RIETI Discussion Paper Series 17-E-050

The Effects of a Size-Dependent Tax Policy on Firm Growth and Finance: Evidence from Corporate Tax Reform in Japan

HOSONO, Kaoru
Gakushuin University

HOTEI, Masaki
Daito Bunka University

MIYAKAWA, Daisuke
Hitotsubashi University

RIETI
Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
https://www.rieti.go.jp/en/

RIETI Discussion Paper Series 17-E-050

First Draft: March 2017

Revised: February 2020

The Effects of a Size-Dependent Tax Policy on Firm Growth and Finance: Evidence from Corporate Tax Reform in Japan*

Kaoru Hosono (Gakushuin University)

Masaki Hotei (Daito Bunka University)

Daisuke Miyakawa (Hitotsubashi University)†

Abstract

This study exploits the introduction of a new corporate tax in Japan that exempts from taxation firms whose stated capital is at (or below) a certain threshold to examine how firms react to a size-dependent tax policy associated with financial activities. Using a firm-level dataset, we find that firms with lower labor productivity, a positive potential tax benefit, and smaller stated capital are more likely to reduce their stated capital to (or below) the threshold. We further find that capital reduction results in lower ex-post growth in assets, sales, and debt, suggesting capital reduction leads to tighter financial constraints. The interaction of a finance-based size-dependent tax policy and financial constraints can deter firm growth.

Keywords: Size-dependent tax policy; Tax avoidance; Firm growth; Financial constraint; Japan

JEL classification: H32, H25, H26, L25

* This research was conducted as a part of a Research Institute of Economy, Trade, and Industry (RIETI) project (Microeconometric Analysis of Firm Growth), as well as a joint research project of Hitotsubashi University and Tokyo Shoko Research Ltd. (TSR). We thank Kozo Kiyota, Makoto Hasegawa, Hisamitsu Saito, Miho Takizawa, Masayoshi Hayashi, Yasushi Iwamoto, Hikaru Ogawa, Masanori Orihara, and the seminar participants at RIETI, University of Tokyo, and Nihon University for helpful suggestions. K. Hosono and D. Miyakawa gratefully acknowledge the financial support received from the Grant-in-Aid for Scientific Research (B) No. 17H02526, JSPS.

† Hosono: Professor, Faculty of Economics, Gakushuin University. 1-5-1 Mejiro, Toshima-ku, Tokyo 171-8588, JAPAN. E-mail: kaoru.hosono@gakushuin.ac.jp. Hotei: Associate Professor, Faculty of Economics, Daito Bunka University, 1-9-1 Takashimadaira, Itabashi-ku, Tokyo 175-8571, JAPAN. E-mail: m-hotei@ic.daito.ac.jp. Miyakawa: Associate Professor, Hitotsubashi University Business School, 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8439 JAPAN. E-mail: dmiyakawa@hub.hit-u.ac.jp.

1. Introduction

Many countries, such as the UK, Finland, and Japan, provide tax preferences to small and medium enterprises (SMEs). Reduced corporate tax rates, enhanced deductions, tax credits, and exemptions from tax liabilities are applied to firms below a certain size, measured by the level of their profits, sales, or number of employees. These size-dependent tax policies often aim to induce job creation and innovation and mitigate financing frictions and tax compliance costs (OECD, 2015). Generally, although those policy targets could be relevant, there are at least two concerns. First, except for compliance costs, which may not be easily handled by SMEs, no clear rationale exists for limiting such tax preferences to SMEs (Crawford and Freedman, 2010; Bergner et al., 2017). Second, and more importantly, thresholds that limit tax preferences to firms below a certain size can create disincentives for SMEs to grow. Most studies utilize theoretical models to show that size-dependent tax policies distort firm size distributions and reduce aggregate productivity through inefficient resource allocation (Garicano et al., 2016; Gourio and Roys, 2014; Guner et al., 2008; Keen and Mintz, 2004).

