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Elasticity of corporate taxable income and loss aversion: Evidence from Japanese tax records

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Abstract

Under the current corporate taxation system, the corporate tax payment is zero if the taxable income is equal to or less than zero. This may induce a firm to reduce its taxable income to equal to or less than zero. Considering the tax loss carry-forward deduction, the marginal tax rate increases discontinuously when the taxable income is greater than the tax loss carried forward from the previous year. This paper estimates the elasticity of corporate taxable income and examines the tax avoidance behavior of small and medium-sized enterprises (SMEs) in Japan using a bunching estimation approach. We find clear bunching at the threshold where the marginal tax rate jumps from zero. Such bunching is not observed at the next threshold of the marginal tax rate. This finding is consistent with the hypothesis that managers regard tax payments as a loss and engage in loss-aversion behavior.
JEL codes: D22, D90, H25, H26, H32

Keywords: Corporate taxation, bunching, loss-aversion, carry-forwards, elasticity of taxable income

JEL Classification: D22 , D90 , H25 , H26 , H32

1 Introduction

Responses to taxation, especially tax avoidance behavior, have attracted the attention of researchers and practitioners. Many empirical studies exploit discontinuous changes in tax rates and deductions at thresholds associated with size or other factors because these discontinuous changes lead to discontinuous increases in tax burdens or costs for preparing required documents, which economic agents have incentives to avoid. In Japan's corporate income tax system, there are two discontinuous increases in marginal tax rates for small and medium-sized enterprises (SMEs). We utilize these discontinuities to analyze the elasticity of corporate taxable income (ECTI) of SMEs using tax records.

When the tax rate or deduction changes discontinuously, we often see a concentration in the distribution (i.e., bunching) just before a discontinuous increase in costs. This is observed for both individuals and firms and is used to estimate the magnitude of tax avoidance and the elasticity of taxable income, as described by Saez (2010). Earlier studies include those by Saez et al. (2012) and Kleven (2016) among others.

The purpose of this paper is to estimate the ECTI and to study the tax avoidance behavior of SMEs using Japanese administrative tax records. To this end, we employ a bunching estimation strategy and exploit discontinuous marginal tax rate increases in the corporate income tax. As explained in the following sections, the marginal tax rate of SMEs increases discontinuously at two thresholds. By comparing the differences in bunching at these two thresholds and examining the heterogeneity of the responses at the thresholds where clear bunching is observed, we examine the tax avoidance behavior of SMEs in response to changes in marginal tax rates.

The contributions of this study are threefold. First, this study contributes to the literature on ECTI estimation in developed countries. In previous papers, ECTI was estimated using bunching for both developed and developing countries (Devereux et al.

2014; Coles et al. 2022; Massenz 2024; Boonzaaier et al. 2019; Lediga et al. 2019; Nascimento and Mattos 2023; Bachas and Soto 2021), and the results suggested differences across regions and firm characteristics. The ECTI tends to be small in developed countries, as shown in Table 1 of Krapf and Staubli (2025), while Agostini et al. (2022) argued that the methodologies used mainly contribute to these differences.[1] Few estimates are available for Japan, and there are only limited applications of bunching estimation strategies to analyze data from Japan, such as Ichikawa et al. (2022) and Kawakubo et al. (2022), who focused on the VAT exemption threshold.[2]

The results of this study are summarized as follows. First, we observe clear bunching at a threshold where the marginal tax rate jumps from zero. The magnitude of bunching, which is measured by relative excess bunching, ranges from one to 2.5 and varies depending on the degree of the polynomial and the sample interval used to estimate the counterfactual distribution. Second, the loss in tax revenues caused by bunching at a threshold of zero is estimated to range from 5 to 7 million JPY per year. Third, at the second threshold of 8 million JPY, where the marginal tax rate increases discontinuously, we did not observe large bunching on the left side of the threshold, and its size is smaller than that at the threshold of 0 JPY. We cannot compute the tax revenue losses at this threshold. The difference in the magnitude of bunching between the two thresholds may reflect the difference in the increases in marginal tax rates and is also consistent with the hypothesis that managers regard tax payments as losses and engage in loss-aversion behavior. Fourth, the ECTI is estimated to be larger for firms with larger sales volumes, although the bunching is smaller for larger firms. Fifth, bunching at the zero threshold may be caused by the manipulation of executive compensation and welfare costs.

[1] He et al. (2021) and Aronsson et al. (2022) reported that bunching estimation has a downward bias for the estimation of the elasticity of individual taxable income.

[2] Onji (2009) noted the bunching created by the VAT exemption threshold. Hosono et al. (2024) examined the size-dependent effects of a tax incentive for specific productivity-enhancing equipment. Ito and Sallee (2018) examined the effects of fuel economy regulations that are downward-sloping step functions of vehicle weight.

The remainder of this paper is organized as follows. Section 2 describes the institutional background, including the corporate income tax system, and Section 3 describes the data. Section 4 presents the estimation method, and Section 5 presents the results. Section 6 discusses the mechanisms that lead to the estimation results. Section 7 presents the study conclusions.

2 Institutional backgrounds

2.1 Corporate income tax in Japan

We examine the behavior of firms under Japan's tax system using a sample of ordinary domestic corporations. They pay other taxes, including the VAT, automobile tax, and property tax, but this study focuses on corporate income taxes.

