as items recorded in the diary are regularly bought, infrequency of purchase is unlikely to substantively affect reports.[11] The basket of non-durables includes a variety of expenditure items that are again recorded in the diary. We exclude from this measure expenditure on alcohol due to established evidence that items such as tobacco and alcohol expenditure are poorly reported in surveys, being sensitive to associated social stigmas.[12] Food expenditure is one of the best covered items of expenditure, with its coverage ranging around 80% in the UK and the US (Brewer and O'Dea, 2012; Meyer and Sullivan, 2010).

[10] Diaries, on the other hand, suffer from 'diary fatigue' which might affect reports if they pose a high burden on respondents, while short period diaries do not deal well with infrequently purchased items. A mixture of both types of technique are used in the HES to record expenditure data – the approach pursued by Statistical Agencies in a number of countries.
[11] Browning and Leth-Petersen (2003), comparing recall and diary recording of expenditure on food at home for the US, suggest that individuals do a 'remarkably good job' when recording food at home as opposed to total expenditure.
[12] The coverage ratio of tobacco and alcohol in the Living Costs and Food Survey in the UK (the equivalent of HES in New Zealand) with respect to the National Accounts is 40%.

Durable goods are usually less well measured in surveys, usually via recall questions, and the recognised inaccuracy of this item of expenditure makes it not ideal for inclusion in a dependent variable.[13] Of course, for reliable parameter estimates, measurement errors in the regression dependent variable are a less severe problem than measurement error in an independent variable (coefficient estimates remain consistent but with less precision; see, for example, Pischke, 2007). However, to retain a cleaner and more accurate measure of expenditure, we omit durables expenditures from our dependent variable.[14]

(ii) Employees do not underreport their income

Wage employees generally have lower opportunities to evade their income, which is typically third-party reported and subject to withholding taxes, thus minimising their scope to underreport. However, there may be cases where wage workers can collude with their employers to negotiate a lower legal wage and receive 'under the table' payments. If this is the case, then the estimate of the self-employment income-gap that we observe would correspond to a lower bound estimate. When using employees as a benchmark against which to assess the self-employment income-gap, we are assuming a baseline with *low,* but not necessarily *zero,* opportunities for evasion.

(iii) *The sensitivity of expenditure to true income is the same for the self-employed and employed*.

This assumption is similar to that posed in Feldman and Slemrod (2007) who assume the same relationship between true income and charitable contributions in the US among self-employed and employed. Similarly, Artavanis *et al.* (2016) assume the credit sensitivity to true income is the same for self-employed and employed. In our case we assume that the pattern of expenditure to true permanent income is unrelated to the selection into self-employment. If there is a different relationship between true income and consumption for both types, then this might be a reflection of hidden risks. In order to control for those risks, we include proxies of income growth and income volatility.

Another potential source of concern is that some self-employed might be able to treat some personal expenses as business expenses or are able legitimately to claim some business expenses against tax that employees incurring similar expenses cannot offset against tax.[15] In this case the self-employed would appear to have a higher disposable income to spend. The survey explicitly asks about personal expenditure and business expenses in separate parts of the survey. If individuals were treating personal expenses as business expenses, then personal expenditure in the survey on items that can typically be reclassified as a business expense should be lower, *ceteris paribus,* for the self-employed than for the employed. In fact we observe the converse in the data. For example, if the self-employed attribute all of their household fuel expenses to their business, then fuel expenditure of the household would be close to zero, and therefore equivalent employees should have higher household fuel expenditure.

For this reason, we restrict our focus on expenditure categories that are not typically those claimed as business expenses. Food is a small fraction of total business expenses – it can only be claimed if it is an entertainment expense, and usually only 50% of the cost is deductible e.g. if incurred during business trips or promotions. In our non-durables measure of expenditure, we include housing costs that would

[13] The coverage ratio in the Living Costs and Food Survey is variable and ranges from 55%-80%.
[14] Additionally, durables may be used differently between employees and the self-employed as a source of saving or consumption smoothing. For example, the greater volatility of income for the self-employed may encourage greater durable purchases in years of unusually high income.
[15] As in a number of countries, employees in New Zealand are unable to claim business-related expenses even where this may be a legitimate aspect of their employment. In general, this reflects an assumption by the tax authorities that legitimate business expenses in this case would be reimbursed by the employer, though this may not always be the case.

take into consideration utility payments that can be claimed as a business expense. If reclassification of personal spending on utilities as a business was a major feature of the self-employed households then it would not be appropriate to use this type of expenditure in an Engel curve approach to underreporting estimation. In section 5 we test robustness to different expenditure classifications.

(iv) The elasticity of expenditure to hidden and reported income is the same.

This assumption reflects the fact that hidden income has the same capacity to fund spending as reported income. There are reasons to believe that in general this will be the case given that the *source* of the income is irrelevant to its purchasing power. If, on the other hand, hidden income of the self-employed is more likely to be saved – perhaps to minimise detection via extravagant consumption patterns – then using observed self-employed expenditures would tend to bias downwards estimates of hidden income. Our use of such expenditure items as food or non-durables, however, can be expected to minimise such issues since there is less reason for the self-employed to seek to avoid spending hidden income on this non-conspicuous type of total spending composed of many, relatively low value, individual items.

4. Data

This section describes the administrative and survey data used in section 5. The Household Economic Survey (HES) collects information on expenditure and reported income by households in New Zealand and forms the core dataset in the analysis. Taxpayers' administrative data provide a second source of income reported to the tax administration by each individual. Both data sources are available in Statistics New Zealand's Integrated Data Infrastructure (IDI), where individuals and households are matched across a number of survey and administrative sources.

4.1 The Household Economic Survey

The Household Economic Survey (HES) collects information on expenditure and income across households in New Zealand. HES in a face-to-face interview where responses are recorded using computer assisted methods.[16] The extended version of the survey that includes a detailed questionnaire on household expenditure is run every three years and an interim shortened version runs in the two intervening years. Each individual in the household is surveyed about income earned in the reference period and expenditure is measured at the household level for a wide array of expenditure categories.[17] This dataset provides the key variable: expenditure of the household; and a measure of household income as reported to the survey, obtained by aggregating income reported by each household member.

4.2 Tax Authority Data

The Inland Revenue Tax Data tables held by Statistics New Zealand within the IDI collect information on income reported to the tax authority.[18] These tables contain the universe of annual income tax returns filed by individuals (Employer Monthly Schedule (EMS) and the IR3 tax return) with anonymised records accessed by authorised researchers using the secure IDI data-lab.

[16] Face-to-face has been signalled as an efficient way of minimising non-response and highlighted by the Rockwool Foundation as a desirable survey method to ensure response to sensitive questions (Rockwool Foundation, 2006). Expenditure questions may not in general be considered sensitive but this will apply to certain items of expenditure, e.g. tobacco or alcohol as we discuss below.
[17] The types of income and expenditure surveyed in the HES are discussed in more detail in later sub-sections.
[18] For further discussion of the IDI see Appendix A.

In New Zealand, employees' income from wages and salaries are withheld (PAYE) and third-party reported by their employers using the EMS. This is a mandatory reporting requirement for all employers with paid employees. The IR data tables are built on the basis of EMS and supplemented with information from the IR3 return. The IR3 tax return is required for individuals who earn income other than salary and wages, dividends and interest and/or taxable Māori authority contributions. Particularly interesting for our analysis are IR3 filing individuals earning self-employment income that can readily be classified into sole traders, director/shareholder of a company, or partners in a partnership.

Interestingly, the register income data allows us to distinguish a regular EMS payment made by an employer to an employee from the salary payments that self-employed individuals pays themselves, allowing more accurate classification of individuals into self-employment.[19] Otherwise, directors or shareholders receiving a salary would be misleadingly classified as employees while it is apparent that self-employment provides them with some discretion regarding the amount they receive as a salary.

This dataset provides granular information about the individuals in the survey. Unlike previous studies this enables us to: (1) identify the legal form (partners, sole traders, director/shareholders etc.) of the self-employed from a reliable source; (2) observe income as reported to the tax administration, for which there are stronger underreporting incentives in the form of tax savings (but also potentially greater sanctions if discovered); and (3) circumvent potential misclassifications of employment income sources where self-employed individuals pay themselves a salary.

This third aspect is a key issue as the *opportunity* for underreporting is clearly different when the third-party ('employer') that reports income is the self-employed person him/herself compared to when it is a separate individual. It also avoids our analysis having to rely on survey interviewee's self-classification into employment and self-employment income sources.

4.3 A Combined Dataset

Respondents to the household economic survey are matched to the register data using a unique identifier assigned by Statistics NZ. Linking the individual in the survey to their tax records allows us to observe longitudinal records on reported incomes to IR. Each individual's (anonymised) income from the register also needs to be aligned to the income received during the reference period of the survey, since survey interviews are conducted at various points throughout the tax year. Our methods of aligning annual survey and register income data, and tests of alignment accuracy, are described in Appendix A.

