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# Do the Self-Employed Underreport Their Income? Evidence from Japanese Panel Data†

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## Abstract

This paper examines to what extent self-employed households underreport their income to tax authorities in Japan. To this end, we employ the so-called expenditure-based approach, which essentially compares the current expenditure of self-employed and wage earner households while controlling for their income, net worth, and household characteristics. Using Japanese household-level panel data for the period 2009−2019, we find that the self-employed possibly underreport their income by 33.0–36.4%. Our findings are also robust to the different preferences (degree of risk-loving, time discount rates, etc.), planned retirement age, and degree of measurement error in expenditure between the self-employed and wage earners.

Keywords: Income underreporting, Self-employment, Engel curves, Life-cycle/permanent income hypothesis,

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## 1 Introduction

Tax compliance is key to increasing tax revenue in a country like Japan where government debt has been growing rapidly. It is also important to achieving horizontal equity, i.e., the idea that individuals with similar income and assets should pay the same amount of taxes. In addition, if some households intentionally underreport their income to tax authorities to reduce the tax they pay, inequality measures based on reported income can be misleading.

Despite these concerns, previous studies find that in many countries the self-employed tend to underreport their income to tax authorities, taking advantage of a collection system in which they self-report their income, while the income of most wage earners is reported by third parties (typically the employer). In fact, in Japan the term "Kuroyon" (or "9−6−4") is frequently used to describe the suspicion that the fraction of income correctly reported to tax authorities is 90% for wage earners, 60% for the self-employed (except farmers), and 40% for farmers.[1]

To uncover the degree of income underreporting among the self-employed, several approaches have been employed in previous studies. The first approach is the random audits approach taken by Kleven et al. (2011), for example. In their experiment conducted in Denmark, randomly selected taxpayers are thoroughly audited after filing their tax returns. They find that the self-employment income is underreported by about 15.7%. A caveat of this approach is that it can only capture income underreporting that is detectable in tax audits, and the estimates therefore should be considered as a lower bound of true income underreporting.[2]

The second approach is a randomized control trial. Slemrod, Blumenthal, and Christian (2001), for instance, sent a letter to a treatment group consisting of 1,724 randomly selected Minnesota taxpayers stating that the income tax returns they were about to file would be closely examined, while the control group (consisting of 22,368 individuals) received no such letter. They then compared the changes in reported taxable income from 1993 to 1994 between two groups and found that among low- and middle-income groups the taxable income increased more in the treatment group than in the control group. They also showed that this tendency was more pronounced among those who self-report business or farm income. Their findings imply that the self-employed underreport their taxable income to reduce the tax they have to pay.[3]

The third approach consists of estimating the ratio of income underreporting by the self-employed based on aggregated data. This approach was widely used in Japan from the 1980s to the early 2000s (see, e.g., Ishi 1981; Hayashi 1990; Ota, Tsubouchi, and Tsuji 2003; Arai 2007). The idea behind this approach is to compare the income of the self-employed in tax statistics, which includes underreported

[1] See Ota, Tsubouchi, and Tsuji (2003) for more details about Kuroyon (9-6-4).
[2] The Internal Revenue Service in the United States has also conducted a random audits program since 2001. See Slemrod (2007) for the history of the program.
[3] A study using a similar approach is that by Bott et al. (2020), who randomly divide more than 15,000 taxpayers in Norway into several groups to examine the degree of underreporting of foreign income. They find that receiving a letter of any form from the tax authorities significantly increases reported foreign income.

income, with the true income of the self-employed in the System of National Accounts (SNA), which should not be underreported. In order to make this comparison, studies employing this approach calculate the ratio of the income of the self-employed shown in tax statistics to that in the SNA. With a few exceptions, the estimated ratio ranges from around 50% to 80%, implying that the degree of underreporting lies in the range from 20% to 50%. However, this type of estimation suffers from at least two complications. First, since the denominator and the numerator of the estimated ratio are obtained from different statistics (i.e., the SNA and tax statistics), it is difficult to exactly match the coverage and definition of incomes. Second, it is also difficult to estimate the total income of those earning less than the tax exemption limit, whose income is not shown in tax statistics. As a consequence, the estimation results of previous studies appear to be highly dependent on the assumptions used to estimate the total income below the exemption limit. These complications mean that the estimates may have substantial upward or downward bias.

The fourth approach, which is also the one taken in this study, is the so-called expenditure-based approach pioneered by Pissarides and Weber (1989). Relying on the standard life cycle/permanent income hypothesis (LC/PIH), the approach consists of comparing the current expenditure levels of the self-employed and wage earners. More specifically, we regress households current expenditure on a variety of factors that potentially influence current expenditure such as current income, net worth (the sum of the self-reported value of housing wealth and financial wealth less outstanding debt), household characteristics, and preference-related variables. If we find that the self-employed spend more than wage earners even after controlling for the factors, we assume that the only possible explanation for the higher spending of the self-employed is that they underreport their income.

A number of previous studies for a variety of countries employ the expenditure-based approach, all providing evidence consistent with the hypothesis that the self-employed underreport their income. However, the estimated degree of income underreporting among the self-employed varies, ranging from around 10 to 60%, depending on the country, estimation method, definition of self-employed households, and variables used. In their seminal work, Pissarides and Weber (1989) report that in the United Kingdom the self-employed underreport their income by about 36%. Since then, numerous studies following the work of Pissarides and Weber (1989) for a range of countries have been conducted. For instance, Hurst, Li, and Pugsley (2014), focusing on the United States, report that the estimated degree of income underreporting among the self-employed is about 25%, while Engstrom and Holmlund (2009) and Engstrom and Hagen (2017) arrive at a range of 16–34% for Sweden, Schuetze (2002) arrives at 11–23% for Canada, Johansson (2005) at 16–40% for Finland, Cabral, Kotsogiannis, and Myles (2019) at 20% for the U.K., Kukk and Staehr (2014) at 28–62% for Estonia, Martinez-Lopez (2013) at 25% for Spain, Murashov and Ratnikova (2016) at 16–23% for Russia, Besim and Jenkins (2005) at 11–14% for North Cyprus, and Kim, Gibson, and Chung (2017) at 28% for South Korea and 29% for Russia.

In this study, we employ the expenditure-based approach using Japanese household-level panel data to investigate to what extent self-employed households underreport their income to Japanese tax authorities. To the best of our knowledge, the only study applying the expenditure-based approach to Japan is that by Tateoka (2016). However, he uses prefecture-level rather than household-level data. Moreover, he does not deal with potential endogeneity, which may lead to an overestimation of the degree to which the self-employed underreport their income. To deal with potential endogeneity issues, we employ instrumental variable (IV) estimation and use the multi-year average of income, taking advantage of the panel structure of the data we employ. We also control for preferences such as the degree of risk loving since the data we employ contain such information. We therefore believe that the present study is the first attempt to examine the degree of income underreporting among the self-employed in Japan in a rigorous manner.

Our study also has an advantage over previous studies applying the expenditure-based approach to other countries. As explained in detail below, the expenditure-based approach unfortunately does not allow us to employ fixed effects estimation even when the dataset has a panel structure, since a key explanatory variable is the self-employment dummy, which for most households is constant over time. This means that estimation results for the self-employment dummy may simply reflect systematic differences in preferences such as the attitude toward saving. In previous studies, the effects of possible differences in preferences are either ignored or examined via an indirect approach.[4] In this study, we take advantage of the data we use, which contains responses to a variety of questions regarding respondents' preferences such as the degree of risk-loving, impatience, and the desire to leave a bequest.

The remainder of the study is organized as follows. The next section explains the institutional background of the Japanese tax system and our estimation strategy. Section 3 introduces the dataset we employ. Section 4 presents our estimation results, and Section 5 examines whether our main results are robust to possible differences between the self-employed and wage earners in their preferences and planned retirement age as well as differences in the measurement error of expenditure between the two groups. Finally, Section 6 concludes.

## 2 Institutional background and estimation strategy

### 2.1 Institutional background

[4] For instance, Hurst, Li, and Pugsley (2014), using U.S. microdata, split their sample into two groups, consisting of younger households (with a head aged between 25 and 40) and older households (with a head aged between 41 and 55) and assume that younger households place greater importance on precautionary savings than older households. The reason is that if precautionary saving is an important determinant of the degree of income underreporting among the self-employed, the estimated degree of income underreporting differs between the young and the old. The authors find that there is no clear difference in the estimates between younger and older households, leading them to conclude that their estimate of the degree of income underreporting is robust to differences in precautionary saving between the self-employed and wage earners.

In this section, we explain differences in tax treatment between the self-employed and wage earners in Japan. The same income tax schedule is applied to income earned by the self-employed (i.e., business income) and by wage earners (i.e., employment income). However, the way in which expenses are claimed and taxes are filed and paid differs substantially between the two groups. First, while wage earners are only allowed to claim a predetermined fixed amount of expenses, which is set according to the level of employment income, the self-employed have some discretion in accounting for their expenses. Although tax law stipulates that the self-employed can only claim expenses incurred as part of their business, it is not impossible for them to claim household-related expenses (i.e., daily living-related expenses and expenses on items for personal use). Second, the self-employed and wage earners pay taxes in very different ways. While for wage earners income tax is withheld at source, the self-employed file their own tax returns. This means that tax authorities can automatically obtain accurate information on the income of wage earners; however, for the self-employed, they have no choice but to rely on the income information filed in tax returns. These two differences mean that the self-employed have greater opportunity to underreport their income than wage earners.