The corporate tax is a national corporate income tax, and its tax base is the difference between taxable revenues and deductible expenses. This tax base is generally not the same as accounting profits and is computed by making tax adjustments on the basis of pretax accounting profits. When the taxable income is negative, it is called a tax loss.

Japan's system has a tax loss carry-forward system to smooth tax payments across business years. A firm can deduct a portion of or the complete tax loss of previous years from its taxable income. With the 2015 revision, the deduction limit for large corporations was lowered from 80% to 50% of taxable income, and the carry-forward period was extended from 9 to 10 years. For SMEs, the deduction limit remained at 100%, and there was no change during the sample period.

The standard rate of the corporate tax was 43.3% in the 1980s and decreased to 25.5% in 2014, which is the beginning of the sample period. It further decreased gradually to 23.2% in 2018. For SMEs, a reduced rate is applied to income of 8 million or less, and this rate was 15% during the sample period.

Firms must also pay local taxes, that is, local corporate inhabitant tax and corporate enterprise tax. The local corporate inhabitant tax consists of two parts. The first is a lump-sum tax based on the amount of capital, and the second is an add-on that is proportional to the corporate tax. The rates of the latter are 1% as a prefectural tax and 6% as a municipal tax. The rates and bases of corporate enterprise tax differ depending on industry and capital. It consists of three parts based on value added, capital, and income if a firm has more than 100 million JPY in capital and is not involved in the electric power supply, gas supply, or insurance industries. For ordinary corporations with capital equal to or less than 100 million JPY that is not involved in the above industries, a rate of 7% is applied to their income in excess of 8 million JPY.

This paper focuses on the effects of national and local corporate taxes on the income of SMEs. The marginal tax rate is zero if the taxable income is negative; 16.05% ($= 15 + 15 \times (0.01 + 0.06)$) for income between 0 and 8 million JPY; and 26.216% ($= 23.2 + 23.2 \times (0.01 + 0.06 + 0.07)$) for income above 8 million JPY. Thus, the marginal tax rate increases discontinuously at incomes of 0 and 8 million JPY.

2.2 Corporate and personal income taxes

In previous studies (Tajika and Yashio 2016; Yashio 2020), the tax avoidance behavior of SMEs was examined as that of the owners of family-owned small firms. We follow Yashio (2020) to explain the relationship between personal and corporate income taxation.

An owner of a family-owned small firm is a manager, a worker, and a shareholder. Because the tax system differs depending on the type of business (corporate or individual) and the income type (e.g., corporate income, individual labor income, and individual dividend income), income shifting can reduce the tax burden. This phenomenon is also observed in other countries (Slemrod 1995). Until the early 2000s, because corporate tax rates were high while personal income tax rates were low due to the salary income deduction, owners often received income from their business as their own salary or increased welfare expenses, making corporate taxable income zero or negative. However, the 2009 tax reforms changed this situation. In particular, the corporate income tax rate for SMEs was reduced by 4.5%, and social insurance premium rates increased, which reduced the tax advantages of owners paying salaries to themselves. Yashio (2020) estimated corporate and personal income tax rates using microdata from Financial Statements Statistics of Corporations by Industry and found that more owners retained income from their corporations after 2009 than before this date.[3]

We do not analyze the impact of the personal income tax system because information on owners' personal income tax is not available. The relationship between taxable income and some expense items is examined in a later section.

3 Data

The data come from corporate tax (that is, a national tax) records for the seven-year period from 2014 to 2020. We had access to Appendix Table 1(1) of tax return forms (see Doi et al. (2025) for details). An observation in year t is from a tax return for a business year that starts between April 1 in year t and March 31 in year $t+1$. If for some reason there are multiple tax returns during the business year, which starts between April 1 in year t and March 31 in year $t+1$, then we aggregate them to produce a single observation. The corporations included in our sample are ordinary domestic corporations, excluding those in liquidation and closed and consolidated corporations. While the original data are repeated cross-sectionally, we create panel data using the tax office number and the reference number assigned by the tax offices. The total number of firms in the sample was 2.59 million in 2014 and 2.77 million in 2020.

[3] le Maire and Schjerning (2013), Harju and Matikka (2016), Miller et al. (2024), and Massenz (2024) noted that the income shifting by owner-manager firms between corporate and personal incomes does not involve changes in real business activities.

The information included in Appendix Table 1(1) of the tax return forms is as follows: corporation name, corporation number, place of tax payment, capital, indicators of non-SMEs and family corporations, taxable income (or loss), tax payment, and tax loss carry forward. There is also a column for the amount of sales; however this value is not necessarily accurate. There is no information on balance sheets and profit-and-loss statements; therefore, no further breakdown of sales or expenses is available. We do not have information on the number of employees. We focus mainly on SMEs. A corporation is classified as an SME when its capital is equal to or less than 100 million JPY and non-SMEs are not marked.

We calculate adjusted corporate taxable income considering the tax loss carry-forward deduction. We define adjusted income in year t as the taxable income in year t plus the tax loss carry-forward deduction in year t minus the tax loss carry-forward from year $t-1$. Because the tax loss carry-forward is deducted from the taxable income, the taxable income is zero if the taxable income before the deduction is smaller than the tax loss carry-forward. Since the tax loss carry-forwards are fixed before the end of the business year, the firm may manipulate the before-deduction income to be just less than the tax loss carry-forwards. For example, assume that a firm has a loss carry-forward of 4 million JPY from the previous year and a before-deduction income of 3 million. In this case, the loss carry-forward deduction is 3 million, the taxable income is zero, and the adjusted income is -1 million ($0 + 3 - 4 = -1$). When the adjusted income is positive, the taxable income is positive even after the tax loss carry-forward is deducted. Therefore, we can expect bunching on the left side of the threshold for the distribution of the adjusted income.