To build the dataset we start with the survey. The three-year cycle for the full HES (with an extensive questionnaire on household expenditure) restricts our sample to the years 2006/07, 2009/10 and 2012/13. Interviewees in the survey are matched to their tax records using the unique IDI identifier provided to obtain their income as reported to the tax authorities. We restrict the sample to households where the household reference person (HRP) is in employment and the household receives employment and/or business income. We further restrict the HRP to be below 60 years of since other studies have found expenditure that patterns vary in retirement; see, for example, Aguiar and Hurst (2005).

Households need to be classified into employee or self-employed households. The availability of register income enables us to distinguish clearly self-employment income sources from employment where the former includes net profit and any PAYE payments or withheld payment received by the sole

[19] This also applies to those self-employed (e.g. contract workers) required by IR to be subject to withholding payments, which effectively provides a third-party report of their incomes.

trader, director/shareholder or partner. We include two alternative definitions of a self-employed household. The first classifies a household as self-employed if it has *any* income from a self-employed source, and is otherwise treated as an employed household. This definition reflects a household's *opportunity* for misreporting self-employment income due to the general absence of third-party reporting.

The second definition classifies a household as self-employed if it derives more than 25% of household income from self-employment; it is classified as an employed household otherwise.[20] This second definition, which we refer to as a *25% rule*, seeks to avoid misclassification of households as employed when a substantial proportion of household income comes from self-employment sources. If focuses on the *weight* of self-employment income within household finances.[21]

Tax records for interviewees allow us to identify where the self-employed is a sole proprietor, a director/shareholder or part of a partnership, enabling tests of whether different self-employed categories display different underreporting behaviour.

4.4 Measuring Income

The survey collects separate information on each income source received by each individual within the household. They can be classified into five groups: labour (employment and business) income; pensions; investment income; benefits; other sources of recurrent income. The main difference between the income sources collected in the survey and those available from the register is that the IDI tax tables record information on *taxable* income. There are some additional differences in coverage of taxable income in the IDI that are discussed below.[22]

To account for the difference in coverage between sources we have constructed a mapping (in Appendix B) of income types in the two sources from which we have constructed two measures of income that are comparable across the survey and the register (IDI). The first includes employment (labour) and business income only. It captures all payments from EMS for employees, net profits and withheld payments received by the self-employed. We refer to it below as *Labour Income* for short (though recognise that, for the self-employed at least, it may include income best described as a return on capital). The second, which we will refer to as *Total Comparable Income*, collects information on employment and business income, rental income, taxable benefits, paid parental leave and accident compensation (ACC).

Income is recorded gross-of-tax in the survey and also in the tax tables. As the full taxable base is not available to us, we are unable to compute the tax liability to obtain disposable income – without the prospect of introducing more error into the variables. We therefore work with variables in gross terms. The fact that we do not account for all sources of household income only matters in our framework if

[20] This definition is applied to register income as it is thought to be a more accurate measure of reported income that can be obtained from a recall question.

[21] A concern with this definition, introduced by Pissarides and Weber (1989), is that despite having been used as a strategy to measure the importance of the self-employment source, the rule is applied on the proportion of *reported* self-employment income to total reported income which differs from '*true*' income. This definition might therefore entail misclassification of households that underreport their self-employed sources heavily and who, using this rule, are classified as employed, this mis-measuring the benchmark 'employees' group. For this reason, we also explore the alternative 'opportunity' based definition.

[22] Some sources of taxable income such as dividends and interests are not observable within the IDI. Interests and dividends are subject to withholding taxes and therefore there is no obligation to file a tax return as long as they are withheld at the right tax rate.

the residual income not included in our measure is held differentially by the self-employed and employed conditional on their comparable income. In order to test whether there is evidence of this, we compute from the survey a measure of 'non-comparable income' – obtained by subtracting the survey income components that are comparable to the register from the total income measure in the survey. We find that, conditional on deciles of comparable income, there is no evidence that the self-employed and the employed differentially hold remaining income not accounted for in our comparable income measure.[23]

Self-employment income is often characterised by being more volatile than employment income, which is also observed in our data; see Appendix C. Such volatility of income can be interpreted as a form of income risk, causing current income to deviate from permanent income where the latter is likely to be more relevant for observed expenditure patterns, and hence should be controlled for. Fortunately, the longitudinal dimension of the register data allows us to control for individuals' income volatility experienced in the years prior to the survey. We also construct a measure of prior income growth as a proxy for changes (updates) in expectations of permanent income, and ultimately affect expenditure. We construct income risk from the standard deviation of the log of taxable income over the three years prior to the survey and income growth by the average growth of taxable income over the prior year to the survey. Artavanis *et al.* (2016) follow a similar approach to proxy for local economic conditions and income risk.

4.5 Measuring Expenditure

We create two measures of household expenditure to use as dependent variables: food and non-durable goods.[24]

Food expenditure is thought to be accurately reported to the survey for several reasons. Firstly, being a necessity, food is an item of expenditure that is less affected by transitory shocks and is not subject to infrequency of purchases. Secondly, it is not an item of expenditure that is associated with a particular lifestyle that non-compliant taxpayers may like to conceal such as expensive holidays or car purchases. Thirdly, expenditure on food is recorded using a two-week diary filled in by survey respondents which ensures more accurate reporting.[25]

Food has also been shown to be one of the items of expenditure that is better captured in expenditure surveys. Brewer and O'Dea (2012) in the UK, through a comparison of the National Accounts with the Living Costs and Food Survey (LCFS) find that food has a coverage ratio of around 80% for the period 1974-2009. These results compare to the patterns found in the US by Meyer and Sullivan (2009) who find a coverage ratio of 85%. Although there is no equivalent evidence for New Zealand, the similarity of the survey methodology with those in other countries leads us to expect the results to be comparable.

[23] The main types of income that are non-comparable are investment income, non-taxable benefits and family tax credits; see Appendix B. Of course, to the extent that the self-employed use trusts or companies as vehicles to receive some of their income, such as tax-free via capital gains, this may not be recorded within the 'non-comparable income' category captured in survey or register data. A further consideration is that since self-employment income relates to the last available tax record, there is a possible time mismatch between the periods to which survey expenditure and income refer. To correct for this time difference in both magnitudes, self-employment income is updated to the quarter during which the interview took place using the CPI inflation rate.

[24] Summary statistics of expenditure and income are presented in Appendix C. All income and expenditure variables are deflated to the year 2006 using the quarterly CPI. An alternative specification used the food CPI to deflate food expenditure but results are comparable.

[25] We comment further on the assumption of accurate reporting of food expenditure in Section 5.

The second expenditure category is a composite measure computed using expenditure on non-durable goods. This basket of non-durables goods is composed of expenditure on food, clothing and utilities, covering a wider spectrum of goods and hence allowing for more heterogeneity. We exclude expenditure on durables as these are potentially affected by problems of infrequency of purchase, telescoping and recall errors as evidenced in the US and the UK by Meyer and Sullivan (2009) and Brewer and O'Dea (2012) respectively.

5. Income Underreporting Estimates

The results presented in this section are obtained from estimation of equation (4). Following Pissarides and Weber (1989) and others, we recognise that annual reported income is likely to contain both transitory and permanent components, where the latter is expected to affect consumption expenditures. We therefore use instrumental variables regressions (IV) with educational attainment and the individual's occupation used as instruments for reported income. We further control for past income variability and average growth, household and head of the household demographics (age, gender, single/couple, number of children), and our previously discussed wealth indicators (type of dwelling, tenure, etc) and region, and controls for each of the three survey years.

Before turning to our underreporting results in detail, Appendix Table C4 compares OLS and IV estimates, and reports tests for endogeneity. If, as argued above, income is endogenous this is expected to bias downward estimates of β_1 in (5). If the self-employment dummy variable, SE, is exogenous, then γ in (5) would not be biased downwards directly as a result of endogeneity of γ but could be biased in either direction indirectly as a result of the bias in β_1, the bias depending on the covariance between SE and income. If – as we find – any bias in γ is relatively small compared to that for β_1, then from (5) we expect an *upward* bias in the underreporting variables, k and κ.

Appendix Table C4 confirms that OLS estimates of β_1 are biased downwards compared to IV estimates (it is around a third to a half of equivalent IV values) such that underreporting estimates are biased upwards in the OLS cases. The estimated SE dummy parameters appear to be biased downwards in OLS regressions only in the case of the survey data. As a result, using OLS, the upward bias in the underreporting estimate is greater using survey data. In all cases however OLS regressions severely bias underreporting estimates upwards, and Hansen J-test statistics strongly support the hypothesis that OLS estimates suffer from endogeneity. We discuss the implications of measurement error affecting underreporting in IV estimates in sub-section 5.3.