Value-added taxes (VATs) and corporate taxes are typical cases of size-dependent tax policies. For example, Finland, Japan, the UK, and many other countries impose a VAT only on firms with sales above a specific threshold. Further, some countries offer lower corporate tax rates to SMEs with taxable income below a threshold. Recent studies have taken advantage of these discrete tax schemes and have used highly disaggregated data to investigate the implications of taxation on firm size distributions. As we detail in the next section, Onji (2009), Liu et al. (2018), and Harju et al. (2019) investigate the VAT in Japan, the UK, and Finland, respectively; Devereux et al. (2014) investigate the corporate income tax in the UK; and Almunia and Lopez-Rodriguez

(2018) investigate a tax authority that monitors tax payments by firms in Spain. Many of them find that firms respond to such size-dependent tax policies by avoiding a tax burden through "bunching," where they cluster at or just below the threshold level of the respective size measure.[1]

Bunching, in the form of a firm size distribution at or just below the threshold, reflects a clear response by firms to avoid taxes. Although the existence of bunching has already been well documented, there are at least two points most studies miss.

First, none of them analyze which types of firms are more likely to bunch when the eligibility criteria for tax preferences are based on the size of *financial* activities, such as paid-up or stated capital. All extant theoretical studies on size-dependent tax policies and regulations assume that the threshold is established based on the size of *real* activities (employment, physical capital, or sales), mainly because eligibility criteria based on real activities are widely used in many countries. For example, Guner et al. (2008) and Gourio and Roys (2014) build theoretical models of size-dependent regulations based on employment and physical capital, respectively, and both predict that a high-productivity firm operates strictly above the threshold, while a low-productivity firm operates at or below it. Keen and Mintz (2004) theoretically analyze the size-dependent VAT and arrive at a similar prediction: while high-productivity firms operate above the threshold level of sales, low-productivity firms operate at or below it. Distribution-based empirical studies find that the number of firms just above the threshold level of the size distribution is relatively small, which is consistent with the theoretical predictions that such firms are likely to have low productivity relative to firms well above the threshold. However, to the best of our knowledge, no

[1] Size-dependent policies also exist in individual income taxes. In this case, countries provide tax credits only when the taxable income (earnings) is below a threshold, and tax rates vary in a stepwise manner over multiple threshold values to mitigate income differences. Saez (2010) finds bunching in the distribution of earnings due to the earned income tax credit (EITC) in the United States. Kleven and Waseem (2013) observe substantial bunching in the distribution of taxable income because of tax notches created by the personal income tax in Pakistan.

theoretical or empirical study exists on size-dependent policies that use eligibility criteria in terms of financial activities in their corporate income tax systems, although countries such as Canada and Japan adopt such policies based on paid-up capital and stated capital, respectively, (OECD, 2015). Financial activities potentially affect real activities through financial frictions. Thus, study of a finance-based size-dependent policy enables understanding how such policies affect firm behavior through financial frictions.

Second, few studies comprehensively examine how and to what extent such tax avoidance affects firms' ex-post real and financial behaviors; no study except Harju et al. (2019) establishes a firm-level association between a size-dependent tax policy and the ex-post dynamics of firm growth.

Against this background, this study identifies which types of firms reduce their stated capital to (or below) the threshold set by a finance-based size-dependent policy and the consequences of such tax avoidance on their growth and financing. Thus, to achieve this goal, we exploit the introduction of the "pro forma standard taxation" system in Japan as an example of a finance-based size-dependent tax policy. The government announced the introduction of this tax in December 2002 and introduced it as a part of Japan's corporate enterprise tax (a local government tax) in 2004. This new tax is imposed on firms' stated capital, capital reserves, and value added, but exempts firms with stated capital at or below JPY 100 million from taxation.[2]

As already mentioned, some studies examine firm responses to a size-dependent tax policy and its ex-post effect. Among those, the following studies are the most closely related to this current work.

[2] Throughout this study, we use "capital" instead of "stated capital" to avoid confusion and use "physical capital" to refer to an input in the production process.