4 Estimation strategy

We employ the bunching method to estimate the magnitude of the ECTI and tax avoidance behavior (Kleven 2016; Suzuki 2023). We use the estimation results to calculate the following three measures. The first measure is the relative excess bunching, a measure of bunching around the thresholds. The second metric is the tax revenue losses compared to a counterfactual income distribution. The third metric is the ECTI.

The procedure is as follows. First, we estimate a counterfactual distribution of taxable income when there is no tax avoidance due to the thresholds. Then, we take the difference between the observed and counterfactual distributions to compute the aforementioned measures. Following the bunching estimation literature (Saez 2010; Kleven 2016), we estimate the following equation by OLS:

$$c_j = \sum_{\alpha=0}^{p} \kappa_\alpha y_j^\alpha + \varepsilon_j, \tag{1}$$

where c_j is the number of firms in bin j and y_j is the median value of bin j. p is the degree of the polynomial function that approximates the distribution. No terms are used to remove the apparent bunching due to rounding. We estimate this equation excluding an interval $[y^L, y^H]$ near the thresholds. As a robustness check, we also estimate the equation where the dependent variable is log-transformed.

We use the BIC to determine the degree of the polynomial function Bosch et al. (2020) using $p = 6, 8, 10$. In previous studies (e.g., Ichikawa et al. (2022)), $p = 7$ was used to ensure flexibility. The sample interval is 0.5 million JPY above and below the threshold, and we use a 1 million interval as a robustness check. The bin width is 10 thousand JPY.[4]

[4] Bosch et al. (2020) proposed using the Freedman-Diaconis rule to choose the bin width. In this rule, the appropriate bin width is $2\text{IQR}(x)n^{-1/3}$, where IQR is the interquartile range and n is the sample size. In our six-year sample of the interval of 2 million JPY near the threshold of zero, $n = 2,893,674$ and IQR $= 74$. Thus, the suggested interval is 10.3 thousand JPY ($2 \times 74 \times 2,893,674^{-1/3}$).

We set the excluded interval $[y^L, y^H]$ following Bosch et al. (2020). (1) We run a regression of equation (1) excluding the interval $[y^L, y^H] = [0, 0]$. (2) We compute a confidence interval around the fitted values and select the bins near the threshold and outside the interval. These bins constitute a bunching window. (3) We repeat steps (1) and (2) for 400 combinations of $[y^L, y^H]$ with 20 bins above and below the threshold. The mode of the bunching windows is used for our analysis.

We compute the relative excess bunching following the literature. This is a measure of the degree of bunching, which is greater when the bunching at the threshold is greater. An estimate of relative excess bunching $\hat{b}$ is defined as follows:

$$\hat{b} = \frac{\sum_{i=y^L}^{y^*} (c_i - \hat{c}_i)}{\sum_{i=y^L}^{y^*} \hat{c}_i / N}, \tag{2}$$

where $\hat{c}_i$ is a counterfactual distribution obtained as a fitted value of the above regression and N is the number of bins between the threshold y^* and the lower bound of the bunching window y^L. The numerator is the number of excess bunching firms, and the denominator is the average number per bin in the same interval.

We also estimate the tax revenue lost due to bunching. Without bunching, the government would obtain more tax revenue from the interval above the threshold. The estimated lost tax revenue $\hat{R}$ is defined as follows:

$$\hat{R} = t_2 \sum_{i=y^*}^{y^H} (c_i - \hat{c}_i) y_i \tag{3}$$

where t_2 is the marginal tax rate above the threshold. As $c_i < \hat{c}_i$ holds above the threshold, $\hat{R}$ is negative.

We compute the ECTI using these measures following Devereux et al. (2014). Denoting the marginal tax rate as t_c, the ECTI is defined as the ratio of the rate of change in taxable income to the rate of change in the net-of-tax rate, $1 - t_c$. Since this study mainly focuses on the threshold of taxable income zero, we cannot define the usual elasticity. Therefore, we define the elasticity using the taxable income under the counterfactual distribution. The estimated ECTI is

$$\hat{e} = \frac{\sum_{i=y^*}^{y^H}(\hat{c}_i - c_i)y_i / \sum_{i=y^*}^{y^H}\hat{c}_i y_i}{\ln((1-t_1)/(1-t_2))} \tag{4}$$

where t_1 is the marginal tax rate below the threshold.

For these three measures, we compute the standard errors using bootstrapping with 200 times following methods in the literature (Saez 2010).