5.1 Underreporting

Table 1 summarises results for the estimated income-gap of the self-employed using alternative measures of expenditure, income and definitions of a self-employed household; detailed regression results are in Appendix C. Panel A estimates the income-gap classifying the self-employed using the 'opportunity' definition – where a household is classified as self-employed if they receive any self-employment income stream even if it is not their main source of income. This 'opportunity' definition has two main advantages. Firstly, the direct observation of income sources from IR's tax register avoids

having to classify individuals based on their survey response reports of self-employment and employment income sources. [26]

Secondly, unlike previous literature, this definition avoids using the *magnitude* of the self-employment income stream. Previous papers, such as Pissarides and Weber (1989) and Hurst et al. (2014) have used the share of reported self-employment income in total income to classify households into self-employment. However, classifying households based on reported, rather than true, income risks incorrectly assign a household into employment status where self-employment income is substantially underreported. [27]

Columns (1) and (2) of Table 1 respectively show income-gap results when using income measured from the register, and from the survey. Results are reported for each combination of expenditure (food and non-durable) with income ('labour' and 'comparable') as discussed in section 4.

Table 1 Income-Gap Estimates and Robustness to Definitions.

		(1): Register	(2): Survey
Panel A: Self-Employment: Opportunity			
Expenditure	**Income**	**Income-gap**	
Food	Labour	0.200***	0.114*
		(0.057)	(0.063)
Food	Comparable	0.193***	0.120*
		(0.048)	(0.062)
Non-Durables	Labour	0.204***	0.119**
		(0.047)	(0.051)
Non-Durables	Comparable	0.196***	0.124**
		(0.040)	(0.050)
Panel B: Self-Employment: 25% Rule			
Expenditure	**Income**	**Income-gap**	
Food	Labour	0.216***	0.107
		(0.066)	(0.075)
Food	Comparable	0.206***	0.111
		(0.055)	(0.073)
Non-Durables	Labour	0.254***	0.153***
		(0.053)	(0.059)
Non-Durables	Comparable	0.239***	0.158***
		(0.045)	(0.057)

Note: This table contains estimated income-gaps using different expenditure and income variables, income sources and definitions of self-employment income. Each table contains the coefficients of interest, the multiplier and the income-gap. Statistics on the quality of the instruments are provided in Appendix B. Asterisks indicate significance at *** p<0.01; ** p<0.05; * p<0.1.

Using food expenditure as the dependent variable and labour income as reported in the register, we estimate the self-employed underreport on average 20.0% of their income to the tax authority. The

[26] The US Internal Revenue Service (IRS) in their tax gap reports document that underreporting is concentrated in categories of income with limited information reporting, and underreporting generally decreases across income categories with greater information reporting.

[27] Pissarides and Weber (1989) instrument the self-employment dummy variable in order to correct for the misclassification. However, there are no clear instrumental variables to correct for this bias such that weak instruments can introduce a larger bias than not instrumenting.

estimate is similar (20.4%) when we use the broader set of non-durable expenditure items, demonstrating that using the different expenditure items does not seem to affect the measurement of the income-gap. This is despite the possibility that non-durables expenditure contains some items that could potentially be claimed as business expenses such as housing costs (utilities, rent). If reclassifying such personal expenses as part of the business is important within the data then the estimated income-gap using the non-durables basket should be biased downwards relative to the food-based estimate. That is, the self-employed individual's apparent personal consumption of non-durables – and hence income estimate – is lower, *ceteris paribus*. However, including non-durables in regressions appears to result in a similar estimated level of underreporting, on average.

We also test whether the measure of income used affects the estimation of income underreporting: lines (2) and (4) report results using the wider income definition which includes rental income, taxable benefits, and other regular payments (paid parental leave, student allowances) in addition to labour income. With values of 19.3% and 19.6%, this demonstrates that the income-gap is consistently estimated across both different expenditure and income measures.

Panel B in Table 1 tests for the robustness of the specification to the definition of a self-employed household, by instead applying the 25% rule to household incomes calculated from the register (a household is self-employed if more than 25% of household income comes from self-employment sources). Despite possible misclassification of households due to the rule being based on reported, rather than true, income it can be regarded as a way of refining those households for whom self-employment represents a substantial share of their household finances and hence greater incentive and/or opportunity to underreport.

If this is the case we would expect a higher level of underreporting to be observed once households with a small share of self-employment income are deselected. The results in Panel B, column (1) show that the income-gap estimates are robust to this change of definition: with food expenditures, the estimated income-gap is 21.6% (using labour income) and 20.6% (using comparable income) which are close to the results obtained in Panel A. The level of underreporting uncovered is only estimated to be larger when non-durables are chosen as the measure of expenditure: equivalent percentages are 25.4% and 23.9%. Since all of those register-based income-gap estimates in Panel B are larger (to varying degrees) than their Panel A equivalents, there is some evidence here that those with larger opportunities to evade – namely more than 25% of their total income from self-employment – display somewhat greater underreporting than the broader category of self-employed.

Turning to survey-based estimates, while the income components in both the register and the survey are conceptually equivalent, the variables differ in a number of respects, including due to measurement error in the survey variable as individuals are asked to recall the income from the previous 12 months or, for the self-employed, the last time accounts were prepared. We defer the discussion on the validity of incomes reported in the survey and its impact on income-gap measurement to sub-section 5.3. For now, it is sufficient to note that, in Table 1 column (2), using income from the survey consistently leads to a lower estimate of income underreporting, typically by around 6-10 percentage points. In addition, the survey based estimates are typically both noisier (slightly larger standard errors) and are not always significantly different from zero. Given the prevalence of survey-based estimates in the existing literature, this raises the important question of whether measurement error especially within survey data may inhibit identification of the full extent of income underreporting.

5.2 Robustness to identifying assumptions

Earlier we acknowledged that the method used to identify the magnitude of underreporting depends on a number of identifying assumptions. Below we consider, to the extent that the available data allows, how far those assumptions might influence our income-gap estimates.

(i) Do the self-employed have a preference for eating out?

Though food expenditure might reasonably be thought to be purchased similarly by the employed and self-employed for a given income, one caveat to this is that the self-employed may have a higher propensity to eat food out of the home rather than within (our food expenditure data includes both). For example, if the self-employed work longer hours there may be a preference for substituting commercially-prepared, for home-prepared, food. If this is the case, the equivalent food consumption would be more expensive for the self-employed.

To explore this issue, we could use a 'food eaten in' variable to replace our dependent variable in Table 1. However, since food eaten in and out are likely to be close substitutes, this would bias estimation of underreporting as food-in expenditures by the self-employed, for any given level of income, would not be similar to employees due preference differences rather than income reporting differences. It is therefore better to use total food expenditures whilst recognising that differences in food prices associated with eating in or out may raise expenditure on the latter, other things equal.

In the absence of food price data, to examine this issue – albeit indirectly – we repeat regressions of the form in (4) but where the dependent variable is the *share* of food eaten out in total food expenditure; see Table 2. Regression (2) suggests that, as expected, the share of food eaten out (by both groups) is positively related to their income levels, but both regressions (1) and (2) confirm that there is only a weak tendency for the self-employed to spend relatively more on food outside the home – by around 2 percentage points. This is clearly too small to account for the 20% income underreporting estimates above though it could contribute a small fraction.[28]

Table 2 Testing for Differences in Food Preferences

	(1)	(2)	(3)
Dependent variable: *Share of food eaten out in total food expenditure*			
SE Dummy	0.0203**	0.0252***	0.17
	(0.009)	(0.009)	(0.11)
Income		0.0511***	0.0511***
		(0.006)	(0.006)
SE Dummy∗Income			-0.013
			(0.01)

Note: The regression uses labour income (survey) and is conditional on the usual set of covariates. Self-Employment Definition: Opportunity. Robust standard errors are in parentheses. Asterisks indicate significance at the following levels: *** p<0.01, ** p< 0.05, * p<0.1.

(ii) Non-comparable income differences

As noted earlier, we have sought to measure income comparably across the employed and self-employed by restricting our income definitions to 'labour' income (= business income for the self-employed) and the broader 'comparable' income including rental income, taxable benefits etc.

[28] Regression (3) allows for an interaction dummy variable with income that tests whether the self-employed consume a higher share of food out that is related to their income? This is clearly rejected by the data.

However, it is possible that to the extent that non-comparable income (NCI) – mainly interest and dividends – is held differentially by the self-employed, this could give rise to different food or non-durable expenditures not captured by the earlier results.

For example, if the self-employed have higher investment income, this could give them a higher expenditure capacity that we are otherwise treating as underreporting, whereas it results from mismeasurement of their full income stream. Importantly for our results however, any other income that is excluded from our estimation only matters for biases in income underreporting estimates if it is differentially held by the employed and self-employed.[29]

To explore this, we re-estimate Table 1 regressions for restricted samples of households where NCI is less than 10%, and less than 25%, of household income, as reported in the survey (the only source of such information). Results are reported in Table 3, which shows income-gap estimates based on food/non-durable expenditure and labour/comparable income.

It can be seen that income-gap estimates are little affected by the exclusion/inclusion of households with differing amounts of non-comparable income. For example, using food expenditure/labour income, we obtain slightly lower gap estimates of 0.197 and 0.175 compared to our earlier estimate of 0.20. In general, the greater restriction on non-comparable income (to 10% rather than 25%) leads to income-gap estimates around 2 to 2.5 percentage points lower than with the full sample. That is, the ability of the self-employed to consume more for the same level of comparable income due to having higher levels of non-comparable income, at most accounts for a relatively small fraction of the previous underreporting estimates.