### 2.2 Estimation strategy

The expenditure-based approach can be explained based on the Engel curves, which describes the relationship between expenditure and income. Suppose we find that the Engel curves for the self-employed and wage earners based on reported income and expenditure are as drawn in Figure 1, where $\log c$ on the vertical axis is the logarithm of expenditure and $\log y$ the logarithm of reported income. If, as in Figure 1, the Engel curve for the self-employed is located above that for wage earners even after controlling for other factors influencing expenditure such as net worth, household demographics, and preferences (the attitude toward saving, etc.), we infer that the only possible explanation for the higher spending of the self-employed is income underreporting among them. That is, it is likely that the self-employed underreport their revenue and/or overclaim business expenses to minimize their taxable income and hence the amount of tax to be paid.

To investigate to what extent the self-employed underreport their income, we make, like previous studies, the following assumptions. First, both the self-employed and wage earners report expenditure (except for business expenses) truthfully in the survey we use. We believe that this assumption is not overly unrealistic, since generally there is little incentive for respondents to lie about their expenditure level in surveys.[5] Second, we assume that while the self-employed possibly underreport their income, wage earners report their income truthfully in surveys. Again, this is probably not an overly unrealistic assumption. The reason is that wage earners' income usually is directly reported to tax authorities by

[5] We recognize information on expenditure collected in surveys typically contains a certain degree of measurement error. However, as depicted in Figure 1, we essentially compare the expenditure levels of two groups, i.e., the self-employed and wage earners; therefore, as long as the direction and degree of measurement error in the expenditure of the two groups are similar, measurement error does not cause a serious problem in our analysis.

their employer, making tax evasion by underreporting their income nearly impossible. In contrast, the self-employed can intentionally underreport their income to tax authorities by taking advantage of the fact that they self-report their income. If they underreport their income to the tax authorities, it is likely that they also underreport their income in a survey like the one we use in the current analysis. Third, we assume that the slopes of Engel curves for the two groups are identical. We formally test the validity of this assumption in Section 4.

Given these assumptions and after controlling for all observable factors influencing the expenditure level, the horizontal difference between the two Engel curves denoted by $UR$ in Figure 1 captures the possible degree of income underreporting among the self-employed. Since $UR$ is the difference in the reported income (in logarithm) of the two groups, a value of $UR = 0.1$, for example, can be interpreted as indicating that the possible income underreporting among the self-employed is approximately 10%.

Following Pissarides and Weber (1989) and other previous studies in this field, we use expenditure on food at home ($c$) as the dependent variable since most items categorized under food at home cannot be purchased as a business expense. In contrast, suppose that we used durable goods expenditure for our analysis instead and that a self-employed respondent purchased a personal computer for personal use but falsely reported it as a business expense to tax authorities to reduce the income tax payable. In this case, the respondent may not report this durable goods purchase in the survey asking about household *living* expenditure, since the purchase ostensibly was for business use. In this case, we would fail to capture the true expenditure level, resulting in an underestimation of the income underreporting among the self-employed. For similar reasons, our dependent variable does not include expenditure on eating out since the self-employed can include eating out as a business expense if they eat out with their customers, suppliers, or other persons related to their business to entertain them.

Even if we use expenditure on food at home as the dependent variable, we still face two problems. First, the self-employed in agriculture and fisheries may consume self-produced goods at home. Second, self-employed restaurant owners may eat food purchased as a business expense at home. These types of consumption are probably not included in the reported self-employed expenditure on food at home since no payment is made for consumption. As a result, expenditure on food at home for the self-employed in these two areas would underreport the true level of consumption, leading again to an underestimation of the income underreporting of the self-employed. To address this issue, we omit the self-employed working in the aforementioned industries (see Section 3 for details about the sample selection). However, our main results are robust to the inclusion of the self-employed in these industries.[6]

[6] Feldman and Slemrod (2007) use charitable contributions instead of food expenditure as the dependent variable based on the assumption that charitable inclinations among the self-employed and wage earners are identical.

Figure 1 shows that $UR$ can be calculated as the ratio of two parameters: the slope of the Engel curve ($\beta$) and the vertical difference between the two Engel curves ($\gamma$). $\beta$ can also be interpreted as the income elasticity of expenditure, whereas $\gamma$ indicates how much more the self-employed spend on food at home than wage earners, all else being equal. To avoid the approximation error that arises when using the log difference to calculate $UR$ ($\equiv \log y_{WE} - \log y_{SE}$, where $y_{WE}$ and $y_{SE}$ represent the household income of wage earners and self-employed, respectively), we identify the income underreporting among the self-employed by $1-\kappa \equiv 1-\exp(-\gamma/\beta) = (y_{WE}-y_{SE})/y_{WE}$ as in Hurst, Li, and Pugsley (2014) and Engstrom and Hagen (2017). For example, if $1-\kappa = 0.1$, this means that the self-employed possibly underreport their income by 10%.

To estimate $1-\kappa$, we assume the following consumption function:

$$\log c_{it} = \alpha + \beta \log y_{it} + \gamma SE_{it} + \boldsymbol{\phi}' \boldsymbol{X_{it}} + \mu_t + \varepsilon_{it}, \qquad (1)$$

where $i$ is the index for households, $t$ represents the year, $c_{it}$ is household expenditure on food at home, $y_{it}$ is household disposable income, $SE_{it}$ is a dummy which takes a value of one if the household head is self-employed and zero if he or she is a wage earner. We define the household head as the person who earns the most in the household.

$\boldsymbol{X_{it}}$ is a vector of control variables, which include a series of household head age dummies, a dummy if the household head is married, a dummy if the household head is male, a series of family size dummies, eight regional dummies, the number of children attending elementary, junior high, or high school, and the household's net worth. It is important to control for net worth to eliminate the possibility that the self-employed spend more on food at home simply because they have more net worth. A series of year dummies ($\mu_t$) are also incorporated to capture all kinds of aggregate effects, while $\varepsilon_{it}$ is a random error term. The estimates for $\beta$ and $\gamma$ are used to obtain the estimate for $1-\kappa$.

We estimate Equation (1) using ordinary least squares (OLS) in our baseline estimations. Although our dataset has a panel structure, we do not conduct fixed effects estimation. The reason is that the job type (self-employed or wage earner) of most household heads in our sample does not change over time. Insufficient variation in our key explanatory variable, the self-employment dummy, over time can lead to imprecise estimates. In fact, we also estimated Equation (1) employing the fixed effects approach, but none of the estimates for $\beta$ and $\gamma$ were statistically significant.

Using OLS for our estimation means that we need to pay careful attention to potential endogeneity issues. In estimating Equation (1), there are at least two possible sources of endogeneity. The first is that the current income variable ($\log y_{it}$) may be endogenous. According to the LC/PIH,

the current expenditure is affected by the permanent income[7], not necessarily the current income. Thus, if we use the current income for $\log y_{it}$ in Equation (1), our explanatory variable ($\log y_{it}$) is likely to contain measurement error, making the estimate for $\beta$ biased towards zero. In this case, we end up with an upward bias in our estimate of the degree of income underreporting among the self-employed.

To address this problem, we employ two strategies widely used in previous studies. First, taking advantage of the panel structure of our dataset, following Engstrom and Hagen (2017), we use the 7-year average of a household's income instead of the current income in each year. The 7-year average income in year $t$ is calculated by averaging the income from year $t-3$ to year $t+3$. In the income process widely assumed in the literature (see Meghir and Pistaferri, 2010, for a comprehensive survey), the current income not explained by individual characteristics such as age consists of two parts: transitory income shocks and a permanent income component. Taking the multi-year average should smooth out transitory income shocks and thus provide as with a good proxy for permanent income.

As the second strategy to solve the problem that current income is endogenous, we employ the IV approach. Instruments used in previous studies include the educational attainment of the household head, the size of the home, the amount of property tax paid, capital income, whether the spouse works, and the gender and nationality of the household head. In this paper, we use the educational attainment of the household head since this is the most widely used instrument in the literature.[8] We examine the validity of our instrument in Sections 4 and 5.

The second variable in Equation (1) that might be endogenous is the self-employment dummy ($SE_{it}$). For instance, if the self-employed are more risk-loving than wage earners, and those who are more risk-loving spend more today due to lower precautionary saving motives, the degree of risk-loving not controlled for is contained in the error term in Equation (1). In this case, the estimate for $\gamma$ suffers from an upward-bias. To address the potential endogeneity caused by the self-employment dummy, in Section 5 we directly add preference-related variables such as the degree of risk-loving as additional explanatory variables and examine whether the estimate for $\gamma$ remains more or less unchanged.