5 Results

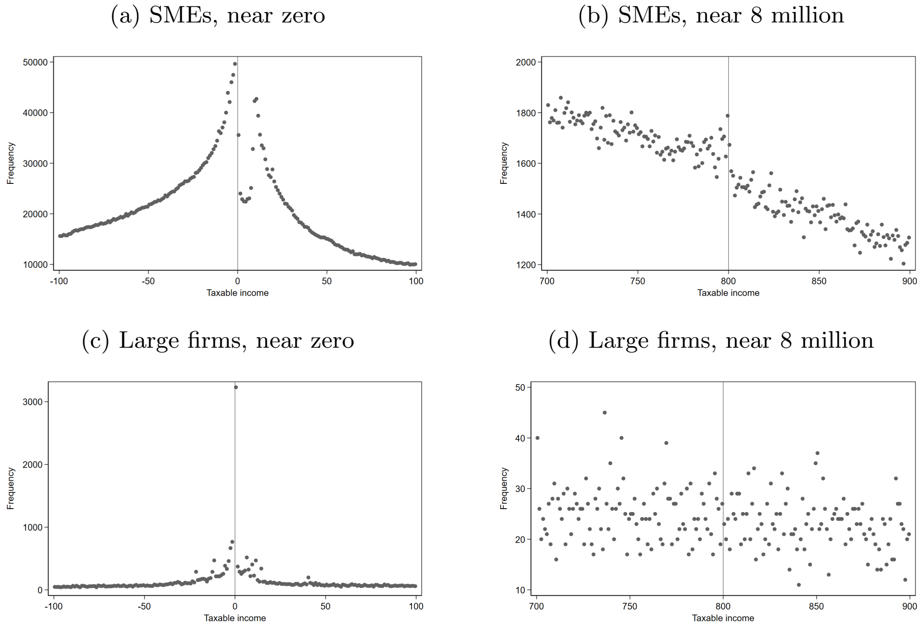
5.1 Descriptive statistics

Figure 1 shows the distribution of taxable income in the interval between 1 million JPY above and below the thresholds of zero and 8 million JPY, where the marginal tax rate for SMEs changes discontinuously. We pool the seven-year data, and we do not adjust for inflation because the price level did not change substantially during this period. Panels (a) and (b) show the distributions of SMEs, (c) and (d) show those of large firms, (a) and (c) show those near the threshold of zero, and (b) and (d) show those near 8 million JPY. In panel (a), we exclude the bin just below the threshold because the number of firms in this bin (more than 4.5 million) is more than 70 times larger than that in the next bin.

Panels (a) and (c) show that the distributions jump immediately to the left of the threshold of zero and then decrease immediately to the right. This is particularly noticeable for SMEs, as shown in panel (a).

Panel (b) shows a small bunching region just to the left of the threshold of 8 million JPY for SMEs, but there is no clear decrease to the right. As the marginal tax rate

Fig. 1: Distributions of taxable income



Note: The bin width is 10 thousand JPY. The vertical solid lines are the thresholds. The bin just to the left of the threshold of zero is excluded because the number of firms in this bin (more than 4.5 million) is more than 70 times larger than that in the next bins.

for large firms does not change at this threshold, we cannot observe clear bunching, partly because of the small number of firms. [5]

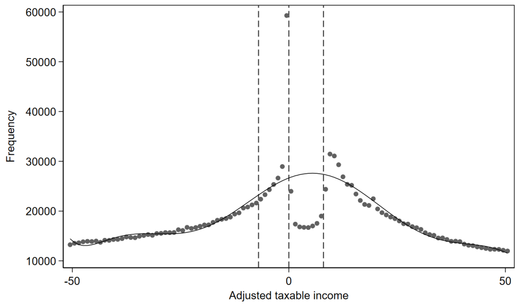
As explained above, the taxable income is the income after the tax loss carry-forward is deducted. If the carry-forward loss is greater than the before-deduction income, then the taxable income is zero. It is quite possible that the bunching at the zero threshold in Figure 1 is caused by this mechanism. Because the tax loss carry-forward is known before the end of the business year, a firm may keep its before-deduction income within the tax loss carry-forward to avoid its tax burden. Considering this, we focus on the adjusted income in the following analyses.

[5] To examine the distribution in more detail, we plot the distributions with a bin width of 1 thousand JPY (Figure A1). The results show substantial bunching at the zero threshold. For large firms, the number of firms per bin becomes too small to plot the graph in order to maintain confidentiality.

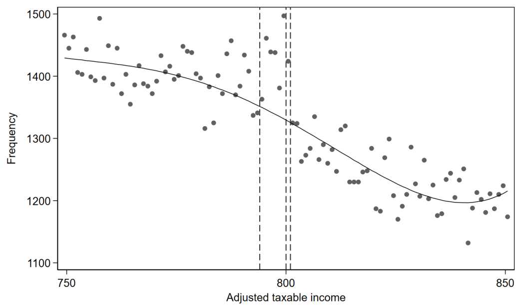
5.2 Bunching estimation: Threshold of zero

Fig. 2: Bunching estimation

(a) Threshold of zero



(b) Threshold of 8 thousands JPY



Note: The bin width is 10 thousand JPY. The vertical dashed lines are the thresholds and the upper and lower limits of the excluded interval.

Figure 2a and Table 1 present the bunching estimation results for SMEs when the degree of the polynomial function in Equation (1) is 6, 8, or 10 with a sample interval of 0.5 million JPY above and below the threshold. Figure 2a shows the estimated counterfactual distribution with a degree of 8 based on the BIC. Figure 2a illustrates bunching just to the left of the threshold that then decreases to the right, although the magnitude of bunching is considerably smaller than that in Figure 1.

As shown in Table 1, the upper bound of the excluded interval y^H is stable regardless of the choice of the degree of the polynomial, whereas the lower bound is not stable. This may be because the distribution is not well approximated by the polynomial function. The estimates of the relative excess bunching are approximately 1 but vary depending on the degree of the polynomial. The estimates of the lost tax revenues also depend on the degree of the polynomial. Because the losses are calculated over six years, they range from 500 to 700 million JPY per year.