Table 3 Allowing for Non-Comparable Income

		(1) NCI<25% Total	(2) NCI<10% Total	Table 1 Full sample
Panel A: Self-Employment Opportunity				
Expenditure	**Income**			
Food	Labour	0.197***	0.175***	0.200***
		(0.05)	(0.051)	(0.057)
Food	Comparable Income	0.201***	0.179***	0.193***
		(0.047)	(0.048)	(0.048)
Non-Durables	Labour Income	0.197***	0.171***	0.204***
		(0.041)	(0.042)	(0.047)
Non-Durables	Comparable	0.201***	0.175***	0.196***
		(0.038)	(0.04)	(0.040)
N		2,376	2,172	2,580

Notwithstanding these results, it is important that the income measure used as a right-hand-side variable in these income-gap regressions is specified to be as comparable as possible. This can be seen by substituting total income (comparable plus non-comparable) in Table 1 regressions, though this is only possible for survey-based data. Undertaking this exercise reveals, for example, that, the Table 1 estimate of underreporting using food expenditure/labour income of 0.114, becomes 0.094, and for non-durables

[29] Unlike New Zealand, many OECD countries levy social security (SS) taxes on employees' wages and salaries (paid by employee and employer). This provides an additional incentive in some countries towards self-employment both due to avoidance of employer SS contributions and the exemption of capital income (e.g. dividends) from SS taxation. This is likely to make the 'non-comparable' income category in New Zealand somewhat smaller for the self-employed than otherwise.

becomes 0.098 instead of 0.119. Use of total income therefore has a further tendency to reduce the already smaller underreporting estimate obtained from survey data, as opposed to register data.

(iii) Wealth, capital gains and trusts

A possible reason for observing lower reported income for given expenditure compared to employees could be due to wealth effects, where business assets owned by the self-employed enable higher consumption, for example by providing collateral for higher borrowing or allowing higher consumption in the face of a more volatility income stream. Similarly, if the self-employed have greater assets, anticipated accrued or realised capital gains may help fund higher expenditure, and imply higher expected income than that captured in our model. In this case, our estimates of self-employed underreporting would be biased upwards.

As we noted above, given limited available wealth and capital gain data, we have sought to control for those effects by including soft variables such as housing characteristics, in addition to income growth and volatility variables. In addition, our use of education level and occupational variables as instruments is designed to eliminate the impact of volatility in annual income – for both the employed and self-employed – and our IV results confirm that this source of endogeneity would seem to be adequately dealt with by this process.

An important further source of assets and income not recorded in our dataset arises when individuals own trusts. In New Zealand many individuals hold assets in trusts as a form of asset protection and/or tax minimisation. They are widely held by New Zealand households and not simply by those with high, or self-employment, income; see Tax Working Group (2010). During the years covered by our data the top marginal personal income tax rate and the rate applied to trust income were misaligned (2001-2010), and it was common to observe income flowing through trusts, as opposed to personal income, to benefit from the lower trustee rate. If this occurred more for the self-employed, it would imply that there is income not being captured in our measure of reported (personal) income that could nevertheless be financing higher expenditure by the self-employed.

In addition, trusts are frequently used as a means of protecting assets in New Zealand such that ownership of a trust might provide some indication of asset holding. A similar argument applies to ownership of rental properties which provide a source of wealth and potential tax-free capital gain income. These sources of capital gains and proxies for wealth might be especially pronounced among the self-employed yielding higher expected income to finance higher expenditure.[30]

Unfortunately, income from trusts is not covered in our register data, but whether the individual receives income from a trust is indicated in the survey. We therefore use a 'flag' for those households receiving trust income, rental income (or a combination of the two) to proxy for this type of asset that could signal higher expected income. As our aim is to understand whether the income-gap we observe is partly due to a wealth effect, using register income (and the survey trust flag) we eliminate households with rental

[30] This issue might be especially pronounced for the incorporated self-employed, as the practice of creating a trust is especially widespread among this group. Dividends are also not separately identified in our data although we do test for its implications in terms of restricting the impact of the non-comparable income which includes the latter. As one of our robustness checks, we repeat the estimation of income underreporting but eliminate the incorporated from our sample. This results in a similar level of underreporting to that obtained for the full sample.

income in column (1) of Table 4, those receiving trust income in column (2) and a combination of the two in column (3). As can be seen, the income-gap results essentially remain unchanged.

While, in principle, receipt of income from trusts is recorded in the survey, the response rate to the question is relatively low. This may be due to recall problems or because income from trusts can remain as trust (as opposed to personal) income, or can be distributed to beneficiaries. There is however a question in the survey that we can use to instrument ownership of a trust.

Table 4 The Effect of Wealth

		(1)	(2)	(3)
Sample Selection Criterion		No Rental	No Trust	No Rental or Trust
Expenditure	**Income**			
Food	Labour	0.204***	0.226***	0.232***
		(0.062)	(0.067)	(0.073)
Food	Comparable	0.184***	0.218***	0.211***
		(0.053)	(0.055)	(0.061)
Non-Durables	Labour	0.202***	0.201***	0.206***
		(0.05)	(0.053)	(0.057)
Non-Durables	Comparable	0.183***	0.198***	0.189***
		(0.043)	(0.043)	(0.047)
N: Self-Employed		1812	1734	1656
N: Employed		597	492	447

Householders are asked about their house ownership and a non-negligible number claim their house is owned by a trust. Responding to the survey that the house is owned by a trust, together with evidence on receipt of trust income, can be treated as an alternative flag for trust *ownership*. This increases substantially the number of households in our category of potentially accruing capital gains or with indicators of wealth.[31] We use this alternative proxy for trust ownership in Table 5, Panel A, and trust ownership and/or receipt of rental income as a proxy for wealth in Panel B. We run regressions on equation (6) to estimate a within-group comparison of self-employed, with and without potential for capital gains, and their employee counterparts.

A test of the equality of income-gaps reveals that the income-gap between the self-employed with higher wealth (as marked by our flag) and the self-employed with lower wealth is not statistically different implying that even when we control for, and calculate the income-gap within, wealth groups the estimation of the income-gap does not significantly vary. To the extent that data allows we have therefore shown that even narrowing down the sample to households less affected by potential wealth effects as in Table 4, and estimating the income-gap in a within-group comparison of households with/without potential for capital gains as in Table 5, income-gap estimates seem to remain robustly

[31] We recognise that trusts can also be held with the intention of asset protection and some might just hold the individual's main residence. In this case, the flag will capture the potential of capital gains accruing from that first residence but may not be too effective in separating the wealthy from a median household. Some trusts may have been formed to reduce the tax bill in the period where a discrepancy occurred between the two tax rates which in turn will imply that this flag might also capture a willingness to search for tax savings.

around 20%.[32] It would seem reasonable to conclude therefore that our income-gap estimates around 20% are largely independent of whether or not some self-employed households have access to additional income not recorded in our datasets or participate in trusts. It is important to note, however, that if some households do have access to such additional income, it may be taxed appropriately under a different tax (e.g. as a trust or closely-held company) such that the 'underreported' person income we observe here need not imply a commensurate underpayment of tax.

A final 'wealth' issue we address concerns the possible greater use of savings by the self-employed to finance their expenditures. If the self-employed have more volatile income they may use savings to fund current expenditure when income is temporarily low. Alternatively, when income if temporarily higher, they may divert income into saving rather than expenditure.

Table 5 Proxying for Wealth and Capital Gains (CG)

Income type:	Labour Income		Comparable Income	
Expenditure category:	Food	Non-Durables	Food	Non-Durables
Panel A: Proxy for Trust Ownership				
SE vs. E with CG				
	0.079	0.193**	0.050	0.151*
	(0.129)	(0.098)	(0.114)	(0.089)
SE vs. E with No CG				
	0.224***	0.205***	0.222***	0.205***
	(0.063)	(0.052)	(0.053)	(0.043)
Test of Income-Gap equality:				
Chi^2	1.190	0.012	2.232	0.339
p-value	0.275	0.914	0.135	0.560
Panel B: Proxy for Trust Ownership & Rental Income				
SE vs. E with CG				
	0.120	0.201**	0.050	0.151*
	(0.109)	(0.087)	(0.114)	(0.089)
SE vs. E with No CG				
	0.222***	0.202***	0.222***	0.205***
	(0.065)	(0.053)	(0.053)	(0.043)
Test of Income-Gap equality:				
Chi^2	0.753	0.000	0.466	0.040
p-value	0.386	0.990	0.495	0.841

Note: We estimate equation (6) and we include an intercept for SE and E with and without the proxy for capital gains: proxy for trusts in Panel A and proxy for trusts and rental in Panel B. To obtain the income-gap we use as a benchmark group for the self-employed with and without capital gains, the corresponding group of employed. This allows a within category (capital gains flag and no capital gains flag) comparison. The number of observations for each group are shown in Appendix C, Table C5. An alternative specification that compares SE with CG, SE with no CG against a baseline of employed is also estimated and results are available in Table C6.