## 3 Data

The data we use for our analysis are from the "Keio Household Panel Survey (KHPS)" and the "Japan Household Panel Survey (JHPS)." Both are annual household-level panel surveys conducted by the Panel Data Research Center at Keio University, and we use data for the period from 2004 to 2019, the last year for which data are available. Respondents to both surveys are selected based on two-stage stratified random sampling. The structure of the data is shown in Table 1, where the numbers in the

[7] In the current paper, we define the permanent income as the expected lifetime income divided by the life expectancy.
[8] Another possible way to alleviate the problem that current income may be endogenous is to use, if available, the reported *regular* income, which highly likely excludes temporary income shocks. See Kukk and Staehr (2014) for more details.

table show the survey wave for each cohort. The KHPS has been conducted since 2004, and the JHPS since 2009. Until 2014, the KHPS collected data mainly on employment, income, consumption, and housing, while the JHPS collected data mainly on employment, income, education, and health. The KHPS added new households in 2007 and 2012, and the JHPS added new households in 2019. In 2014, the two surveys merged into the JHPS/KHPS, and the same questionnaire was used from then onward. The JHPS/KHPS is conducted every February and asks respondents to recall their expenditure on a variety of goods and services in January. To make it possible to compare households' expenditure to their annual disposable income, we annualize the monthly expenditure by multiplying it by 12. All monetary variables are converted into real terms using the consumer price index (CPI).

To conduct our analysis, we restrict the sample in the following manner. First, households where the head is neither self-employed nor a wage earner are dropped. Second, we exclude households where the head is self-employed *and* the industry where the head usually works is classified as falling under "agriculture," "fishery, forestry, marine products," "wholesale, retail (including department stores and supermarkets)," or "restaurants, accommodations," since such households are potentially able to consume self-produced goods at home or eat food purchased as a business expense at home.[9] Third, we only use observations for the period 2009–2019 since disposable income is not available for 2004–2008. Fourth, to make it possible to compare different specifications in our empirical analysis, we restrict the sample to households that are surveyed for seven consecutive years. We will refer to the sample obtained after limiting observations in the manner described as the "restricted sample."

One caveat regarding the JHPS/KHPS is that it only collects information on expenditure in January. If the seasonality of expenditure on food differs between the self-employed and wage earners – for example, if, relative to wage earners, the self-employed spend more on food at home in January than in other months – this would bias our results. To remove any differences in the seasonality in the data, we therefore adjust the January expenditure data using the monthly expenditure data from another dataset, the "Family Income and Expenditure Survey (FIES)" conducted by the Ministry of Internal Affairs and Communications in Japan. Details of the methodology we employ for the seasonal adjustment are provided in the Appendix. All expenditure data employed in the remainder of the study are seasonally adjusted.

Table 2 provides descriptive statistics of our restricted sample. The disposable income of the self-employed is about 12% lower than that of wage earners, which is consistent with the observation that the educational attainment of the self-employed tends to be lower than that of wage earners. However, the self-employed spend about 15% more on food at home than wage earners, and the difference is statistically significant at the 1% level. This is our starting point, and we suspect that the true

[9] The remaining industries into which the self-employed are classified, in descending order in terms of the number of observations in our sample, are "other service," "construction," "real estate," "manufacturing," "education, learning support," "transportation," "medicine, welfare," "finance, insurance," "information & telecommunications other than information services and surveys," "other," "utilities," and "information services and surveys."

disposable income of the self-employed is much higher than their reported income since they spend more.[10]

However, there are several other potential explanations of why the self-employed spend more on food at home despite their lower disposable income. One possible explanation is that, as shown in Table 2, the self-employed tend to have larger net worth. In addition, the self-employed may have different preferences such as being less interested in precautionary saving. They may also plan to work longer in their lifetime than wage earners since when to retire is up to them. In that case, their expected lifetime income may be higher than that of wage earners even though their current income is lower. In Sections 4 and 5, we control for these potential factors as much as possible and examine whether we still observe that the self-employed spend more than wage earners.

Finally, to complete the preliminary analysis, Figure 2 plots the relationship between the 7-year average of disposable income and expenditure on food at home using our restricted sample. The Figure 2 shows the following. First, the Engel curve for the self-employed is located above the Engel curve for wage earners, which is consistent with the argument that the self-employed underreport their income, as discussed in Section 2. Second, visual inspection suggests that the assumption of equal slopes seems to hold. However, these findings from Figure 2 are only based on the relationship between the two variables. In the next section, we formally estimate the degree of income underreporting among the self-employed using multiple regression analysis.

## 4 Estimation results

This section presents the results of estimating Equation (1) using our restricted sample. As discussed above, the estimation techniques we employ are OLS and IV estimation. Panel A in Table 3 shows the regression results when we use the logarithm of expenditure on food at home as the dependent variable. In specification (1), where current income is used for $\log y_{it}$, the estimate for $\beta$ is 0.146, which is the estimated income elasticity of expenditure on food at home. The estimate for $\gamma$ is 0.089, meaning that the self-employed spend 8.9% more on food at home than wage earners, all else, such as current income, net worth, and household characteristics, being equal. Combining these two estimates provide us with the estimated degree of income underreporting among the self-employed, $1-\kappa$. Our estimated $1-\kappa$ in specification (1) is 45.8%.

As discussed in Section 3, the estimated $1-\kappa$ in specification (1) may be biased upward due to differences between households' current and permanent income caused by transitory income shocks. To alleviate this bias, in specifications (2) to (4) we replace current income with the 3-year, 5-year,

[10] The total expenditure of the self-employed is also higher than that of wage earners, but the difference is not statistically significant (the p-value is 0.108). We discuss possible explanations for the much smaller difference in total expenditure between the two groups in Section 4.

and 7-year averages of income. As expected, the estimate for the income elasticity ($\beta$) increases when we use multi-year averages of income; moreover, it increases the longer the period we use to calculate the average, which is consistent with the argument that specification (1) suffers from attenuation bias in estimating $\beta$. The estimated $1-\kappa$ becomes 33.0% in specification (4), which is lower than the estimate in specification (1). The 90% confidence interval ranges from 23.1% to 42.8%, which is within the 20–50% range obtained in previous studies on the degree of underreporting in Japan based on aggregate data.

As a robustness check, in specification (5), following previous studies, we instrument current income by the household head's years of schooling. The rationale is that household heads' years of schooling are likely to be strongly correlated with household disposable income and that years of schooling should affect the household expenditure on food at home only through household disposable income (once household characteristics, net worth, and year effects are controlled for) and should be uncorrelated with the error term $\varepsilon_{it}$. If this reasoning holds, both the instrument relevance and exogeneity conditions are satisfied. In specification (5), the first-stage F-statistic is 148.6, implying a sufficiently strong correlation between the instrument and current income. The estimated $1-\kappa$ is 36.4%, which is again lower than the estimate in specification (1), consistent with the argument that using current income yields an upward-biased estimate of $1-\kappa$. The 90% confidence interval ranges from 20.6% to 52.1%, which again is more or less within the 20–50% range obtained in previous studies.

However, in the IV estimation we have to carefully take into account that the instrument exogeneity condition may be violated since the error term may include unobserved preferences (recall that we cannot employ the fixed effects approach). For example, if those who are more patient spend less (and save more for the future) and have more years of schooling, the instrument exogeneity condition is violated and the estimate for $\beta$ will be downward-biased. To address this issue, in Section 5 we add preference-related variables such as time discount rates elicited from the JHPS/KHPS as additional control variables and examine whether our main results remain intact.

It is also possible that households with more years of schooling prefer healthier diets, resulting in higher expenditure on food at home. If so, the estimate for $\beta$ and thus the estimate for $1-\kappa$ will be upward-biased. Unfortunately, the JHPS/KHPS does not contain any questions allowing us to deduce respondents' dietary preferences. We therefore consider the estimation results based on the 7-year average of income as likely to be the most reliable results and regard the IV estimation results as complementary.

Next, for reference, Panel B of Table 3 presents the estimation results obtained using total expenditure as the dependent variable. Specifications (4) and (5) show that the estimated $1-\kappa$ are 13.1% and 16.1%, which are much smaller than the estimates obtained in Panel A. As discussed in Section 2, one explanation for this is that when the self-employed purchase goods and services (e.g.,

computers, clothes, books, and eating out) for personal use, they possibly pretend that some of the purchases are for business use and declare them as business expenses. In this case, since the JHPS/KHPS asks respondents about their *living* expenditure, they are likely to exclude such purchases, which possibly explains their low total expenditure shown in Table 2 and 3.

Another potential explanation for the much lower estimate of $1-\kappa$ in Panel B is that the self-employed simply have a strong preference for food at home. That is, it could be that they spend more on food at home and less on other goods and services. Although this might be the case, to the best of our knowledge, there is no supporting evidence for this hypothesis in Japan. We therefore believe that the former explanation is more plausible in accounting for the much smaller estimate of $1-\kappa$ in Panel B.

The interpretation of the results in Table 3 above is based on the assumption that the slopes of Engel curves for the two groups are identical. If this assumption does not hold, the degree of income underreporting among the self-employed depends on the logarithm of expenditure. In this case, we have to be more careful about how we interpret the estimation results. To test the validity of the assumption that the slopes of Engel curves are identical for the two groups, we add the interaction term of the logarithm of disposable income and the self-employment dummy on the right-hand side of Equation (1). The estimation results are summarized in Table 4. In all specifications the estimated coefficients on the interaction term are not statistically significant. Thus, we find no evidence that the slopes of Engel curves differ between the two groups.