The ECTI with respect to the net-of-tax rate is estimated to be approximately 2. These estimates appear large considering that those from previous studies for developed countries are generally less than one. Our estimates are even larger than those for South Africa, as presented in Lediga et al. (2019), and this study also focused on the threshold of zero.

Table 1: Results: Baseline specification

Degree of polynomial	6	8	10
y^L	-10.5	-6.5	-3.5
y^H	7.5	7.5	8.5
Relative excess bunching	1.011	1.278	0.972
	(0.117)	(0.106)	(0.225)
Lost tax revenues	- 290,104	-315,817	-399,381
(10 thousand JPY)	(5,920)	(7,833)	(7,772)
ECTI	1.942	2.052	1.951
	(0.029)	(0.039)	(0.032)

(note) The sample interval is 0.5 million JPY above and below the threshold of zero.

To check the robustness of this baseline specification, we examined different sample intervals, dependent variables, and bin widths to estimate the counterfactual distributions. The results are presented in Tables B1 to B3. These estimation results are summarized as follows. First, the upper bound of the bunching interval is approximately stable across the sample intervals, but the lower bound is not stable. Second, the estimates of the relative excess bunching vary depending on the degree of the polynomial and vary more substantially depending on the bin widths and the sample interval. When the sample interval is 1 million JPY above and below the threshold, these estimates are larger than the baseline and range from 1.5 to 2.5. Third, the estimates of lost tax revenues are not stable with respect to the sample intervals and the degree of the polynomial. These estimates range from 1.4 to 4.4 billion JPY for the six-year period. Fourth, the estimates of the ECTI are in the range of 1.1 to 2.4 and are larger for smaller sample intervals. Fifth, these results are robust to the choice of the dependent variable (log-transformed).

5.3 Bunching estimation: Threshold of 8 million JPY

Figure 2b and Table B4 show the bunching estimation results obtained using the distribution of the adjusted income with a threshold of 8 million JPY, at which point the marginal tax rate for SMEs increases discontinuously. As shown in Figure 2b, while we observe slight bunching on the left side of the threshold, there appears to be no corresponding decrease in the distribution, and the upper limit of the excluded interval is very close to the threshold. The relative excess bunching, calculated using only the left side of the threshold, is estimated to be approximately 0.4, which is statistically significantly different from zero but much smaller than that in the case of the zero threshold. The sign of the estimated lost tax revenue is opposite to that expected, suggesting no tax revenue loss. Thus, for the threshold of 8 million JPY, although bunching occurs on the left side of the threshold, it is small, and there is no reduction in the distribution on the right side of the threshold.

5.4 Heterogeneity at the zero threshold

We examine heterogeneity at the threshold where clear bunching is observed. We focus on the heterogeneity associated with the firm size, which is determined by the amount of sales.[6] Although the sales data are not completely accurate, as mentioned above, these data are sufficient for classification. Since the larger the sales amount is, the

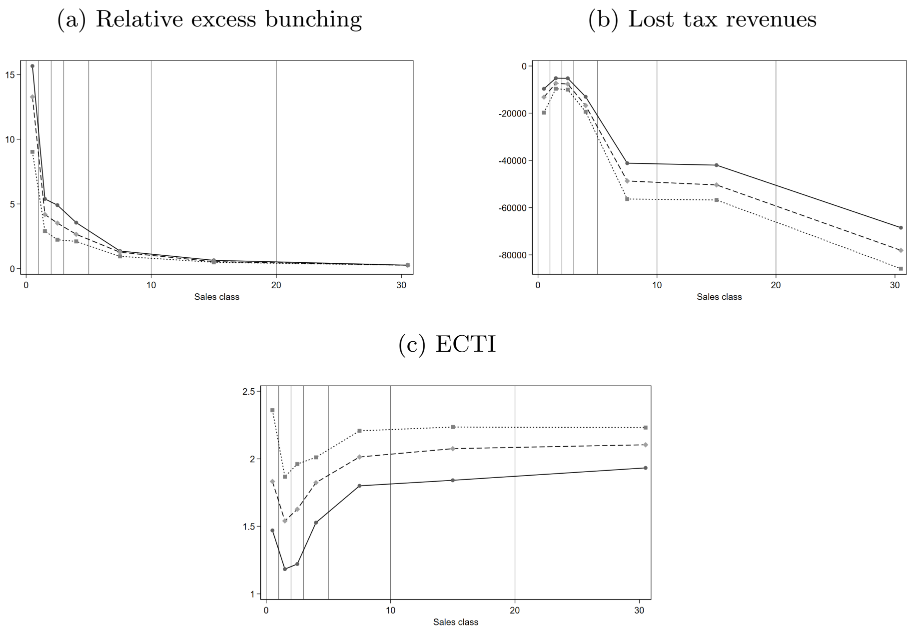
[6]We also used capital size as an alternative measure of firm size, but the results are not stable, as shown in Figure B4. Thus, capital size may not be a good indicator of firm size in our setting.

smaller the number of firms, we limit our analysis to firms with sales of 50 million JPY or less.