We have argued that our instruments should control for this aspect. However, as a further check we run our previous regressions but with total expenditure as the dependent variable. If we obtain a similar

[32] Nevertheless, income-gap results in Table 5 for those 'with capital gains' yield relatively lower point estimates using food expenditures, and standard errors are generally larger. This would seem to reflect more 'noise' in the limited data available here and hence suggest caution in assessing the magnitude of income-gap estimates.

estimate of underreporting by the self-employed it would indicate that our previous results are not largely driven by a general tendency of the self-employed to save more or less than their employee counterparts. Panel B of Table 6 shows the results of those regressions. It is clear that the underreporting estimates are very close to the 20% reported in Table 1 using the same register data, providing further confirmation that our earlier results are robust to caveats around savings differences.

(iv) Business versus personal expenses

It is well-known that the self-employed may reduce their tax liabilities either through reporting lower gross income or by inflating expenses; the latter especially providing opportunities to the self-employed. If some personal expenses can be claimed as business expenses then total personal expenditure should appear lower for the self-employed for given income, or alternatively 'true' income may be higher for the self-employed than would be inferred from their observed expenditure.

In our dataset self-employment income is recorded as net profit; that is, after deduction of any relevant expenses. Hence to the extent that the self-employed underreport gross profit or over-report expense deductions, both have a symmetric effect in our dataset on their observed income (net profit). As a result, our evidence on self-employment 'income underreporting' includes both underreported gross income and over-reported deductions.

Nevertheless, it is interesting to consider whether there is any evidence of expenses misreporting. We do so by examining personal expenditure categories that can be expected especially to provide opportunities for misclassification as business expenses. If this occurs by the self-employed, these personal expenses should appear lower for the self-employed for given income compared to items of expenditure for which deductibility is not granted. As a result, if we run regressions using only these business expense categories, instead of food, as the dependent variable, the self-employed should look more similar to employees, yielding lower estimates of underreporting. That is, the Engel curve for the self-employed (which lies above the employee equivalent in Figure 1) should be shifted down when expenditures vulnerable to misclassification are used.[33] Indeed, with sufficient diversion of those expenses from 'personal' to 'business' the Engel curve for the self-employed could even lie below that of employees; that is, we could in principle obtain negative estimates of underreporting.

In Table 6 Panel A, we consider those potentially misclassified expenses. In row (1) we examine expenditure on three categories: household utilities (electricity, gas, water etc.), transport and communications (postage, telephone etc.); in row 2 we add housing expenditures. Again using register data it can be seen that the income underreporting estimates (around 8-11%) are indeed much lower than reported in Table 1, around 20%. This evidence therefore suggests that using the Engle curve methodology to identify underreporting is less reliable if the expenditure variable used for this exercise is vulnerable to reclassification as business expenses by the self-employed.

[33] Consistent with the underreporting methodology used throughout this paper, this exercise assumes that reports of such personal expenses to the survey, by households diverting some personal expenses to their businesses, capture only those personal expenditures and not those assigned to their business accounts. For example, if a self-employed sole trader buys a computer entirely from business funds, it is assumed that this is not reported to the HES as personal computer expenses by this individual, even if the computer is partly used for personal purposes.

Table 6 Testing Robustness to Expenditure Types

Income type:	(1) Labour (IR)	(2) Comparable (IR)
Panel A: Expenditure: Business Expenses		
Expenditure: Potential Misclassification	0.085	0.096
Utilities, Transport, Communication	(0.086)	(0.067)
Expenditure: Potential Misclassification	0.112**	0.118**
Utilities, Transport, Comm., Housing	(0.055)	(0.046)
Panel B: Saving Preferences		
Total Expenditure	0.190***	0.183***
	(0.034)	(0.029)
Total Expenditure excl. housing/mortgage[(1)]	0.209***	0.199***
	(0.036)	(0.03)
Total Expenditure excl. housing/mortgage & durables[(2)]	0.212***	0.201***
	(0.037)	(0.031)

Note: Total expenditure is the broader set of non-durables and durable expenditure of the household. It includes: food, alcohol, clothing, housing and mortgage, communication, transportation, health, recreation and a miscellaneous category. Two alternative specifications of the total expenditure variables are included. (1) Total expenditure excluding housing and mortgage expenditure to test for the robustness to the impact on the estimation of the potential mismeasurement of rental and mortgage expenses (as a meaningful comparison would require imputing rental costs for owner occupied housing). (2) Total expenditure also excluding expenditure on durables to test for the impact infrequency of purchase/telescoping errors.

Specifically, in our case, implicitly (and erroneously) treating these three or four vulnerable expense categories 'as if' they were the same across employees and self-employed, continues to generate a substantive income-gap estimate but this is around half as large in Table 6 as that obtained using more comparable expenditure categories as dependent variables. The extent of such re-classification cannot be identified directly from these results however since, as noted earlier, large diversion of personal-to-business expenses could even lead to negative income-gap estimates. It does however suggest that net income underreporting by the self-employed is likely to be at least partially via diversion of those expense types, and is worthy of further investigation.

5.3 Measurement error and underreporting

As noted earlier, classical measurement error within our income data could potentially yield biased income-gap estimates due to downward 'attenuation' bias in estimates of the parameters β_1 and/or γ from regressions such as (4). From equation (5), the direction and size of bias in the income-gap will depend on the relative size of any biases in the two parameters. If, in addition, the size of the error is correlated with income leading to a case of non-classical measurement error, any attenuation bias may be reinforced or counteracted by this correlation. Hence, our income-gap estimates could be biased towards, or away from zero if these measurement error effects are important.

This potential measurement error effect is the subject of on-going research. Initial investigations reveal that measurement error has a mean close to zero for the employed while being severely biased for the self-employed. The self-employed report higher income on average to the survey than they do to the register which contributes to the fact that estimations of income underreporting using survey incomes yield a lower estimate of income underreporting than using the income reported to the register.

We interpret this finding as reflecting the role of incentives for reporting to each income source. For the employed, reporting consistently to the survey and the register is easier due to the high frequency of payments and third-party withholding of their income yielding limited possibility for non-

compliance. However, for the self-employed, the time span between the presentation of their tax return and the preparation of business accounts, together with greater opportunities to misreport their incomes, allows larger discrepancies when comparing the register and the survey.

Provisional evidence also suggests that attenuation biases associated with measurement error appear to be a primary source of the lower level of self-employment underreporting when those estimates rely on survey data alone.[34] It further hints at the possibility that income underreporting estimates for other countries – which are largely based on survey data – are likely to be downward-biased if measurement error properties are similar to those in New Zealand data. At a minimum this suggests that other countries' survey-based estimates should not be compared directly with register-based estimates for New Zealand, without first assessing the size of possible attenuation biases on estimated parameters for both income and self-employment variables in income-gap regressions.

5.4 Characteristics of underreporting

In this sub-section we consider the heterogeneity of the estimated income-gap associated with different characteristics of interest that may help inform how those gaps vary across household types. Since this analysis involves various self-employed sub-samples, we focus on the larger sample size obtained using the 'opportunity' classification of self-employment income. The analysis uses equation (6), following the same method as in sub-section 5.1, using IV methods to help correct for measurement error in the income variable. Income is measured using information from the register. We present a summary of results below.

Gender and age

One of the main advantages of using a combination of survey and register data is that we can investigate the demographics of non-compliance using variables that are not typically available to the tax administration (since they are not required for tax purposes). Panel A in Table 7 documents our finding that males underreport more than females and this is observed consistently across income and expenditure variables. Note that the specification in equation (6) isolates the effect of gender from the confounding effect of the opportunity to underreport. That is, self-employed males and females are compared to their male and female employee counterparts.

Similar gender effects have been documented in the tax evasion literature based on experiments (Spicer and Becker, 1980) and surveys (Torgler and Schneider, 2007). Recently, Kleven et al. (2011) using a randomised audit experiment also found that being female is negatively associated with non-compliance. This evidence is not however uncontested. Schuetze (2002), for example, found no difference in male/female compliance behaviour, and Baldini *et al.* (2009), who use discrepancies between survey and register income as a proxy for tax evasion fail to find a gender difference. [35]

Non-compliance is also typically found in the literature to be inversely related to age. In our analysis, we created three age brackets splitting the age distribution into: <35 years of age, 35-50 and >50, based

[34] For example, using food expenditure and labour income, Appendix Table C4 shows that the estimates of the income-gap based on survey data are around 12% lower than when using register data (β_1 is around 11% lower and γ is around 22% lower). Separate analysis (not shown here) indicates that, due to measurement error, downward attenuation biases in parameter estimates for β_1 from regressions on equation (4), , are around 6-14% (depending on whether a few large outliers are omitted or included). Further, when attenuation bias in β_1 is estimated from separate employee and self-employed sub-samples, the bias for the latter is shown to be much larger, with little evidence of measurement error induced bias on average for employees, as expected given the prevalence of third-party reporting via PAYE in their case.