Finally, it is worth mentioning another study the results of which suggest that the self-employed in Japan maybe be underreporting their income. Using the Japanese General Social Surveys (JGSS) conducted by the Institute of Regional Studies at Osaka University of Commerce, Ono (2012) examines whether the perceived income tax burden differs across job types. Specifically, the JGSS asks, “Do you think the amount of income tax you have to pay is high?” and respondents choose an answer from among seven choices (Too low, Somewhat low,…, Too high, Don’t know, Pay no tax). Using ordered logit estimation, Ono (2012) reports that being self-employed increases the probability that respondents select “Too low” by about 0.35 percentage points and decreases the probability that they select “Too high” by about 10.72 percentage points. Although this finding may simply reflect different preferences across job types, the fact that the self-employed perceive income taxes to be too low could also be the result of income underreporting.

## 5 Robustness checks

Our regression analysis so far assumed that, controlling for disposable income, net worth, and household characteristics, the self-employed and wage earners have identical preferences. In addition, we also assumed that our IV (the household head’s years of schooling) is uncorrelated with the error term in Equation (1). However, as discussed in Section 4, these assumptions may not hold.

This sections therefore presents several additional analyses. Specifically, Section 5.1, examines whether our main results are contaminated by different preferences between the two groups. Further, Sections 5.2 and 5.3 check whether our main results are simply driven by differences in the planned retirement age or differences in measurement error in expenditure on food at home between the two groups.

### *5.1 Differences in preferences*

The standard Euler equation implies that the attitude toward saving such as the degrees of risk-loving and impatience can influence the current expenditure decision. Thus, if the preference for savings differs between the two groups, this may result in an inconsistent estimate of $\gamma$ since the preference for savings may be correlated with the self-employment dummy. It is possible that the self-employed are more risk-loving since being self-employed has its risks but also potentially offers high returns. If the self-employed are more risk loving, they may be less inclined to save for precautionary purposes and spend more, so that our main results in Table 3 potentially are simply driven by the lower preference for savings of the self-employed.

On the other hand, it is also conceivable that the self-employed have a higher attitude toward saving than wage earners. For example, the self-employed may face greater future income uncertainty. Similarly, they may also be more likely to be borrowing-constrained in the future since their future income may be more unstable than that of wage earners. They may also receive fewer fringe benefits such as employee discounts. Finally, pension system for the self-employed is not well developed in Japan. Failing to control for these factors potentially results in an underestimation of $1-\kappa$.

In addition, it is also possible that our IV is correlated with the attitude toward saving. For instance, those who are more impatient may tend to have fewer years of schooling. In that case, the degree of impatience is correlated with the IV, leading to an inconsistent estimate of $\beta$.

To check whether the self-employment dummy and/or the IV are correlated with the attitude toward saving, we take advantage of several questions in the JHPS/KHPS related to respondents' attitude toward saving. Our most preferred question is the following one asked in the 2017 wave: "Do you think that you are cautious about using savings to cover expenses?" and the answer is either yes or no. Since this question directly asks respondents about their attitude toward dissaving, it presumably reflects all sorts of preferences associated with saving such as the degree of risk-loving, impatience, and the desire to leave a bequest. Unfortunately, this question is only available in the 2017 wave. We therefore do not know whether respondents' attitude toward saving elicited in the 2017 wave also applies to other years. To address this issue, we additionally use the following three pieces of information, which are available for other years of the observation period: the degree of risk-loving (2009–2019), the degree of impatience (2010–2019), and the extent to which respondents' savings are determined by their desire to leave a bequest.

We use this information to construct a number of control variables to check the robustness of our baseline results obtained in Table 3. The results are shown in Table 5, which also contains a number of additional control variables that will be explained below. Since some of the variables are only available for one wave, it is essential to maximize the sample size. We therefore only use IV estimation in this exercise since for the 7-year average of income, for example, we would need to restrict our sample to households that were surveyed for seven consecutive years, which would substantially reduce the sample size. For each of the control variables, we confine the sample to households that answered the question on which the control variable is based. The only difference between the two specifications for each control (for example, specifications (1) and (2) in the case of the dummy regarding respondents' attitude toward dissaving) is whether the control variable is included or not.

*Attitude to dissaving (2017)*

We construct a dummy that takes a value of one if the answer to the question "Do you think that you are cautious about using savings to cover expenses?" is yes and zero if no. The difference in this variable between the self-employed and wage earners after controlling for the variables on the right-hand side of Equation (1) is shown in the row labelled "Difference in preferences" in Table 5. That is, we regress the dummy on all explanatory variables on the right-hand side of Equation (1) and find that the coefficient estimate for the self-employment dummy is -0.02 but not statistically significant. In other words, we find no significant difference in the attitude to dissaving between the two groups.

Next, we estimate Equation (1) with and without the attitude to dissaving dummy (columns (1) and (2), respectively). The coefficient on the dummy is –0.041 but insignificant, suggesting that it is unlikely that our results – at least those for 2017 – are due simply to differences in the attitude toward saving.

*The degree of risk-loving (2010–2019)*

The KHPS in 2012–2019 and the JHPS in 2010–2019 contained the following question: "When you go out to a place you have never been to before with your family or friends, what probability of rain makes you decide to take an umbrella?" Respondents answer either with the percentage (say, 50%), or select "I always take a folding umbrella." For those choosing the latter answer (in our restricted sample, about 13.9% of those who replied to this question chose this answer), we assign a value of 0% since they take an umbrella no matter how good the weather is. This type of question has been used to measure the degree of risk-loving (or risk aversion) in many previous studies (Lee and Ohtake 2012, Ikeda, Kang, and Ohtake 2010, Ohtake and Tomioka 2004, among others).[11] The probability of rain

[11] Ohtake and Tomioka (2004), among others, highlight the advantages of asking this "umbrella" question over a hypothetical question about financial commodities to measure the degree of risk-loving since the latter type of question is not well understood by many respondents.

that makes respondents decide to take an umbrella is 2 percentage points higher for the self-employed, as in columns (3)–(4) in Table 5. Moreover, the difference is statistically significant at the 1% level, indicating that the self-employed are slightly more risk-loving than wage earners.

The impact of the degree of risk-loving on expenditure on food at home is not statistically different from zero and thus our estimated $1-\kappa$ remain intact. In sum, our main results are also robust to different degree of risk-loving between the two groups.

*The degree of impatience (2010–2019)*

To check whether the self-employed spend more today simply because they are more impatient, we elicit the time discount rate of respondents from the JHPS/KHPS. The KHPS in 2014–2019 and the JHPS in 2010–2019 asked respondents the following question: If you were given a choice to receive 10,000 yen next month or an amount of money in 13 months' time, at least how much would you want to receive to take the money in 13 months' time? The options are "9,500 yen (-5%)," "10,000 yen (0%)," "10,200 yen (2%)," "10,400 yen (4%)," "10,600 yen (6%)," "11,000 yen (10%)," "12,000 yen (20%)," and "14,000 yen (40%)." The figures in parentheses show the minimal interest rate respondents expect to wait for an additional year, which we will refer to as the time discount rate. A higher time discount rate indicates a higher degree of impatience.[12] Table 5 shows that the time discount rate of the self-employed is 1 percentage point higher than that of wage earners. This suggests that the self-employed are slightly more impatient and the difference is statistically significant at the 1% level.

The impact of the degree of impatience on expenditure on food at home is 0.126 and statistically significant, meaning that the households whose time discount rate is 10 percentage points higher spend about 1.26% more on food at home, which is consistent with the argument that impatient households spend more now than in the future.

The estimation results in columns (5) and (6) show that including the degree of impatience increases the estimate for $\beta$ from 0.238 to 0.242. As discussed in Section 2, this can be explained by the negative correlation between our IV and the degree of impatience. That is, our IV estimate for $\beta$ without controlling for the degree of impatience is downward-biased. Including the degree of impatience also decreases the estimate for $\gamma$ – the coefficient on the self-employment dummy – from 0.110 to 0.108. This indicates that the fact that the self-employed spend more on food at home can be partially explained by the fact that they are more impatient.

Overall, however, the inclusion of the degree of impatience has only a small effect on the estimates for $\beta$ and $\gamma$ and consequently for $1-\kappa$ (which falls from 36.9% to 36.1%). We therefore

[12] While the 2009 waves of the JHPS and the KHPS also ask the same question (with slightly different wording), respondents are asked to provide a specific number, not choose one answer from multiple options. We therefore decided not to use the 2009 waves to elicit the time discount rate.

think that our main results are also robust to different degrees of impatience.