Figure 3 shows the results obtained using three different degrees of polynomial. Panel (a) shows the relative excess bunching, panel (b) shows the lost tax revenues, and panel (c) shows the ECTI. Although the estimates of the relative excess bunching vary depending on the degree of the polynomial, they are smaller for larger firms. There is essentially no bunching for firms with sales amounts of more than 20 million JPY. As shown by Table 1, the upper limit of the bunching interval is approximately 100 thousand JPY, and the firms can avoid their tax burden by at most 15 thousand JPY. This amount may be too small for large firms. Panel (b) suggests that the lost tax revenues increase with the amount of sales, regardless of the degree of the polynomial. Although it appears inconsistent that the tax revenue loss increases while excess bunching decreases, this may reflect that the amount of tax saved is larger for larger firms. Panel (c) suggests that the ECTI tends to increase as sales increase. Compared with the results in Table 1, the estimates are lower than those obtained from the whole sample. This finding also supports the positive correlation between firm size and ECTI found in Massenz (2024), but differs from that reported by Coles et al. (2022) and Devereux et al. (2014).

The difference in the ECTI with respect to firm size may imply that firms of different sizes use different margins (Krapf and Staubli 2025). For example, income shifting within a corporate group is considered to occur mainly in large firms. Since our sample excludes consolidated firms and we limit the scope of our analysis to SMEs, we can safely ignore the income shifting within a group. Coles et al. (2022) and Devereux et al. (2014) argued that SMEs tend to engage in tax adjustments because of the low probability of tax audits. Our finding that larger firms have greater ECTI values may have occurred because, as Massenz (2024) argued, larger firms can afford to hire more competent tax advisors or learn how to perform tax adjustments.

Fig. 3: Heterogeneity by sales



Note: The bin width is 10 thousand JPY. The vertical solid lines are the categories of sales amount. The solid, dashed and dotted lines represent the result based on the polynomials with the degree of 6, 8 and 10, respectively.

6 Mechanism

The analysis in the previous sections suggests that SMEs avoid paying corporate income taxes. Thus, we next attempted to examine how they do so using another data set.

6.1 Data

Based on corporate tax numbers, we merge the tax records with the microdata from the annual survey of Financial Statements Statistics of Corporations by Industry that is conducted by the Ministry of Finance. The sampling method of this survey depends on capital size. All firms with capital equal to or more than 500 million JPY are selected, while the equal probability systematic sampling method is employed for firms with less capital.[7] The number of respondent firms was 28,619 in 2015. This survey is used to collect the data on the major items in the balance sheets and profit-and-loss statements for these firms. As mentioned above, previous studies conducted based on data from Japan (e.g., Yashio (2020)) have noted that the owner-managers of SMEs manipulate their own salary or compensation, welfare expenses, entertainment expenses, and donation expenses to avoid corporate income tax. This paper focuses on the number of employees and board members, personnel expenses for employees, executive compensation, and welfare expenses, which are available from the survey. Because the results explained above suggest that tax avoidance at the zero threshold occurs mainly for small firms, the sample is limited to small firms.

6.2 Econometric methods

A firm must make its taxable income non-positive to avoid corporate income tax payments. If the firm does not pay its corporate income tax, then its expenses should be greater than those of other firms. To test this hypothesis, we use a regression discontinuity design with a running variable of adjusted taxable income (Bachas and Soto 2021). Although this method is usually used for causal inference, we do not examine causality here.

Assuming linearity, the estimation equation is

$$E_k = \beta_0 + \beta_1 1(x_k > 0) + \beta_2 x_k + \beta_3 x_k 1(x_k > 0) + \delta Z_k + u_k, \tag{5}$$

where E_k is the expenses of firm k, x_k is its adjusted taxable income, Z_k is a vector of covariates and $1(.)$ is an indicator function. β-s and δ are parameters to be estimated, and u_k is an error term. If a firm manipulates its expenses to make its taxable income non-positive, then the coefficient β_1 is negative. We use the industry, business year,

[7]Firms in the finance and insurance industries and those with capital equal to or more than 100 million JPY are included.

and the interaction term between the industry indicators and sales as covariates. The threshold of the discontinuity design is a taxable income of zero. The sample interval is between the taxable income of minus and plus 100 thousand JPY. Given that the sample size is not very large, we pool the data from 2015 to 2020 as cross-sectional data.

6.3 Results

Table 2 shows the estimation results. Columns (1) and (2) show the results when the dependent variables are the number of board members and employees, respectively. Columns (3), (4), and (5) present the results using personnel expenses, executive compensation, and welfare expenses. Panel (A) shows the cases in which we use firms with sales of less than 10 million JPY, and panel (B) shows the cases using firms with sales of less than 20 million JPY.

While the coefficients for the number of employees and board members are not statistically significant, those for executive compensation and welfare expenses are estimated to be negative for all the cases and statistically significant, as shown in column (4) in panel (A) and column (5) in panel (B), respectively. These results are consistent with those of previous studies suggesting that owner-managers manipulate corporate taxable income using executive compensation and welfare expenses.

7 Concluding remarks

We investigated the effects of discontinuous changes in the marginal tax rate of the corporate income tax system in Japan using a bunching estimation strategy based on tax records from 2014 to 2020. The marginal tax rate of the national corporate income tax for SMEs increases from 0 to 15% at a threshold of zero and to 23.2% at a threshold of 8 million JPY. We examined bunching at these thresholds while explicitly considering tax loss carry-forwards.