[35] Gender differences have also been extensively documented and studied in criminology with several theories proposed to explain them; see Mears *et al.* (1998).

on the age of the head of household. We find that the estimated size of the income-gap does not vary with age.[36] This is consistent with Kleven et al. (2011) who also fail to find an age effect. Feinstein (1991), using TCMP data for the US, documents the inverse effect of age on compliance only for one of the two years covered by his study.

Table 7 Income-Gap Heterogeneity

	Income type: Labour				
Expenditure category:	Food	Non-Durables		Food	Non-Durables
	Panel A: Gender			Panel B: Region	
Male	0.312***	0.309***	Auckland	0.361***	0.321***
	(0.078)	(0.063)		(0.087)	(0.075)
Female	0.096	0.108	Canterbury	0.333***	0.315***
	(0.083)	(0.070)		(0.099)	(0.091)
			Rest of North	0.047	0.124
				(0.133)	(0.093)
			Rest of South	-0.037	0.001
				(0.149)	(0.119)
			Wellington	0.230*	0.214*
				(0.125)	(0.114)
Test of the equality of income-gaps:					
Chi^2	4.48	5.62		10.06	8.40
p-value	0.03	0.02		0.04	0.08

Note: The estimation of these Engel curves to investigate the income-gap heterogeneity follows equation (6). The income-gap is computed as in equation (7). The income-gap reported in Panel B for the regions of Auckland, Canterbury and Wellington are not statistically different from each other in any of the specifications but they are significantly different from the level of the income-gap in the other two regions: Rest of North and Rest of South. Full results are reported in the Appendix including tests of the equality of the income-gaps. Robust standard errors are in parentheses.

Regional variation

The spatial variation of the income-gap can be informative about the concentration of the income-gap in certain regions, though we can only examine regional effects at a fairly high level of aggregation to avoid small sub-sample sizes. Nevertheless, this method can identify broad 'hot-spots' where non-compliance is concentrated. Based on the six main New Zealand regions, Panel B in 7 reports that underreporting appears to be concentrated in Auckland, Canterbury and Wellington. These three urban regions have income-gaps that are not statistically different from each other, but that are significantly higher than in the Rest of the North and South Islands.[37] Clearly there could be many factors underlying these regional results, but they do indicate that underreporting is concentrated in more densely populated and economically active urban regions.

[36] This age split yielded approximately equal sized age groups; similar results were obtained when we allowed for alternative age group thresholds.

[37] Note that further disaggregation into regions is not possible due to small cells. The test for the equality of the income-gaps informs us about whether, given the limited data available, 'region' is a variable with which the income-gaps vary significantly. On the contrary, not rejecting the null hypothesis of equality of income-gaps means that the variable is not informative in helping to explain variations of the income-gaps. In other words, individuals that belong to these different characteristics are not found to be evading on average in a significantly different manner from the rest. This result (higher underreporting in urban areas) is in contrast to some presumptions that rural areas are more prone to underreporting – for example, because farming activity dominates rural areas and is predominantly self-employed. It is possible however whether unban self-employment occupations (e.g. taxis, construction, professional services) provide similar or greater opportunities for underreporting. Further work on this aspect would require more extensive data than available in this study.

Self-employment legal form

From our register dataset, we can identify whether a self-employed person is registered as a sole trader, a partnership or a director/shareholder of a company. These different legal forms of self-employment could potentially affect non-compliance via the extent of, for example, cooperation among business partners, or the extent of external reporting/oversight such as via requirements for public registering of financial accounts. In addition, the granularity of our register data allows us to observe a sub-set of the self-employed for whom withholding taxes are applied: in New Zealand this applies to contractors within a specified list of occupations.

We therefore classify self-employed households into four categories: (i) sole traders; (ii) director/shareholders; (iii) partnerships; (iv) self-employed subject to withholding (scheduler) payments; where categories (i) to (iii) are defined to exclude those with withholding payments. Category (iv) is especially interesting because it contains only individuals whose self-employment income is entirely third-party reported or withheld. In principle, those individuals should have less scope for underreporting this income than other groups as their income is more traceable. However, it could also result in such individuals having a greater scope and incentive to earn more income from other forms that are not subject to withholding, and where this additional income is hidden or underreported.

Since our analysis is performed at the household level, self-employment income is first aggregated into categories for the household. Where a household receives self-employment income from more than one source, e.g. sole trader and director shareholder; we calculate the primary source of self-employment income and classify the household accordingly.

For this estimation, the benchmark is composed of households with no self-employment income and four different self-employment dummy variables relating to each category are introduced. However, we were unable robustly to estimate the impact of different legal forms on underreporting. Using food expenditure, the income-gap was found to vary significantly with the legal form of the self-employed, with underreporting concentrated among sole traders and those that received schedular payments. However, using the non-durables expenditure basket, underreporting was not found to vary significantly in association with the legal form; hence unable to reject the null hypothesis that all legal forms of self-employment underreport to a comparable extent. The lack of consistency of these results suggests caution in interpreting legal form effects and could be attributable to a low number of observations within each category.

6. Conclusions

This paper has sought both to contribute to the literature on the methods of measuring self-employment income-gaps, to assess the role of register and survey data in income-gap estimation, and to provide empirical magnitudes of those gaps for New Zealand.

Specifically, we use specified expenditure levels within the Engel curve framework of Pissarides and Weber (1989) to infer the true income of the self-employed using employees as a benchmark. We use a unique dataset where survey participants are linked to their (suitably anonymised) administrative tax records to correct for the potential effects of measurement error known to afflict survey responses in the estimation of income underreporting. Using register data, we find that the self-employed in New Zealand underreport on average around 20% of their income. This estimate is found to be robust to alternative specifications of the relevant expenditure and income variables and to alternative definitions of self-employed households. Nevertheless, 95% statistical confidence intervals around this 20%

estimate give an underreporting range of approximately 10-30%, across various specifications; see Appendix Tables C2 and C3.

In New Zealand, it is sometimes claimed that the total income available to some households is not adequately captured in personal income data (whether survey or tax register), due to the relative ease with which individuals or households, perhaps especially the self-employed, can earn income through trusts or closely-held companies. Whatever the merits of this claim, which is hard to verify from existing data, our evidence suggests it has little impact on the estimated size of personal income underreporting by the self-employed relative to employees. Of course, our data to test for effects on household expenditures from trust and other income sources is limited by the partial data available. Nevertheless, underreporting estimates appear robustly similar when we differentiate between those with, and without, access to such income sources. This is not to deny the presence or importance of such trust or corporate income but, regardless, it does not show up in employee/self-employed differences in household expenditure patterns observed from survey-reported data.

The ability to combine survey and register information is rare but in this case has substantial benefits. Firstly, we are able to correct for the impact of measurement error within survey income reports on estimates of the income-gap. We find that using survey-based income leads to average income-gap estimates as much as 6-10 percentage point lower than when register income is available; that is, the survey-based income-gap can be estimated at up to almost half the value obtained from register data.

Secondly, combining the two data sources enables us to access a wider set of demographic variables than is typically available for tax purposes. This brings particular insights for compliance policy by identifying characteristics of non-compliant individuals or households, and hence guide compliance policy.

We find that the income-gap varies significantly by gender and region. *Ceteris paribus*, males are found to significantly underreport more than females and income-gaps are found to be higher in the urban regions of Auckland, Canterbury and Wellington where population and economic activity is more concentrated. We do not find any significant underreporting effects of age or in association with the specific legal form of self-employment.

Given various country-specific data and other differences, comparisons with other studies using similar methods to estimate the extent of non-compliance by the self-employed should be treated with caution. However, to the extent that published estimates are comparable, New Zealand would appear to be at the lower end of the range of values found across countries. Our register-based results are similar to underreporting estimates for the UK and Canada as documented by Cabral *et al.* (2016) and Schuetze (2002) respectively, but less than those obtained for the US (Feldman and Slemrod, 2007) and Greece (Artavanis, et al., 2016). However, since most other countries' income-gap estimates are based on survey data, their estimates may be more suitably compared with the much lower values obtained here when using New Zealand survey data.

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Appendix A: Data Matching

A.1 Integrated Data Infrastructure[38]

The Integrated Data Infrastructure is a repository based mainly on administrative data that also contains a number of surveys undertaken by Statistics New Zealand. The main structure of the IDI can be described as a central spine to which other datasets are linked. The linked datasets cover a wide range of topics: education, taxation, benefits, health and safety among others. It provides researchers with a unique environment where the benefits of survey and register data can be exploited. These datasets are held securely on Statistics NZ servers and only approved researchers and research projects can access the anonymised dataset under strict confidentiality rules.

The population contained in the IDI can be broadly described as all individuals who have ever been resident of New Zealand. By legislation, no identifier can be used across agencies to identify individuals. However, in some cases such as in administrative data a common identifier – generally the tax registration number (IRD number in NZ) – is readily available. Matching of these datasets are direct such that the quality of the match is very high. The IDI however links other datasets to the IDI spine such as those from selected surveys for which such identifiers are not available.