*Importance of the bequest motive (2009–2011)*

The bequest motive may play a greater role in the case of the self-employed since they may want their child(ren) to take over their family business. In this case, they may save more and spend less, implying that our baseline case underestimates $1-\kappa$. To elicit information on the importance of the bequest motive, we use the KHPS and the JHPS for 2010, which asked respondents to indicate the degree to which the following statement applies to them: "I want to leave my children as large an inheritance as possible." Respondents were requested to choose from one of the following five answers: "Applies very much," "Applies somewhat," "Cannot say either way," "Does not apply much," and "Does not apply at all." We create a dummy taking a value of one if the answer is either "Applies very much" or "Applies somewhat" and zero if the answer is "Cannot say either way," "Does not apply much," or "Does not apply at all."[13]

One problem with this variable is that the estimates we obtain for $\beta$ are statistically insignificant, probably because this variable is available only for 2010. To overcome this problem, we assume that the importance of the bequest motive remains unchanged for the same respondent over three years and we use the same values of this dummy variable for 2009 and 2011 as well. Doing so increases the sample size by a factor of about three.

The estimation results are shown in columns (7) and (8) in Table 5. We find no statistically significant difference in the importance of the bequest motive between the two groups. In addition, although the estimate for the bequest motive dummy is negative as expected, we fail to find statistically significant evidence that those who are more inclined to leave an inheritance to their child(ren) save more and spend less (on food at home). A possible explanation is that some may plan to transfer money to their child(ren) through investing in their education, not by leaving an inheritance. In this case, although their desire to leave a bequest may not be that strong, their attitude toward saving is high to provide their child(ren) with a good education.

In sum, we believe that our main results are not driven by differences in the importance of the bequest motive between the two groups.

### *5.2 Differences in planned retirement age*

Another possible explanation why the self-employed seem to spend more despite their lower disposable income could be that they plan to work longer in their lifetime than wage earners since it is up to them to choose when they retire. In this case, their lifetime income may be higher than that of wage earners despite their lower current disposable income, which could explain the higher spending

[13] We also created dummies for each of the five replies and added four of them as explanatory variables. The estimated $1-\kappa$ are almost identical to those shown in Table 5.

of the self-employed.

To examine this hypothesis, we use a question from the 2017 wave, which asked non-retirees about their planned retirement age. Given that the question we use is one of many questions asking what funds the *household* planned to live on after retirement, we assume that respondents provide us with the *household head's* planned retirement age, which is presumably the information that is the most relevant regarding household expenditure decisions.

Figure 3 compares the distribution of the planned retirement age between the two groups. While a majority of wage earners plan to retire at either 60 or 65 years of age, the distribution for the self-employed is more diverse, with the mode at 70 years. The mean planned retirement age of the self-employed is 4.59 years higher than that of wage, and the difference is statistically significant at the 1% level, as shown in Table 5. Thus, it is possible that the self-employed may be spending more despite their lower current disposable income since they plan to work longer in their lifetime than wage earners. In this case, the positive estimate for $\gamma$ should become smaller once we control for the planned retirement age.

Columns (9) and (10) in Table 5 show the estimation results when we control for the planned retirement age. Surprisingly, the coefficient estimate for the planned retirement age is close to zero and insignificant. One possible explanation for the insignificant coefficient is that the timing of retirement may be highly uncertain, especially for the self-employed. For example, even though a self-employed person may plan to retire at age 70, a variety of factors such as a negative health shock or adverse performance of their business may force them to retire earlier than planned. Uncertainty regarding the timing of retirement may lead the self-employed to reduce current spending to engage in precautionary saving, offsetting the positive effect on spending of working until a later age. Another possible explanation for the insignificant coefficient is that many respondents may answer with their *desired* retirement age, not their *planned* retirement age. In this case, measurement error in the planned retirement age leads to attenuation bias, resulting in an estimate biased towards zero.[14]

In sum, although there is a significant difference in the planned retirement age between the two groups, our main results are not influenced substantially affected by controlling for the planned retirement age since the planned retirement age is not a significant determinant of current expenditure on food at home.

### *5.3 Differences in measurement error in expenditure*

As discussed in Section 2, while the information on expenditure is likely to suffer from measurement error as it is collected in recall format, this does not cause a serious problem if the degree and direction of the measurement error are similar for the two groups. In this case, measurement error simply shifts

[14] Our result is in line with Carroll's (1994) finding based on the Panel Study of Income Dynamics in the United States that current food expenditure is affected by current income, but not by projected future income.

the two Engel curves to an equal degree in the same direction, leaving the horizontal distance between the two Engel curves, depicted as *UR* in Figure 1, unaffected. However, there is no guarantee that the degree of measurement error in expenditure is similar for the two groups. For example, the self-employed may have a habit of overreporting their expenditure on food at home, or wage earners may have a habit of underreporting their expenditure. In this case, it is possible that the higher expenditure of the self-employed simply reflects differences in the degree of measurement error between the two groups.

To mitigate this potential issue as much as possible, we add a proxy variable for the measurement error in expenditure on the right-hand side of Equation (1) and examine whether our main results are robust. If the higher spending by the self-employed is driven by differences in the measurement error between the two groups, the estimate of $\gamma$ should be closer to zero once we control for the proxy variable for measurement error.

As a proxy, we use information on whether households keep an account book or not. The underlying idea is that those who keep an account book are likely to provide more accurate expenditure information. The 2009 waves of the KHPS and the JHPS asked respondents: "Does your household keep a household ledger or other record of expenditures?" and possible answers were "We usually do," "We sometimes do," "We rarely do," and "We never do." We create an account book dummy taking a value of one if the answer is either "We usually do" or "We sometimes do," and zero if it is "We rarely do" or "We never do." The conditional mean of the account book dummy is 4 percentage points lower for the self-employed, but the difference is not statistically different from zero, as shown in Table 5.

The coefficient on the account book dummy is −0.077, meaning that those who (usually or sometimes) keep an account book spend less on food at home by about 7.7%. One possible explanation for this finding is that people in general tend to overreport their expenditure on food at home. That is, those who rarely or never keep an account book tend to overreport their expenditure on food at home whereas those who (usually or sometimes) keep an account book report it more accurately. Another possible explanation is that those who keep an account book are more likely to think seriously about their post-retirement years and thus have a higher attitude toward saving.

In sum, given that the share of those who (usually or sometimes) keep an account book does not significantly differ between the two groups, we believe that our main results are not driven by differences in the measurement error in expenditure on food at home.

To summarize the results in Section 5, our main results shown in Table 3 are robust to possible differences in the attitude toward sav, the planned retirement age, and measurement error in expenditure between the two groups.[15]

[15] We also check whether our main results shown in Table 3 are robust to a stricter definition of the self-employment dummy. Taking advantage of the fact that the JHPS/KHPS asks not only about total household income but also about eleven different categories of household income, we create a different self-employment dummy that takes a value of one if the share of income from self-employment is 90% or higher and zero if the share of income from employment is

## 6 Considerations on biases in $1-\kappa$

So far, we have assumed that all self-employed households underreport their income by the same degree, $(1-\kappa)$. However, as mentioned by Hurst, Li, and Pugsley (2014), since household surveys are not tax forms which are submitted to and examined later by tax authorities, it is likely that at least some of the self-employed who underreport their income to tax authorities provide their actual income in the JHPS/KHPS. If this is the case, this would shift the estimated Engel curve for the self-employed downward, leading to an underestimation of $\gamma$ and hence of the degree of income underreporting among the self-employed.

To examine to what extent truthful income reporting in surveys affects estimates of underreporting using the expenditure-based approach, Cabral, Gemmell, and Alinaghi (2020) use a unique dataset for New Zealand that matches survey data with administrative tax register data for the same households and estimate $1-\kappa$ for two cases: (i) using the income information from the survey data, and (ii) using the income information from the tax register data. Employing IV estimation, Cabral, Gemmell, and Alinaghi (2020) show that the estimated $1-\kappa$ is 10.7%–12.0% in the survey income data and 19.3%–21.6% in the register income data. Meanwhile, using a dataset for Estonia in which household income survey information is linked with tax reports, Paulus (2015) conducts similar exercises as Cabral, Gemmell, and Alinaghi (2020) and finds that the estimated $1-\kappa$ is 20.2% in the survey data and 48.1% in the tax register data.

These two studies indicate that survey income data like ours possibly lead to a substantially downward-biased estimate for $1-\kappa$. Although it is not certain whether their conclusions apply to the case of Japan, their findings highlight that our estimates of $1-\kappa$ may be biased downward.

On the other hand, it is also possible that our estimates of $1-\kappa$ may be biased upward due to real assets owned by the self-employed but not reported in the survey. For instance, a self-employed hairdresser, in addition to the house in which he/she lives may own the building (and plot) in which the salon is located. In this case, since the JHPS/KHPS asks respondents only to provide the self-reported value of their home (building and land) but not the value of any non-residential real assets owned (the salon in this case), these are not included in households' net worth. Unfortunately, to the best of our knowledge, there is no dataset collecting information on the value of the non-residential

90% or higher. The estimates of $1-\kappa$ range from 43.3% to 52.7% and are statistically significant at the 1% level. This implies that our baseline definition of the self-employment dummy is not sufficiently rigorous and the estimated $1-\kappa$ shown in therefore Table 3 may be downward-biased. However, we decided not to regard this as our main result for the following three reasons. First, we cannot obtain appropriate scale factors to adjust for seasonality in January expenditure in the case of the stricter definition of the self-employment dummy because of a lack of sufficient information when we use household income by category in the FIES (as a result, the aforementioned estimates are based on seasonally unadjusted expenditure data). Second, many respondents do not provide an answer for the breakdown of household income, resulting in a small number of observations for self-employed households (N=102) in this exercise. This casts doubt on the representativeness of our estimation results. Third, the smaller sample size prevents us from obtaining statistically significant results in the type of robustness check presented in Table 5.

real assets of the self-employed in Japan, so that we cannot correct for this potential bias. We leave this issue for future research.