First, Liu et al. (2018), Almunia and Lopez-Rodriguez (2018), and Harju et al. (2019) show that firms with relatively low productivity are more likely to bunch at or just below the threshold, consistent with the prediction of the theoretical studies on size-dependent taxes and regulations (Garicano et al. 2016; Guner et al. 2008; Gourio and Roys 2014; Keen and Mintz 2004). They also identify other tax avoidance determinants. Liu et al. (2018) examine bunching behavior induced by the size-based VAT in the UK and find that firms with a low input cost to sales ratio are likely to bunch just below the threshold because they have less incentive to claim back intermediate input tax credits. Almunia and Lopez-Rodriguez (2018) focus on a Large Taxpayers Unit (LTU) in Spain that monitors firms with reported revenue above a specific threshold. They find that firms are more likely to bunch below the threshold to avoid tax monitoring in sectors where the final consumer sales ratios are low (high B2B sales ratios), and hence, transactions leave a better paper trail.

While Liu et al. (2018), Almunia and Lopez-Rodriguez (2018), and Harju et al. (2019) investigate how ex-ante characteristics such as the input cost ratio and final consumer sales ratio are associated with the amount of potential tax benefit leading to the bunching activity, we should note that they analyze size-dependent policies based on real outputs. Furthermore, among those three studies, only Harju et al. (2019) examine the effects of bunching induced by the size-dependent VAT in Finland on firms' ex-post behavior; they find that firms with sales just below the threshold show lower sales growth rate than other firms. Note also that, unlike this study, Harju et al. (2019) do not focus on firms' ex-post financial behavior (e.g., debt growth) and performance (e.g., ROA).[3]

[3] Apart from tax policies, Almeida et al. (2016) are also related to this study in that they examine the causal effects of EPS (earning per share)-motivated share repurchases on ex-post real and financial behavior.

Second, Keen and Mintz (2004), Kanbur and Keen (2014), and Liu et al. (2018) develop a theoretical framework for studying the response of SMEs to a VAT with exemptions. Devereux et al. (2014) also build a model of corporate income tax with a lower tax rate for SMEs. Our theoretical model builds on these studies and incorporates the trade-off between tax savings and financial constraints to study firm responses to the pro forma standard tax that exempts SMEs from taxation.

Given the preceding studies, this study's main contributions can be summarized as follows. First, we are the first to explicitly examine a size-dependent tax policy based on *financial* activities, which complements studies that exclusively focus on this policy based on *real* inputs or outputs. Second, unlike preceding studies, we examine a wider range of firm characteristics as the sources of heterogeneous reactions to the tax reform, which is motivated by our theoretical model. Specifically, we focus on a firm's productivity and its potential tax benefit. These characteristics are associated with investment opportunities and the amount of the potential tax payment due to the newly introduced tax system. Further, we investigate how those characteristics affect the decision to reduce capital through the interaction with financial constraints to precisely understand the mechanism that causes heterogeneous firm reactions to the tax reform. Third, we explicitly examine the effects of capital reduction on firms' ex-post behavior by properly considering the selection bias associated with their heterogeneous reactions to the tax reform. Such causal inferences provide new evidence about the effects of a size-dependent tax policy on various measures of firms' financial and real activities.

The rest of this paper is organized as follows. Section 2 provides a brief background on the new tax system and the practical procedure of capital reduction in Japan, the latter of which is especially essential when considering how to model firm capital in a theoretical framework.

Section 3 presents the theoretical model that leads to the hypotheses that the subsequent empirical analyses test. Section 4 discusses the data and method used in our analysis, and the empirical results are presented in Section 5. Last, Section 6 concludes the paper and includes potential avenues for future research.

2. Background Information

2.1 Pro forma standard taxation system in Japan

The Japanese government first announced the introduction of the pro forma standard taxation system on December 13, 2002, and then introduced it in the Japanese fiscal year starting April 1, 2004. This system is set up as part of the corporate enterprise tax, which is a local government tax at the prefecture level. Before its introduction, the corporate enterprise tax was levied only on corporate income and exempted loss-making firms, which raised concerns about the inequality in tax burdens between profit- and loss-making firms. Thus, to remedy such inequality, the new system requires firms to pay a tax of 0.2% of their capital and capital reserve when their capital exceeds JPY 100 million, regardless of whether they are generating profits.[4] Furthermore, these firms are also required to pay 0.48% of their value added (see Table 1).[5] As the most important feature of this tax system, SMEs with capital equal to or less than JPY 100 million (about US$ 900,000) are exempt from paying these taxes.