Table 2: Estimation results: The expenses and taxable income

	(1) N of Board members	(2) N of Employees	(3) Personnel Expenses	(4) Executive Compensation	(5) Welfare Expenses
A. Sales of less than 10 million JPY					
1(tax > 0)	-0.115	-0.210	0.265	-0.522*	-0.147
	(0.164)	(0.183)	(0.541)	(0.303)	(0.117)
N	501	501	145	283	128
B. Sales of less than 20 million JPY					
1(tax > 0)	-0.150	-0.117	0.100	-0.161	-0.299**
	(0.136)	(0.183)	(0.595)	(0.368)	(0.120)
N	728	728	289	475	235

Our results are summarized as follows. First, we observe clear bunching at the zero threshold. The magnitude of bunching, as measured by relative excess bunching, ranges from one to 2.5, depending on the degree of the polynomial and the sample interval used to estimate the counterfactual distribution. The estimates do not depend on the bin width. Second, the loss in tax revenues caused by bunching at the zero threshold ranges from 500 to 700 million JPY per year. Third, at the second threshold of 8 million JPY, we did not observe large bunching on the left side of the threshold. We cannot compute the tax revenue losses at this threshold. Fourth, the ECTI is estimated to be larger for larger firms (in terms of sales), although the bunching is smaller for larger firms. Fifth, the manipulation of executive compensation and welfare costs may explain the bunching at the zero threshold.

Our results suggest that SMEs engage in tax avoidance behaviors in response to discontinuous increases in the marginal rates of corporate income tax. However, the bunching at the threshold of 8 million JPY is smaller than that at the zero threshold. There are two possible explanations for this difference. First, this may be explained by the difference in the increase in the tax rate. The tax rate increases by 16.05% (from 0 to 16.05%) at the zero threshold and by 10.166% (from 16.05% to 26.216%)

at the 8 million JPY threshold, which is smaller than the increase at the zero threshold. Second, firms may avoid paying taxes directly. Several studies have reported the loss aversion behavior of taxpayers of personal income tax who avoid additional tax payments (Engström et al. 2015; Rees-Jones 2018; Engström et al. 2022; Messacar 2023). Cheng et al. (2023) used China's corporate tax reform as a natural experiment and reported that firms facing a tax increase lower their rate of return compared with those facing tax cuts or those that are unaffected, suggesting that these findings are consistent with the loss aversion hypothesis. If the behavior of the owner-managers strongly affects those of SMEs with taxable income near the zero threshold, then loss aversion behavior may also occur in our setting.

This paper has several limitations. Although one contribution of this paper is the use of Japan's tax records for our analysis, only a portion of tax return forms are available, and data on balance sheets, profit-and-loss statements, and the number of employees are not available. In this paper, we merged the micro data from another sample survey, but a more in-depth analysis can be performed if other data in tax return forms are available. These results should be relevant to policy-makers if we can identify the variables manipulated to avoid taxes by elucidating the mechanisms that lead to bunching. These questions should be investigated in future research.

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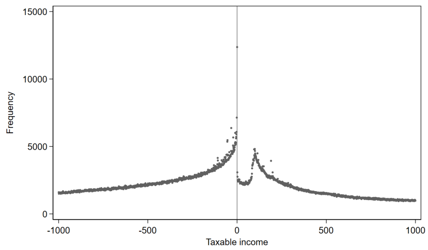
Declarations

All authors did primary data work and reviewed and edited the manuscript. SB contributed to: preparation of the first draft and figures. TD contributed to: project administration. HY contributed to: supervision and policy implications.

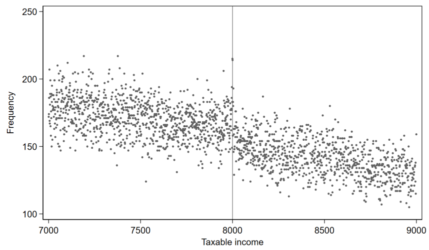
Appendix A Distribution of taxable income

Fig. A1: Distributions of taxable income

(a) SMEs, near zero



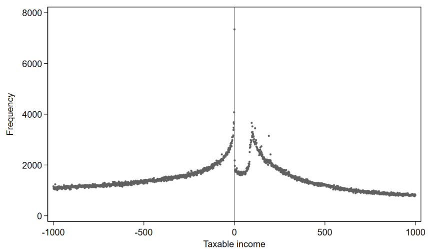
(b) SMEs, near 8 million



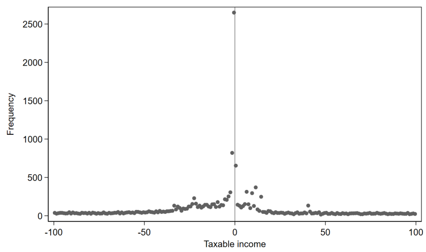
Note: The bin width is 10 thousand JPY. The vertical solid lines are the thresholds. The bin just to the left of the threshold of zero is excluded.

Fig. A2: Distributions of adjusted taxable income

(a) SMEs, near zero



(b) Large firms, near zero



Note: The bin width is 10 thousand JPY. The vertical solid lines are the thresholds.