## 7 Conclusion

This study, using household-level panel data from the JHPS/KHPS for the period 2009–2019, examined to what extent the self-employed in Japan underreport their income. Following numerous previous studies, we employed the so-called expenditure-based approach pioneered by Pissarides and Weber (1989). However, our analysis differs from most previous studies in two respects. First, taking advantage of panel structure of the JHPS/KHPS, we used the average of households' income over a number of years as a proxy for permanent income. Only a small number of studies have taken this "permanent income approach," as Engstrom and Hagen (2017) dubbed it, which allows us to check the robustness of our results based on IV estimation. Second, and more importantly, taking advantage of the information provided by the JHPS/KHPS, which asks a variety of questions associated with expenditure decisions, we further check whether our main results are robust to possible differences in preferences, the planned retirement age, and the degree of measurement error in expenditure between the two groups.

Our baseline estimation results show that the self-employed underreport their income by about 33.0−36.4%. In the robustness check, we find that the self-employed are more risk-loving, impatient, and plan to work longer in their lives than wage earners, which points out the possibility that the self-employed spend more today simply because of different preferences and/or planned retirement age. However, we find that our baseline estimation results are robust to these differences between the two groups.

Our findings have several important implications. First, our estimation results indicate that tax authorities miss out on some tax revenue from the self-employed in Japan. This is particularly important in Japan, where the government debt-to-GDP ratio is over 200%. Second, our findings also have important implications for debate on income inequality. Given that the self-employed underreport their income, inequality measures based on reported income could be misleading, meaning that instead of focusing on income, as suggested by the standard LC/PIH, it may be better to focus on consumption when measuring how well off households are. Third and finally, while some scholar have argued that income underreporting by the self-employed by the early 2000s had become less pronounced than during preceding decades (see, e.g., Ota, Tsubouchi, and Tsuji 2003), our estimation results do not support this interpretation. On the contrary, the magnitude of our estimates is almost the same as those obtained for the 1970s and 1980s (20–50% as summarized in Section 1).

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**Appendix**

This Appendix explains how we adjust for possible difference in the seasonality in January expenditure between the self-employed and wage earners. For the adjustment, we rely on the Family Income and Expenditure Survey (FIES), a monthly survey that is used for computing the weights assigned to goods and services categories in the CPI and for the estimation of private final expenditure in the National Accounts of Japan, and that has also been used by a number of previous academic studies (Hsieh, Shimizutani, and Hori 2010, Stephens and Unayama 2011, Cashin and Unayama 2016, to name a few) to study household behaviors in Japan. The FIES provides detailed information on the expenditure, income, net financial wealth, and household characteristics of a nationally representative sample of about 8,000–9,000 households each month in Japan. Households are surveyed for a period of three (single person households) or six consecutive months (two or more person households). There, although not important for our purpose, the FIES data have a panel structure.

Taking advantage of the monthly data structure of the FIES, we first estimate $\delta_0, \delta_1, \delta_2,$ and $\delta_3$ in the following equation using OLS:

$$c_{it} = \delta_0 + \delta_1 D_t + \delta_2 [D_t \times SE_i] + \delta_3 SE_i + u_{it}, \qquad (2)$$

where $c_{it}$ is either monthly expenditure on food at home or total monthly expenditure and $D_t$ is a dummy for January taking a value of one if the survey month is January and zero otherwise. Note that to adjust for seasonality we make the sample as similar as possible to the restricted sample in the JHPS/KHPS. That is, self-employed households are defined as households in which the head is self-employed, while wage earners are defined as households in which the head is a wage earner. We also drop self-employed households in which the head works either in the agriculture, wholesale, retail, or food business industries. We use observations from January 2009 to March 2018[16] and convert monthly expenditure into real terms using the CPI. Since adding control variables ($y_{it}, \boldsymbol{X_{it}},$ and $\mu_t$ in Equation (1)) to the right-hand side of Equation (2) does not change our estimates of $1-\kappa$ very much, we omit them in this exercise for simplicity. The number of observations used for the estimation is 420,244.[17]

In Equation (2), the difference between expenditure in January and other months among wage earners is represented by $\delta_1$, while the difference between expenditure in January and other months

[16] While the latest wave of the JHPS/KHPS is the 2019 wave, the latest FIES data we can currently access is the March 2018 wave.

[17] While the FIES provides a much larger sample size than the JHPS/KHPS, there are a number of reasons why we did not use it to examine the degree of self-employed income underreporting in the first place. First, the FIES does not have a multi-year panel structure, so that we would not be able to calculate multi-year averages of households' income. Second, it does not collect information on the educational attainment of the household head, an important IV in our analysis. And third, it does not elicit any information on preferences such as the degree of risk-loving and time discount rates.

among the self-employed is represented by $\delta_1 + \delta_2$. Therefore, seasonal differences in January expenditure between the two groups are captured by $\delta_2$. In the following description, we focus on the case of expenditure on food at home and only report the result for total expenditure at the end.

In the case of expenditure on food at home, the estimated $\delta_1$ is about −2,264 and statistically significant at the 1% level, meaning that wage earners' expenditure on food at home in January is about 2,264 yen (about 22.64 U.S. dollars) lower than their monthly expenditure on food at home in other months.[18] More importantly, the estimated $\delta_2$ is about −3,022 and statistically significant at the 1% level, indicating an *additional negative* seasonality in January expenditure on food at home for the self-employed. This indicates that relying only on expenditure information for January may result in underestimating the true expenditure level for the self-employed, highlighting the importance of seasonal adjustment.

To adjust for the different seasonality in the January expenditure on food at home between the two groups, we essentially inflate the January expenditure of the two groups to the average monthly expenditure level of each group over a year. To that end, we define the following variables:

- $c^{WE} \equiv$ average monthly expenditure on food at home for wage earners other than in January
- $c_{Jan}^{WE} \equiv$ average monthly expenditure on food at home for wage earners in January
- $c^{SE} \equiv$ average monthly expenditure on food at home for the self-employed other than in January
- $c_{Jan}^{SE} \equiv$ average monthly expenditure on food at home for the self-employed in January

Each variable can then be captured by a combination of the following estimates.

- $c^{WE}$ = average monthly expenditure on food at home when ($D = 0$ and $SE = 0$)
  $= \delta_0$
- $c_{Jan}^{WE}$ = average monthly expenditure on food at home when ($D = 1$ and $SE = 0$)
  $= \delta_0 + \delta_1$
- $c^{SE}$ = average monthly expenditure on food at home when ($D = 0$ and $SE = 1$)
  $= \delta_0 + \delta_3$
- $c_{Jan}^{SE}$ = average monthly expenditure on food at home when ($D = 1$ and $SE = 1$)
  $= \delta_0 + \delta_1 + \delta_2 + \delta_3$

Using these variables, the average monthly expenditure on food at home for wage earners over a year can be calculated as follows:

[18] For reference, the (unconditional) average monthly expenditure on food at home in our FIES sample is about 57,465 yen for wage earners and 60,143 yen for the self-employed.

$$\frac{C_{Jan}^{WE}+C^{WE}\times 11}{12}=\frac{(\delta_0+\delta_1)+\delta_0\times 11}{12} \tag{3}$$

Therefore, in order to inflate $c_{jan}^{WE}$ up to wage earners' average monthly expenditure on food at home over a year, we multiply $c_{jan}^{WE}$ by the scale factor $x_{food}^{WE}$, which is calculated as follows:

$$x_{food}^{WE}=\frac{(\delta_0+\delta_1)+\delta_0\times 11}{(\delta_0+\delta_1)\times 12}. \tag{4}$$

Similarly, the scale factor for the self-employed, $x_{food}^{SE}$, is obtained as follows:

$$x_{food}^{SE}=\frac{(\delta_0+\delta_1+\delta_2+\delta_3)+(\delta_0+\delta_3)\times 11}{(\delta_0+\delta_1+\delta_2+\delta_3)\times 12}. \tag{5}$$

Based on the estimates for $\delta_0, \delta_1, \delta_2,$ and $\delta_3$ in Equation (2), we obtain $x_{food}^{WE}=$ 1.0375 and $x_{food}^{SE}=$ 1.0876. Therefore, throughout our analysis, we multiply the expenditure on food at home in the JHPS/KHPS for wage earners by 1.0375 and for the self-employed by 1.0876 to adjust the different seasonality in January expenditure on food at home.

Similarly, in the case of total expenditure we obtain $x_{total}^{WE}=$ 0.9908 and $x_{total}^{SE}=$ 0.9801. That is, in contrast to the expenditure on food at home, the total expenditure in January is higher than the total expenditure in other months for both groups, and this tendency is slightly more pronounced for the self-employed than for wage earners. Throughout our analysis, we also use these scale factors to adjust the different seasonality in January total expenditure.