[4] To calculate the tax base, a firm's paid-up capital is divided into four parts, and a different weight is applied to each part. The weight on the first part of the paid-up capital, which is less than or equal to JPY 100 billion, is 100%. The weight on the second part, which is more than JPY 100 billion and less than or equal to JPY 500 billion, is 50%. The weight on the third part, which is more than JPY 500 billion and less than or equal to JPY 1 trillion, is 25%. The weight on the fourth part, which is more than JPY 1 trillion, is zero. The tax base of the paid-up capital is calculated as the weighted sum of these four parts.

[5] Wages that exceed 70% of the factor income are excluded from the taxable value added.

Table 1: The pro forma standard taxation system

Corporate enterprise tax (Local government tax in prefecture level)				
	Firms with stated capital above 100 million JPY			Firm with stated capital at or below 100 million JPY
Year	Tax rate (percent) on			Tax rate (percent) on
	Income (sum of central and local government tax rate)	Proforma standard taxation		Income (sum of central and local government tax rate)
		Value-added (Factor payment + profit)	Paid-in capital (Stated capital + capital reserve)	
1995-1997	12 (55.99)	-	-	12 (55.99)
1998	11 (51.47)	-	-	11 (51.47)
1999-2003	9.6 (44.79)	-	-	9.6 (44.79)
	● Pro forma standard taxation was introduced in 2004 (announced in 2002)			● Exemption from pro forma standard taxation
2004-2011	7.2 (42.39)	0.48	0.2	9.6 (44.79)

Source: Ministry of Finance, Japan

Under the new tax system, the tax rate on SMEs' income is slightly higher than that on non-SMEs' income (44.79% for SMEs vs. 42.39% for non-SMEs). However, the difference (2.4%) is negligible compared with the sum of tax payments on value added (0.48%) and capital (0.2%) for non-SMEs. Therefore, the benefits of avoiding taxes by reducing capital are positive for most firms if their asset size and profits do not change as a result.[6]

2.2 Capital reduction in Japan

According to the Companies Act of Japan, to reduce capital, firms must first obtain agreement at a general shareholder meeting (Article 447 Paragraph 1). They must also announce the planned capital reduction to all creditors at least one month prior to the reduction because it

[6] Suppose a firm has assets worth JPY 200 million (M), yields value added of 50 M, and earns profits of 10 M. If the firm has capital of 100 M (and debt of 100 M), then the total tax payment is 4.4794 M. If the firm has capital of 110 M (and debt of 90 M), then the total tax payment is 4.699 M (4.239 M for income, 0.22 M for capital, and 0.24 M for value added).

might be a disadvantage to creditors. If no creditor opposes the reduction, firms can officially register it. However, if some creditors oppose the move, firms have to repay their debts or provide security to them to overcome their objection. As such, a series of official procedures are required to reduce capital, and the process takes substantial time and financial cost to complete.

The creditors who must agree to a capital reduction usually include, for example, banks and other financial institutions. As traditionally modeled in the theoretical literature and examined in empirical analyses (see, for example, Bernanke et al., 1999; Matsuyama, 2008), these institutions consider the level of net wealth an important measure of debtors' creditworthiness. Thus, we presume that capital reduction leads to tighter financial constraints on firms.

We should note that there are two types of capital reduction that do not involve cash payouts to shareholders. First, if firms hold accumulated losses in their balance sheet, they can offset those losses by reducing their stated capital (loss-canceling capital reduction). In this case, there is no actual effect on the size of the firm's balance sheet because the net wealth (the sum of paid-up capital and accumulated losses) does not change. Second, firms can also reduce capital and increase capital surplus by the same amount without changing the size of the firm's balance sheet (item-changing capital reduction). In both cases, firms do not pay out any cash, but only experience a reduction in the capital on the books.