The IDI matching methodology for surveys is mainly based on probabilistic record matching with careful consideration and monitoring of quality to ensure the reliability of matching is high, ensuring that records from different datasets belong to the same person or entity. Blocking variables are used to ensure that the match is performed subject to the records compared being identical on the blocking variable. Variables are compared in terms of a given set of characteristics and for each characteristic, a measure is computed to assign how closely related the two values are. The sum of those measures, known as a weight, for all given characteristics will form the overall weight for a record pair.

The methodology assigns the pair of records with a weight that shows how reliable the match is and how common the value is. The record pairs with overall weights above a certain threshold are designated as a match. A more thorough explanation of the IDI matching process is given in Statistics New Zealand (2014). This linking methodology is internationally used and is adopted to obtain a high precision rate. Inarguably, linking quality using solely administrative data is superior to the linkage of survey data but all mechanisms are in place to ensure maximum precision. In the absence of a common identifier, linking variables such as the date of birth, first and last names and gender are used. The linking is generally of good quality which may be attributable to the fact that in a small economy like New Zealand, names and dates of birth are more frequently unique.

From the IDI tables, we use the Household Economic Survey and the IR tax year tables. The latter contain the universe of annual income tax returns filed by individuals and businesses. In New Zealand, wages and salary employees' income is withheld and third-party reported by their employers using the Employer Monthly Schedule (EMS). The EMS is a mandatory reporting requirement for all employers with paid employees. The EMS is complemented with the income tax returns filed by individuals (IR3), which is required for those individuals who earn income other than salary and wages, dividends and interests and/or taxable Māori authority contributions which are withheld at source. Particularly interesting within this group are sole traders and other individuals earning self-employment income from a subsidiary job. Those self-employed who are incorporated have the obligation to file an IR4S tax return, and those in a partnership are obliged to file an IR20 tax return.

[38] More details on the Integrated Data Infrastructure project, see www.stats.govt.nz/integrated-data/integrated-data-infrastructure/.

One of the interesting features of this table is that in order to reclassify payments from EMS that are linked to self-employment, Statistics NZ link payer and payee identifiers which identifies the source of EMS payments. This enables a reclassification of payments from EMS that are attributed to self-employed (in any legal form), who pay themselves a salary, as self-employment income rather than as income from employment. That is, records that might initially be classified as a regular Wages and Salary (WAS) category, can be classified as self-employment income where identifiers show that the payment is made by the same person receiving the payment.

A.2 Matching and Linking Criteria

This section provides more detail on the matching and linking criteria used to link the Household Economic Survey (HES) and the register data on incomes. Using data on individuals and households that have been matched by Statistics NZ in the IDI, it is possible to combine administrative and survey responses on income. These use a unique Statistics NZ identifier assigned to individuals across data sources. Having identified matched individuals within the IDI, we then have to ensure that the data we select from the survey and administrative sources are linked such that, for example, reported incomes for each individual or household selected from the two sources relate to the same tax years. This linking process involves a number of steps.

In HES, individuals are asked about their income in the reference period. The reference period is set by the interviewer at the beginning of the interview to be the 12 months prior to the day the survey was conducted. We assume all surveys were conducted at the beginning of the month and, since administrative data on wages and salaries are available on a monthly basis, we match for each individual the income reported to the tax administration for the months that exactly match their reference period. That is, if an individual was interviewed in November 2011, we set the reference period November 2010 to October 2011 and we aggregate his/her employment income from the tax record to obtain total income from the register. This should be a 1-to-1 map to the survey for those with a successful match in the absence of measurement errors.

In the case of self-employment income, the survey enquires about the last period for which accounts were prepared or a tax record is available. Due to the restriction of information in the matched dataset we are not certain to which period individuals are referring when reporting their self-employment income in the survey. We impose two criteria to test for the robustness.

The month of March marks the end of the tax year and the deadline for presenting the returns to the tax administration is July. The first linkage criterion hinges on the rationale that those reporting to the survey prior to July will likely report their incomes for the tax year that closed in April of the previous tax period. That is, those reporting in January 2011 will report about the year 2009/10 as their accounts are not yet prepared for the year 2010/11 and that is the last record available. Those reporting after July will have already presented their accounts for the tax year that closes in the year the survey was conducted and will report on that tax year just completed. That is, those interviewed in November 2011 will report on the tax year 2010/11.

This first criterion overlooks the possibility that some overlap is expected especially for the months between March and July. For example, those prompt in complying with their filing obligation may report on the current year rather than the past tax year. Assigning them the past tax year will result in timing errors that relate to the linking process rather than interviewees not reporting accurately.

In order to test whether this criterion provides a satisfactory rationale for how respondents complete the survey, we restrict the sample to those self-employed that report income to the survey that lies within

1% of the reported income to IR. Mapping their survey month to whether they reported their past tax year or their current tax year, we do find the pattern outlined above. Those interviewed prior to July report on the previous tax year to the survey and those after July report on the current tax year. However, the criterion is not perfect and apart from the overlap in March and July some interviewees after July still report on the previous year.

To circumvent this issue and allow more flexibility to the criterion trying to ascertain what the respondents are referring to, we establish criterion 1 but allow the match to change from the current tax year or the prior if the reported income to the survey lies within 10% of the reported income in any of the years, and lies further from the corresponding income following criterion 1.

As an example, consider Person 1 who was interviewed in November 2011, and who reports $50,000 to the survey as self-employment income. Looking at administrative data, for the tax year 2010/11 we have a report of $40,000 and for the tax year 2009/10 a report of $50,000. Following criterion 1, the individual would be assigned such that his income from the register belongs to the tax year 2010/11 as he was surveyed after July. However, his register income matches his survey report for the year 2009/10 very closely. Criterion 2 would then assign self-employment income to the year 2010/11.

Whereas this criterion allows for the flexibility of closely aligning to the income the self-employed report to the survey, the drawback is that some of this mismatches may not be a linking error but in fact measurement error. This is, individuals may be reporting their true income rather than their income reported to the survey, or it can be failure to recall their income tax year from the current year. It does however allow us to minimise the errors in the linkage. Following criterion 2, only 2% of the cases are reclassified.

A.3 Linkage Accuracy

Table A1 Linkage accuracy of individuals in HES, disaggregated by income source.

	Survey and IR	Survey, Not IR	IR, Not Survey	Not HES, not IR	Total
Individuals	49,707	14,052	519	17,268	81,549
Income Source					
Labour Income	34,461	1437	2,856	10,950	49,707
Pensions Income	9,378	93	240	39,999	49,707
Taxable Benefits	1,059	2,712	5,679	40,257	49,707
Student Allowance	837	228	303	48,339	49,707
Paid Parental Leave	345	48	231	49,086	49,707
Rental Income	342	1,998	486	46,884	49,707
Earnings Compensation	591	324	453	48,342	49,707
Comparable Income-All (D2)	43,509	1,047	4,050	1,104	49,707

Appendix B: Income sources concordance between Inland Revenue and HES data in the IDI

	Source of Income	Inland Revenue	HES (category no.)
Employment income	Wages and Salaries	Wages and salaries from EMS, withholding payments, commissions and bonuses.	Wages and salaries from current and past employment including regular pay, other honoraria, commissions and bonuses. (1.1)
	Self-Employment Income	Sole trader (IR3), company director/shareholder income (IR4S), partnership (IR20), other honoraria, commissions, bonuses.	Self-employment income from current/previous jobs. Net profit, share of profit and loss. (1.2)
	Other		Income from casual jobs and hobbies. (1.3)
Investment income		Rental Income (IR3)	Rental income (2.3)
		-	Interest, dividends, royalties (2.1, 2.2, 2.4)
		-	Overseas interests and dividends and other foreign income. (5.1)
		-	Other investment income (income from trusts, funds).
Pensions	Government	NZ Superannuation and veterans pensions	NZ Superannuation and veterans pension (3.1.)
	Private	-	Private Superannuation income, income from annuities (non-governmental). (4.1, 4.2)
Other government transfers		Benefits	Unemployment benefit, sickness benefit, domestic purposes benefit, invalid's benefit (3.2 – some)
		Student Allowance	Student allowance (3.2)
		Paid Parental Leave	Paid parental leave (3.2)
		-	In-work tax credit, Minimum family tax credit
		-	Other non-taxable benefits.
Other sources of regular and recurring income	ACC	Accident Compensation Corporation (ACC) receipt	Accident Compensation Corporation receipt (1.4)

Appendix C: Summary Statistics & Regression Results

Table C1 Summary statistics of income and expenditure variables (in logs).