**References for Appendix**

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Hsieh, C., Shimizutani, S., and Hori, M. (2010) "Did Japan's shopping coupon program increase spending?" *Journal of Public Economics*, Vol. 94, No. 7–8, pp. 523–529.

Stephens, M., and Unayama, T. (2011) "The consumption response to seasonal income: Evidence from Japanese public pension benefits," *American Economic Journal: Applied Economics*, Vol. 3, No. 4, pp. 86–118.

Figure 1

Engel curves for wage earners (WE) and the self-employed (SE)

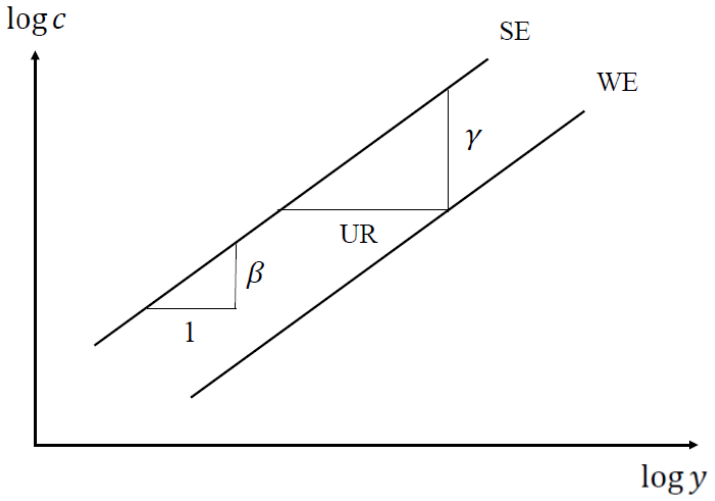
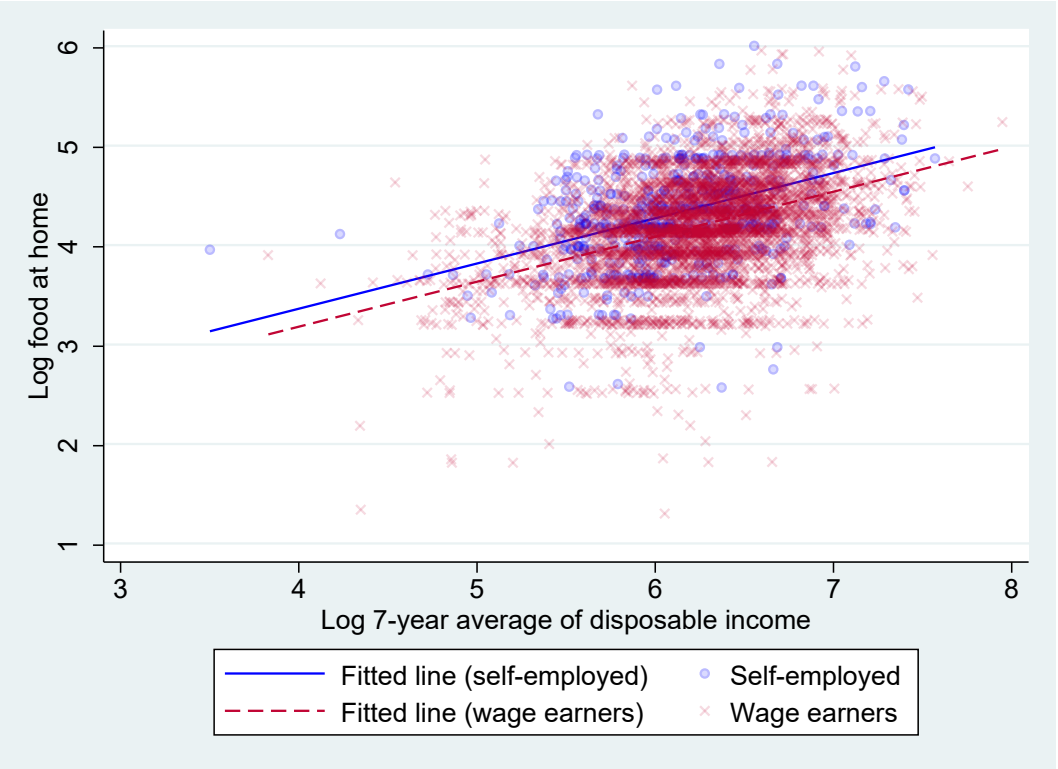


Figure 2

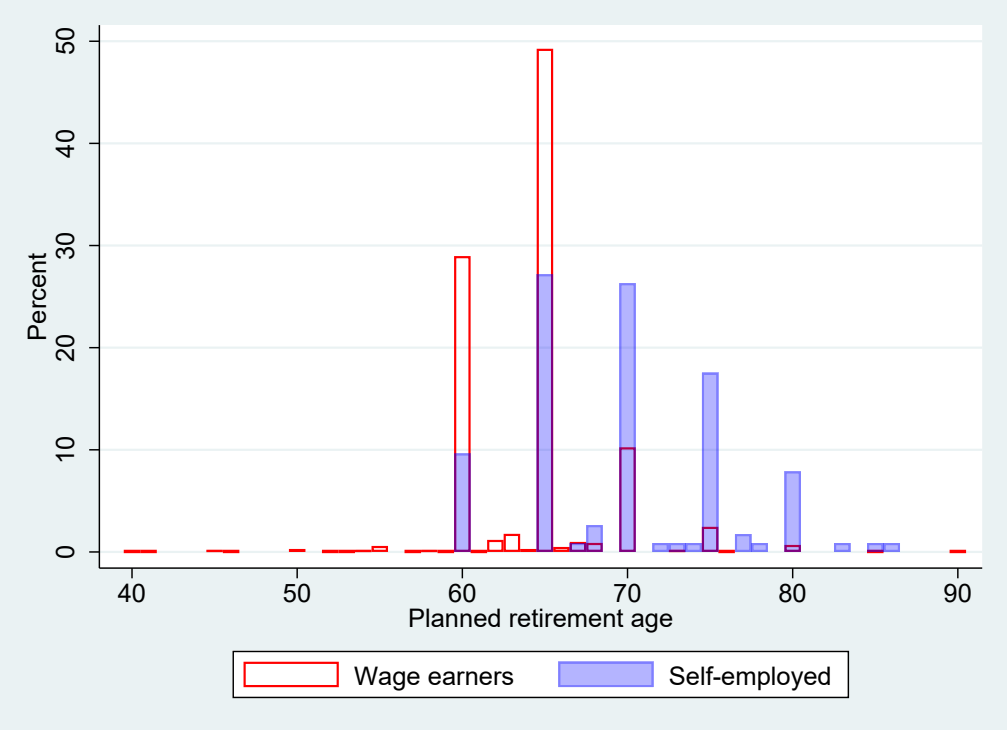
Engel curves drawn from our restricted sample




*Note*: Monthly expenditure on food at home is seasonally adjusted employing the method described in the Appendix.

Figure 3

Distribution of planned retirement age




*Note*: The figure is drawn from a question in the 2017 wave of the JHPS/KHPS, which asks non-retirees about their planned retirement age.

Table 1: Data structure of the JHPS/KHPS

| Year | KHPS (2004) | KHPS (2007) | JHPS (2009) | KHPS (2012) | JHPS (2019) |
|---|---|---|---|---|---|
| 2004 | 1 | | | | |
| 2005 | 2 | | | | |
| 2006 | 3 | | | | |
| 2007 | 4 | 1 | | | |
| 2008 | 5 | 2 | | | |
| 2009 | 6 | 3 | 1 | | |
| 2010 | 7 | 4 | 2 | | |
| 2011 | 8 | 5 | 3 | | |
| 2012 | 9 | 6 | 4 | 1 | |
| 2013 | 10 | 7 | 5 | 2 | |
| 2014 | 11 | 8 | 6 | 3 | |
| 2015 | 12 | 9 | 7 | 4 | |
| 2016 | 13 | 10 | 8 | 5 | |
| 2017 | 14 | 11 | 9 | 6 | |
| 2018 | 15 | 12 | 10 | 7 | |
| 2019 | 16 | 13 | 11 | 8 | 1 |

*Notes*: The JHPS/KHPS consists of five cohorts, which joined the survey in 2004, 2007, 2009, 2012, and 2019, respectively. The JHPS and the KHPS use the same questionnaire after 2013. In the current study, we only use observations for 2009–2019 since disposable household income is available only from 2009 onward.