Thus, to reduce capital without loss-canceling or item-changing, the firm must pay cash to shareholders with dividends or by repurchasing shares. Consequently, the firm must decrease the size of its assets to conduct capital reduction; otherwise, it must increase its debt by an amount equal to or more than the cash paid out to shareholders. We call this reduction a "paid out" capital reduction, and our empirical analysis only addresses this type of reduction, which presumably leads to tighter financial constraints on firms.[7] About 76% of all capital reductions in our sample

[7] Online Appendix A summarizes the differences between the paid-out capital reduction and the other types of capital reductions.

from 1996 to 2006 are paid-out capital reductions. However, we should note that we focus on capital reductions from a level above the tax threshold (100 million JPY) to a level at or below it; thus, our sample of paid-out capital reductions is about 27% of all capital reductions.

3. Model

To derive some testable hypotheses, this section presents a simple theoretical model that illustrates firm reactions to changes in the tax scheme. Specifically, we consider a firm that first decides whether to reduce its capital to the threshold level in the new tax system and then produces output to maximize its after-tax profits given the size of its capital. A crucial feature of the model is that the firm faces a borrowing constraint that depends on its capital. A firm that reduces capital, therefore, faces a decision of whether higher tax savings outweigh tighter borrowing constraints. To the best of our knowledge, no preceding theoretical study examines the motives and consequences of capital reduction.

3.1 Setup

3.1.1 Timeline and technology

First, a firm that has inherited capital (e) knows that the government has introduced a pro forma standard tax system.[8] After observing its productivity (A), the firm decides whether to keep the size of its inherited capital (e) or reduce it to the threshold level ($\bar{e}$), above which the firm incurs a pro forma standard tax payment, where $e > \bar{e}$. Then, the firm produces output (y) from the physical capital (k), labor (l), and intermediate goods (m), according to the production technology in Eq. (1):

[8] We neglect capital reserves in the model for simplicity.

(1) $$y = Ak^{\alpha} l^{\beta} m^{\gamma},\ \alpha + \beta + \gamma < 1.$$

The firm sells the output in a competitive market at a unit price. We assume diminishing returns to scale.[9]

3.1.2 Borrowing constraint[10]

We assume that the firm has access to competitive financial intermediaries that receive deposits from the firm and rent physical capital k at rate R to the firm. The rental rate of physical capital (R) is equal to $(r + \delta)$ under the competitive intermediation market, where δ and r denote the depreciation rate and the interest rate, respectively. Suppose that, after production has taken place, the firm can renege on the contracts and keep the fraction $(1 - \phi)$ of the undepreciated physical capital $(0 < \phi \leq 1)$ and *all* the revenue net of labor payments, intermediate payments, and taxes ($y - wl - pm - T$, where w, p, and T denote the wage rate, the price of intermediate goods, and taxes, respectively). If the firm reneges on the contracts, the intermediary punishes it by garnishing the financial assets the firm has deposited with the financial intermediary, which is represented by e. For the rental contracts of physical capital to be incentive compatible, the following inequality must hold:

$$(1 + r)e - (r + \delta)k \geq (1 - \phi)(1 - \delta)k.$$

Rearranging the inequality yields:

[9] If we instead assume a competitive market and constant returns to scale, then the net-tax profit becomes negative ($\pi = -T < 0$) when the financial constraint is not binding. Alternatively, we can assume that the technology has constant returns to scale in variable factors and that the firm operates in an imperfectly competitive market. The analytical results do not change with this alternative specification.

[10] Our specification of the borrowing constraint is similar to Buera and Shin (2013). In their model, an entrepreneur's capital rental is limited by her/his financial wealth.

(2) $$\lambda e \geq k$$

where $\lambda = \frac{1}{1-\frac{(1-\delta)}{1+r}\phi}$, and $1 < \lambda \leq \frac{1+r}{r+\delta}$.