Appendix B Estimation results

B.1 Threshold of zero

Table B1: Results: Threshold of zero with the sample interval of 1 million JPY

Degree of polynomial	6	8	10
y^L	-6.5	-5.5	-10.5
y^H	7.5	7.5	7.5
Relative excess bunching	2.465	2.002	1.512
	(0.034)	(0.045)	(0.091)
Lost tax revenues	-141345	-187120	-234000
	(1929)	(2521)	(4183)
ECTI	1.148	1.425	1.677
	(0.015)	(0.017)	(0.024)

(note) The sample interval is 1 million JPY above and below the threshold of zero.

Table B2: Results: Threshold of zero, log-transformed

Degree of polynomial	6	8	10
(a) The sample interval: 0.5 million JPY			
y^L	-10.5	-10.5	-0.5
y^H	7.5	7.5	8.5
Relative excess bunching	1.218	1.030	0.564
	(0.110)	(0.067)	(0.286)
Lost tax revenues	-290570	-337957	-425266
	(6795)	(14532)	(6819)
ECTI	1.944	2.142	2.032
	(0.032)	(0.069)	(0.022)
(b) The sample interval: 1 million JPY			
y^L	-10.5	-10.5	-10.5
y^H	7.5	7.5	7.5
Relative excess bunching	2.584	1.990	1.654
	(0.061)	(0.039)	(0.070)
Lost tax revenues	-140036	-192339	-234540
	(1991)	(2874)	(4012)
ECTI	1.145	1.456	1.679
	(0.015)	(0.019)	(0.022)

Table B3: Results: Threshold of zero, bin width of 1 thousand JPY

Degree of polynomial	6	8	10
(a) The sample interval: 0.5 million JPY			
y^L	-7.65	-7.65	-10.05
y^H	8.35	8.35	8.35
Relative excess bunching	13.937	11.355	4.659
	(0.452)	(2.133)	(3.110)
Lost tax revenues	-307817	-365940	-439157
	(3214)	(12002)	(18420)
ECTI	1.880	2.105	2.352
	(0.017)	(0.045)	(0.062)
(b) The sample interval: 1 million JPY			
y^L	-2.85	-2.25	-2.25
y^H	8.45	8.55	8.95
Relative excess bunching	26.280	21.402	18.581
	(0.374)	(0.350)	(0.436)
Lost tax revenues	-150349	-202784	-246120
	(2648)	(2284)	(2400)
ECTI	1.104	1.395	1.610
	(0.024)	(0.015)	(0.014)

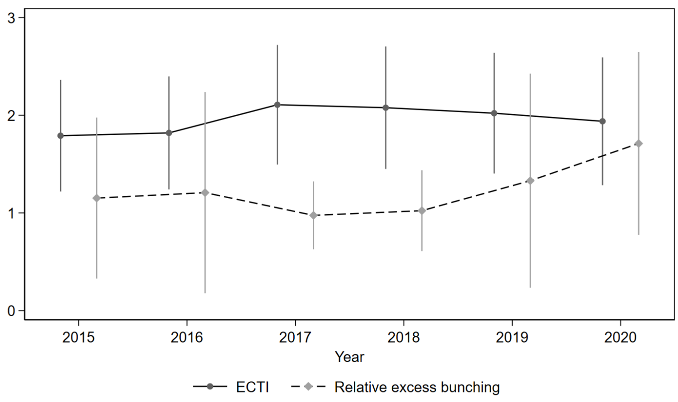
B.2 Threshold of 8 million JPY

Table B4: Results: Threshold of 8 million JPY

Degree of polynomial	6	8	10
(a) The sample interval: 0.5 million JPY			
y^L	795.5	795.5	795.5
y^H	800.5	800.5	800.5
Relative excess bunching	0.351	0.354	0.357
	(0.071)	(0.068)	(0.071)
Lost tax revenues	77166	77862	78698
	(33977)	(34671)	(35105)
(b) The sample interval: 1 million JPY			
y^L	794.5	794.5	794.5
y^H	800.5	800.5	800.5
Relative excess bunching	0.426	0.413	0.412
	(0.074)	(0.073)	(0.072)
Lost tax revenues	85415	83947	83686
	(33038)	(33343)	(33440)

B.3 Heterogeneity at threshold of zero

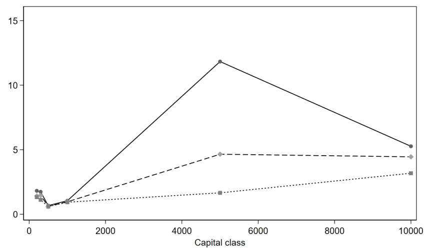
Fig. B3: Relative excess bunching and ECTI by year



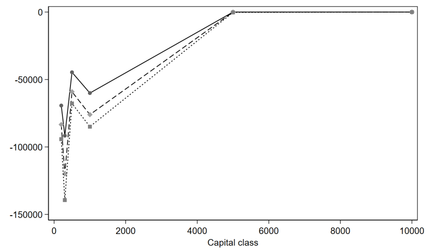
Note: The bin width is 10 thousand JPY, and the degree of the polynomial function is 8. The whiskers show the confidence interval.

Fig. B4: Heterogeneity by capital

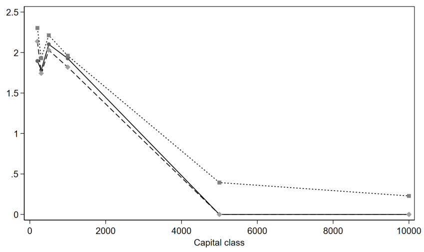
(a) Relative excess bunching



(b) Lost tax revenues



(c) ECTI



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