Table 2: Descriptive statistics

| Variable | Self-employed | | Wage earners | | Difference |
|---|---|---|---|---|---|
| | Mean | Std. dev. | Mean | Std. dev. | (SE − WE) |
| Log food at home | 4.33 | 0.52 | 4.20 | 0.51 | 0.15 *** |
| Log total expenditure | 5.79 | 0.46 | 5.76 | 0.42 | 0.03 |
| Log disposable income | 6.06 | 0.66 | 6.19 | 0.58 | -0.12 *** |
| Net worth (10,000 yen) | 2,505 | 3,741 | 1,745 | 2,739 | 760 *** |
| Male dummy (household head) | 0.91 | 0.29 | 0.89 | 0.31 | 0.02 |
| Age (household head) | 54.74 | 12.12 | 49.05 | 10.64 | 5.68 *** |
| Family size | 3.20 | 1.30 | 3.31 | 1.35 | -0.11 * |
| Number of children | 0.51 | 0.87 | 0.59 | 0.89 | -0.08 * |
| Marital dummy (household head) | 0.85 | 0.36 | 0.86 | 0.34 | -0.01 |
| Educational attainment (household head) | | | | | |
| Junior high school dummy | 0.11 | 0.32 | 0.04 | 0.18 | 0.08 *** |
| High school dummy | 0.43 | 0.49 | 0.41 | 0.49 | 0.01 |
| Technical college/junior college dummy | 0.07 | 0.26 | 0.09 | 0.28 | -0.01 |
| Undergraduate dummy | 0.36 | 0.48 | 0.41 | 0.49 | -0.05 ** |
| Postgraduate dummy | 0.03 | 0.17 | 0.05 | 0.22 | -0.02 ** |
| Number of observations | 535 | | 4,679 | | |
| Number of households | 232 | | 1,773 | | |

*Notes*: Monthly expenditure data are seasonally adjusted using the method described in the Appendix and annualized by multiplying them by 12. Disposable income is the household annual disposable income in the preceding year. All monetary variables are converted into real terms using the CPI (2015=100) and transformed into logarithmic form, with the exception of net worth (the sum of the self-reported value of housing wealth and financial wealth less outstanding debt). The number of children refers to the number of children attending elementary, junior high, or high school. The last column reports the results of hypothesis testing for differences in means between the self-employed and wage earners. To avoid the approximation error that arises when using the logarithmic difference, the difference for the first three variables (food at home, total expenditure, and disposable income) is calculated as $(x_{SE} - x_{WE})/x_{WE}$, not $\log x_{SE} - \log x_{WE}$. ***, **, * indicate statistical significance at the 1, 5, and 10% levels, respectively.

Table 3: Regression results

| | (1) Current income | (2) 3-year average | (3) 5-year average | (4) 7-year average | (5) IV (educ) |
|---|---|---|---|---|---|
| **Panel A** | | Dependent variable: Log (food at home) | | | |
| Log (income) | 0.146*** | 0.221*** | 0.235*** | 0.238*** | 0.224*** |
| | (0.013) | (0.016) | (0.016) | (0.017) | (0.066) |
| Self-employment dummy | 0.089*** | 0.096*** | 0.097*** | 0.095*** | 0.101*** |
| | (0.022) | (0.021) | (0.021) | (0.021) | (0.024) |
| 1-κ | 45.8%*** | 35.2%*** | 33.8%*** | 33.0%*** | 36.4%*** |
| | (8.2%) | (6.3%) | (6.0%) | (6.0%) | (8.0%) |
| First-stage F-statistic | | | | | 148.6 |
| Number of observations (Total) | 5,214 | 5,214 | 5,214 | 5,214 | 5,214 |
| Number of observations (SE) | 535 | 535 | 535 | 535 | 535 |

| | (1) Current income | (2) 3-year average | (3) 5-year average | (4) 7-year average | (5) IV (educ) |
|---|---|---|---|---|---|
| **Panel B** | | Dependent variable: Log (total expenditure) | | | |
| Log (income) | 0.240*** | 0.379*** | 0.404*** | 0.417*** | 0.415*** |
| | (0.016) | (0.016) | (0.015) | (0.015) | (0.061) |
| Self-employment dummy | 0.046** | 0.059*** | 0.061*** | 0.059*** | 0.073*** |
| | (0.020) | (0.019) | (0.019) | (0.019) | (0.022) |
| 1-κ | 17.5%*** | 14.3%*** | 14.1%*** | 13.1%*** | 16.1%*** |
| | (6.8%) | (4.3%) | (4.0%) | (3.9%) | (4.1%) |
| First-stage F-statistic | | | | | 148.6 |
| Number of observations (Total) | 5,214 | 5,214 | 5,214 | 5,214 | 5,214 |
| Number of observations (SE) | 535 | 535 | 535 | 535 | 535 |

*Notes*: Both expenditure on food at home and total expenditure are seasonally adjusted using the method described in the Appendix. $1-\kappa$ is the degree of income underreporting among the self-employed and is calculated as $1-\exp(-\gamma/\beta) = (y_{WE}-y_{SE})/y_{WE}$. Standard errors are in parentheses. Standard errors for the estimates of Log (income) and the self-employment dummy are heteroskedasticity robust standard error, while the standard error for the estimates of $1-\kappa$ is computed using the delta method. ***, ** indicate statistical significance at the 1 and 5% levels, respectively. The IV used in specification (5) is years of schooling of the household head.

Table 4: Equality of slopes of Engel curves for the self-employed and wage earners

| | (1) Current income | (2) 3-year average | (3) 5-year average | (4) 7-year average |
|---|---|---|---|---|
| | Dependent variable: Log (food at home) | | | |
| Log (income) | 0.147*** | 0.215*** | 0.230*** | 0.230*** |
| | (0.013) | (0.017) | (0.017) | (0.018) |
| Log (income) | -0.008 | 0.045 | 0.046 | 0.058 |
| ×Self-employment dummy | (0.035) | (0.040) | (0.040) | (0.040) |
| Number of observations (Total) | 5,214 | 5,214 | 5,214 | 5,214 |
| Number of observations (SE) | 535 | 535 | 535 | 535 |

*Notes*: *** indicates statistical significance at the 1% levels.

Table 5: Regression results (robustness checks)

| | Dependent variable: Log (food at home) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Additional control variable: | Attitude to dissaving dummy | | Degree of risk loving | | Time discount rate | | Importance of bequest motive dummy | | Planned retirement age | | Account book dummy | |
| Observation period | 2017 | | 2010–2019 | | 2010–2019 | | 2009–2011 | | 2017 | | 2009 | |
| Log (income) | 0.369*** | 0.373*** | 0.243*** | 0.245*** | 0.238*** | 0.242*** | 0.153*** | 0.152*** | 0.230** | 0.233** | 0.301*** | 0.316*** |
| | (0.124) | (0.124) | (0.040) | (0.041) | (0.045) | (0.045) | (0.049) | (0.049) | (0.099) | (0.098) | (0.081) | (0.081) |
| Self-employment dummy | 0.132*** | 0.131*** | 0.106*** | 0.106*** | 0.110*** | 0.108*** | 0.114*** | 0.114*** | 0.155*** | 0.169*** | 0.167*** | 0.165*** |
| | (0.048) | (0.048) | (0.013) | (0.013) | (0.015) | (0.015) | (0.020) | (0.020) | (0.049) | (0.051) | (0.029) | (0.029) |
| Additional control variable | | -0.041 | | 0.007 | | 0.126*** | | -0.006 | | -0.003 | | -0.077*** |
| | | (0.033) | | (0.018) | | (0.030) | | (0.013) | | (0.003) | | (0.019) |
| 1-κ | 30.0%*** | 29.7%*** | 35.4%*** | 35.2%*** | 36.9%*** | 36.1%*** | 52.5%*** | 52.6%*** | 48.1%*** | 50.6%** | 42.7%*** | 40.7%*** |
| | (11.6%) | (11.4%) | (5.1%) | (5.1%) | (6.0%) | (5.9%) | (11.2%) | (11.3%) | (16.0%) | (16.4%) | (9.5%) | (8.9%) |
| First-stage F-statistic | 49 | 49 | 376 | 362 | 299 | 297 | 226 | 223 | 52 | 54 | 89 | 89 |
| Difference in preferences (SE−WE) | -0.02 | | 0.02*** | | 0.01*** | | 0.01 | | 4.59*** | | -0.04 | |
| Number of observations (Total) | 1,263 | | 13,742 | | 11,223 | | 5,730 | | 1,129 | | 2,032 | |
| Number of observations (SE) | 135 | | 1,518 | | 1,224 | | 681 | | 114 | | 245 | |

*Notes*: That attitude to dissaving dummy takes a value of one if the answer to the question "Do you think that you are cautious about using savings to cover expenses?" is yes and zero if no. The degree of risk loving variable is based on the answer to the question "When you go out to a place you have never been to before with your family or friends, what probability of rain makes you decide to take an umbrella?" The time discount rate is calculated from the answer to the question If you were given a choice to receive 10,000 yen next month or an amount of money in 13 months' time, at least how much would you want to receive to take the money in 13 months' time? For example, if the answer is 12,000 yen, his/her time discount rate is 20%. The dummy regarding the importance of leaving a bequest takes a value of one if the response to the statement "I want to leave my children as big an inheritance

as possible" is either "Applies very much" or "Applies somewhat" and zero if it is "Cannot say either way" or "Does not apply much" or "Does not apply at all." The account book dummy takes a value of one if the answer to the question "Does your household keep a household ledger or other record of expenditures?" is either "We usually do" or "We sometimes do" and zero if it is "We rarely do" or "We never have." The "Difference in preferences" row shows the coefficient estimate for the self-employment dummy when we regress the preference-related variable on all the explanatory variables on the right-hand side of Equation (1). *** and ** indicate statistical significance at the 1 and 5% levels, respectively.