The borrowing constraint in Eq. (2) means it is tightened if the firm reduces its capital, or λ is smaller. If the firm reduces capital from e to $\bar{e}$, then the relevant borrowing constraint is the same as Eq. (2) where e is replaced by $\bar{e}$.

The parameter ϕ (and hence λ) depends on the degree of contract enforcement in an economy. It may also depend on the type of physical capital; if the physical capital can be easily pledged as collateral, ϕ is likely to be high. As such, ϕ may differ across industries that use different kinds of physical capital.

3.1.3 Taxes

We construct a tax system that mimics the post-reform corporate tax system in Japan as much as possible. Therefore, we define the tax base of corporate income as follows:

(3) $$\pi^{pre} = Ak^{\alpha}l^{\beta}m^{\gamma} - \delta k - r(k-e) - wl - pm.$$

The term $(k-e)$ denotes net borrowings for physical capital if positive and net savings if negative. Eq. (3) contains the negative of $r(k-e)$, as the tax rule allows borrowing costs to be deductible while interest earnings are taxable. The post-reform corporate tax system can be represented as shown in Eq. (4):

(4) $$T = \tau_L I(\pi^{pre} > 0)\pi^{pre} + \tau_V(y - pm) + \tau_E e \text{ if } e > \bar{e};$$

otherwise, $\tau_H I(\pi^{pre} > 0)\pi^{pre}$, where τ_L, τ_V, and τ_E, denote the corporate income tax rate, the tax rate on value added, and the tax rate on capital when the pro forma standard taxation is applied, and τ_H denotes the corporate income tax rate when the pro forma standard taxation is avoided, respectively. I denotes an indicator function equal to one if the argument is met.[11] The threshold $\bar{e}$ denotes the level of capital above which the pro forma standard tax is levied. We assume that $0 < \tau_L, \tau_V, \tau_E, \tau_H < 1$ and $\tau_L < \tau_H$ based on the post-reform tax system in Japan. We also assume that the tax rate on value added (τ_V) is sufficiently low relative to the tax rate on income applied to the firm that reduces capital (τ_H). This assumption is consistent with the Japanese post-reform tax system.

Assumption 1: $(1 - \tau_L - \tau_V)^{1-\gamma} > (1 - \tau_L)^{\alpha+\beta}(1 - \tau_H)^{1-\alpha-\beta-\gamma}$

3.2 Profit maximization and capital reduction

The firm's problem can be solved backwards in two steps. First, for a given level of capital, *e* or $\bar{e}$, the firm chooses *l*, *m*, and *k* to maximize after-tax profit π under the borrowing constraint. Second, given the solution to the optimization problem, the firm decides whether to keep its initial capital at *e* or reduce it to $\bar{e}$. In Step 1, given the factor prices of the wage rate (*w*), the rental rate of physical capital ($R = r + \delta$), and the intermediate good price (*p*), the firm chooses (*k, l*, *m*) to maximize the profit net of tax payments (*T*) in Eq. (5) under the borrowing constraint in Eq. (2):

(5) $$\pi = Ak^{\alpha}l^{\beta}m^{\gamma} - (r + \delta)k - wl - pm - T$$

[11] Without a fixed cost, $\pi^{pre} > 0$ always holds under the diminishing returns to scale technology (Eq. (1)).

Note that we deduct the opportunity cost of equity, re, as well as taxes, T, from the tax base of corporate income, π^{pre}. Then in Step 2, by comparing the after-tax profits for *e* and $\bar{e}$, the firm chooses the one that yields the higher after-tax profit.

3.3 Analytical solutions

We first examine the types of firms that are likely to be financially constrained, the types of firms that are likely to reduce capital dependent on whether the firm is financially constrained, and, finally, the effects of capital reduction on firm size and debt that depends on whether the borrowing constraint is binding. The proofs are available in Online Appendix B.