Self-Employment Definition	Opportunity		25% rule	
	Employed	Self-Employed	Employed	Self-Employed
Panel A: Expenditure				
Food	8.842	9.145	8.887	9.129
	(0.757)	(0.683)	(0.753)	(0.699)
Non-Durables	9.219	11.150	9.261	9.524
	(0.646)	(0.805)	(0.651)	(0.634)
Panel B: Register				
Labour Income	11.005	11.128	11.041	11.029
	(0.783)	(0.837)	(0.768)	(0.952)
Comparable Income	11.081	11.150	11.108	11.055
	(0.609)	(0.805)	(0.612)	(0.915)
Panel C: Survey				
Labour Income	10.989	11.212	11.031	11.156
	(0.799)	(0.749)	(0.785)	(0.814)
Comparable Income	11.040	11.253	11.079	11.199
	(0.719)	(0.724)	(0.712)	(0.79)
N	1914	663	399	2178

Note: Summary statistics of expenditure and income are disaggregated by the two alternative definitions of a self-employed household. The 'opportunity' definition classifies a household into self-employment if it benefits from an income source that comes from self-employment. This definition aims at capturing the 'opportunity' to misreport. A household is classified as employed in the absence of any self-employment income source. Under the 25% rule, a household is classified into self-employment if it derives more than 25% of household income from a self-employment source. The classification is based on register income.

Regression Results

Table C2 IV and OLS estimation of Engel curves using food as the expenditure item

Dependent variable: Food expenditure	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Method:	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Panel A: Coefficients of interest								
Income	Labour and Business (IR)		Labour and Business (Survey)		Comparable Income (IR)		Comparable Income (Survey)	
	0.159***	0.460***	0.170***	0.443***	0.247***	0.545***	0.204***	0.443***
	(0.0228)	(0.0904)	(0.0237)	(0.0868)	(0.028)	(0.101)	(0.0239)	(0.0816)
SE Dummy	0.0739***	0.103***	0.0568**	0.0537*	0.0849***	0.117***	0.0577**	0.0565*
	(0.0286)	(0.0323)	(0.0282)	(0.0291)	(0.0286)	(0.0318)	(0.0282)	(0.0289)
Panel B: Estimations of underreporting								
Multiplier	1.59***	1.25***	1.395***	1.129***	1.411***	1.239***	1.327***	1.136***
	(0.298)	(0.089)	(0.238)	(0.08)	(0.167)	(0.073)	(0.187)	(0.08)
95% CI	1.006	1.076	0.928	0.972	1.084	1.095	0.960	0.980
	2.174	1.424	1.863	1.287	1.737	1.382	1.694	1.292
Income-gap	0.371***	0.200***	0.283**	0.114*	0.291***	0.193***	0.246**	0.12*
	(0.118)	(0.057)	(0.122)	(0.063)	(0.084)	(0.048)	(0.106)	(0.062)
95% CI	0.140	0.089	0.043	-0.009	0.127	0.099	0.038	-0.001
	0.602	0.311	0.523	0.238	0.455	0.286	0.455	0.241
Hansen J		1.266		1.069		0.409		0.412
Hansen J p-value		0.531		0.586		0.815		0.814
F statistic		36.2		33.46		48.94		56.07
N	2,577		2,577		2,577		2,577	
Employed	1,914		1,914		1,914		1,914	
Self-Employed (Definition = 'Opportunity')	663		663		663		663	

Note: Each column contains the main results of the regression of food expenditure on the different income variables. Summary results are presented in Table 1, Panel A. Columns (1) and (2) regress food on Labour Income built from the register while (3) and (4) use the equivalent measure from the survey. Columns (5), (6) and (7), (8) show the same results as in (1) - (4) but using the comparable income measure. Asterisks indicate significance at the following levels: *** p<0.01, ** p< 0.05, * p<0.1. CI = confidence interval.

Table C3: IV and OLS estimation of Engel curves using non-durables as the expenditure item

Dependent variable: Non-Durables Expenditure	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Panel A: Coefficients of interest								
Income	Labour and Business (IR)		Labour and Business (Survey)		Comparable Income (IR)		Comparable Income (Survey)	
	0.159***	0.485***	0.164***	0.466***	0.246***	0.573***	0.200***	0.466***
	(0.0207)	(0.0781)	(0.0214)	(0.0756)	(0.0278)	(0.0856)	(0.0218)	(0.0693)
SE Dummy	0.0793***	0.111***	0.0623***	0.0590**	0.0903***	0.125***	0.0632***	0.0619**
	(0.0246)	(0.029)	(0.0241)	(0.0253)	(0.0246)	(0.0285)	(0.024)	(0.025)
Panel B: Estimations of underreporting								
Multiplier	1.647***	1.256***	1.463***	1.135***	1.444***	1.244***	1.372***	1.142***
	(0.269)	(0.074)	(0.228)	(0.066)	(0.15)	(0.061)	(0.172)	(0.065)
95% CI	1.121	1.111	1.017	1.005	1.150	1.124	1.036	1.015
	2.174	1.401	1.909	1.264	1.737	1.364	1.709	1.269
Income-gap	0.393***	0.204***	0.317***	0.119**	0.307***	0.196***	0.271***	0.124**
	(0.099)	(0.047)	(0.106)	(0.051)	(0.072)	(0.04)	(0.091)	(0.05)
95% CI	0.199	0.112	0.108	0.018	0.167	0.119	0.092	0.027
	0.587	0.296	0.525	0.219	0.448	0.274	0.450	0.222
Hansen J		1.81		1.533		0.704		0.703
Hansen J p-value		0.405		0.465		0.703		0.704
F statistic		36.2		33.46		48.94		56.07
N	2,577		2,577		2,577		2,577	
Employed	1,914		1,914		1,914		1,914	
Self-Employed (Definition = 'Opportunity')	663		663		663		663	

Note: Each column contains the main results of the regression of non-durable expenditure on the different income variables. Summary results are presented on Table 1, Panel A. Columns (1) and (2) regress food on Labour Income built from the register while (3) and (4) use the equivalent measure from the survey. Columns (5), (6) and (7), (8) show the same results as in (1) - (4) but using the comparable income measure. Asterisks indicate significance at the following levels: *** p<0.01, ** p< 0.05, * p<0.1. CI = confidence interval.

Table C4 Estimation of underreporting: Impact of removing incorporated

Sample Selection Criterion		(1) No DR	(2) No Trust or DR
Expenditure	**Income**		
Food	Labour	0.249***	0.287***
		(0.059)	(0.072)
Food	Comparable	0.226***	0.258***
		(0.051)	(0.061)
Non-Durables	Labour	0.210***	0.212***
		(0.051)	(0.059)
Non-Durables	Comparable	0.191***	0.194***
		(0.042)	(0.048)
Observations: N			
Self-Employed		1914	1734
Employed		501	402

Table C5 Estimation of income underreporting: the effect of wealth.

Income type:	Labour		Comparable	
Expenditure category:	Food	Non-Durables	Food	Non-Durables
Panel A: Proxy for Trust				
SE vs. E with CG	0.079	0.193**	0.05	0.151*
	(0.129)	(0.098)	(0.114)	(0.089)
SE vs. E with No CG	0.224***	0.205***	0.222***	0.205***
	(0.063)	(0.052)	(0.053)	(0.043)
Test of equality Income-Gap:				
Chi Squared	1.190	0.012	2.232	0.339
p-value	0.275	0.914	0.135	0.560
Panel B: Proxy for Trust+ Rental				
SE vs. E with CG	0.12	0.201**	0.05	0.151*
	(0.109)	(0.087)	(0.114)	(0.089)
SE vs. E with No CG	0.222***	0.202***	0.222***	0.205***
	(0.065)	(0.053)	(0.053)	(0.043)
Test of equality Income-Gap:				
Chi Squared	0.753	0.000	0.466	0.040
p-value	0.386	0.990	0.495	0.841
Number of Observations : Panel A				
Proxy Trust	E	SE	Total	
Trust	180	171	351	
NoTrust	1734	495	2229	
Number of Observations : Panel B				
Proxy Trust & Rental	E	SE	Total	
Trust	258	216	474	
NoTrust	1656	447	2103	

Table C6 Impact of wealth and capital gains (CG) on the estimation of the income-gap

Income type:	Labour		Comparable	
Expenditure category:	Food	Non-Durables	Food	Non-Durables
Panel A: Proxy for Trust				
CG	0.115	0.216**	0.082	0.172**
	(0.119)	(0.091)	(0.107)	(0.083)
No CG	0.219***	0.201***	0.217***	0.202***
	(0.062)	(0.052)	(0.052)	(0.043)
Test of equality Income-Gap				
Chi Squared	0.295	0.156	0.099	0.356
p-value	0.587	0.693	0.752	0.551
Panel B: Proxy for Trust + Rental				
CG	0.156	0.229***	0.171**	0.232***
	(0.097)	(0.077)	(0.084)	(0.072)
No CG	0.214***	0.195***	0.2***	0.183***
	(0.064)	(0.053)	(0.054)	(0.044)
Test of equality Income-Gap				
Chi Squared	0.692	0.025	1.531	0.112
p-value	0.406	0.874	0.216	0.738
Number of Observations				
Panel A:				
Proxy Trust	Employed	SE CG	SE No CG	Total
N	1914	171	492	2577
Panel B:				
Proxy Trust + Rental	Employed	SE CG	SE No CG	Total
N	1914	216	447	2577

Note: This is the result of estimating equation (6) although the benchmark group are the employed. We therefore compare SE with a capital gains flag and SE with no capital gains flag, to the employee benchmark. This is an alternative specification of the robustness check contained in Table 5, where a within-group estimation was presented.

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