Proposition 1A: *The borrowing constraint is binding for firms with capital e if and only if* $\boldsymbol{A} > \overline{\boldsymbol{A}}(\boldsymbol{e})$*, where* $\overline{\boldsymbol{A}}(\boldsymbol{e})$ *is an increasing function of* $\boldsymbol{e}$*.*

Proposition 1A argues that, given its capital, a high-productivity firm is more likely to be financially constrained. This proposition is natural because higher productivity increases demand for physical capital. It also argues that given its productivity, a firm with lower capital is more likely to be financially constrained. We obtain a similar result in Proposition 1B: that given its capital, a high-productivity firm that reduces capital is more likely to be financially constrained.

Proposition 1B: *The borrowing constraint is binding for firms with capital* $\bar{\boldsymbol{e}}$ *if and only if* $\boldsymbol{A} > \bar{\bar{A}}(\bar{\boldsymbol{e}})$*, where* $\bar{\bar{A}}(\bar{\boldsymbol{e}})$ *is an increasing function of* $\bar{\boldsymbol{e}}$**.**

Corollary 1: $\overline{\boldsymbol{A}}(\boldsymbol{e}) > \bar{\bar{A}}(\bar{\boldsymbol{e}})$

Corollary 1 means that if the borrowing constraint is binding in the case of keeping capital constant, then it is also binding in the case of reducing capital. Next, we analyze the types of firms that are likely to reduce capital, depending on whether the firm is financially constrained.

Proposition 2A: *Suppose that* $\boldsymbol{A} \leq \bar{\bar{\boldsymbol{A}}}(\bar{\boldsymbol{e}})$*; thus, the borrowing constraint is not binding regardless of whether the firm reduces capital.*

(i) *Suppose that* $(\boldsymbol{\tau_L r} + \boldsymbol{\tau_E})\boldsymbol{e} > \boldsymbol{\tau_H r \bar{e}}$*; then, the firm reduces capital if and only if* $\boldsymbol{A} < \widehat{\boldsymbol{A}}(\boldsymbol{e}, \bar{\boldsymbol{e}})$*, where* $\widehat{\boldsymbol{A}}(\boldsymbol{e}, \bar{\boldsymbol{e}})$ *increases with e.*

(ii) *Suppose that* $(\boldsymbol{\tau_L r} + \boldsymbol{\tau_E})\boldsymbol{e} \leq \boldsymbol{\tau_H r \bar{e}}$*; then, the firm never reduces capital.*

Proposition 2A (i) argues that when the borrowing constraint is not binding, regardless of whether the firm reduces capital, low-productivity firms are more likely to reduce capital given the size of their initial capital. By reducing capital, a firm can avoid taxes on value added and capital but incurs more taxes on income. However, such an increase in taxes on income is relatively small for a low-productivity firm. Moreover, the fact that $\hat{A}(e, \bar{e})$ increases with e shows that, given its productivity, a firm with more capital is more likely to decrease capital because the benefits of avoiding taxes on capital are greater for such firms. Proposition 2A (ii) implies that the firm never reduces capital if the initial capital is very low because the benefit from not paying taxes on capital is small.

We further analyze the case where the borrowing constraint is binding even if the firm does not reduce capital. In this case, the constraint is also binding if the firm reduces capital.

Proposition 2B: *Suppose that* $\boldsymbol{A} > \overline{\boldsymbol{A}}(\boldsymbol{e})$*; thus, the borrowing constraint is binding regardless of whether the firm reduces capital.*

(i) Suppose that $(\boldsymbol{\tau_L r} + \boldsymbol{\tau_E})\boldsymbol{e} > \boldsymbol{\tau_H r \bar{e}}$; then, the firm reduces capital if and only if $\boldsymbol{A} < \widetilde{\boldsymbol{A}}(\boldsymbol{e}, \bar{e})$, where $\widetilde{\boldsymbol{A}}(\boldsymbol{e}, \bar{e})$ either increases or decreases with *e*.

(ii) Suppose that $(\boldsymbol{\tau_L r} + \boldsymbol{\tau_E})\boldsymbol{e} \leq \boldsymbol{\tau_H r \bar{e}}$; then, the firm never reduces capital.

Proposition 2B (i) argues that when the borrowing constraint is binding, regardless of whether the firm reduces capital, low-productivity firms are more likely to reduce capital given their initial capital. This situation arises not only because their increase in taxes on income is small, but also because they incur fewer opportunity costs from the tighter borrowing constraint associated with a smaller amount of capital. In contrast to the unbinding constraint case in Proposition 2A, $\widetilde{\boldsymbol{A}}(\boldsymbol{e}, \bar{e})$ can decrease or increase with *e*, which means that, given productivity, a firm with more capital is more or less likely to decrease capital. While the benefits from avoiding taxes on capital are greater for such a firm, the borrowing constraint becomes tighter; hence, the opportunity costs from having less capital become larger for the firm.

Next, we analyze the effects of capital reduction on a firm's size in terms of physical capital (*k*), output (*y*), and debt ($k - e$), which depends on whether the borrowing constraint is binding.

Proposition 3A: *Suppose that* $\boldsymbol{A} \leq \overline{\overline{\boldsymbol{A}}}(\bar{\boldsymbol{e}})$*; thus, the borrowing constraint is not binding regardless of whether the firm reduces capital. Then, if the firm reduces its capital, its physical capital, output, and debt increase.*

The result for physical capital is natural given that under Assumption 1, the relevant marginal tax rate on physical capital is lower when the firm reduces capital. An increase in physical capital leads to an increase in output through its direct effect as well as the effect of lowering the marginal tax rate on physical capital. An increase in physical capital that represents an asset, coupled with a decrease in capital, also leads to an increase in debt.

Proposition 3B: *Suppose that $\boldsymbol{A} > \overline{\boldsymbol{A}}(\boldsymbol{e})$; thus, the borrowing constraint is binding regardless of whether the firm reduces capital. Then, if a firm reduces capital, its physical capital and debt decrease, and the rate of decrease in physical capital and debt is larger as $\frac{\boldsymbol{e}}{\bar{\boldsymbol{e}}}$ is larger. Suppose, further, that $\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\beta} > \left(\frac{\bar{e}}{e}\right)^{\alpha}$; then, the firm's output also decreases, and the rate of decrease in output is larger as $\frac{\boldsymbol{e}}{\bar{\boldsymbol{e}}}$ is larger.*

Reducing capital leads to a tighter borrowing constraint and, hence, less physical capital. In addition, debt also decreases. Proposition 3B is in sharp contrast to Proposition 3A; whether a firm's physical capital and debt decrease subsequent to capital reduction depends on whether the borrowing constraint is binding. This situation is the reason we consider the borrowing constraint. Output decreases subsequent to capital reduction if the decrease in capital, and hence, the decrease in physical capital, is large enough relative to the decrease in the effective marginal tax rate on physical capital. The magnitude of the effects of reducing capital on physical capital, output, and debt is larger as the initial capital, e, relative to the threshold, $\bar{e}$, is larger.

The scope of providing this model is to derive testable hypotheses regarding the mechanism through which the tax policy exerts its influence and its consequences on firm performance and financing. However, the model may be too simple to fit into the real economy. In Online Appendix C, we extend the model above to make it more realistic and present some numerical examples of the extended model. We extend the model in two ways. First, we introduce a fixed operating cost that generates negative profits for very low-productivity firms and allows such firms to avoid corporate income taxes. Next, we allow the borrowing constraint to depend on the firm's cash flow, as well as its capital, by following the formulation used in Buera et al. (2011). Our results show that the numerical solutions to the extended model that we obtain under plausible parameter sets are consistent with the analytical solutions of the basic model (except for very low-productivity firms with huge deficits).

3.4 Testable hypotheses

Based on the results of the analytical solutions to the basic model (and the numerical examples of the extended model), we summarize the testable hypotheses as follows:

Hypothesis 1: *Compared to a high-productivity firm, a low-productivity firm is more likely to reduce capital in response to the pro forma standard taxation.*

Hypothesis 1 is derived from Propositions 2A (i) and 2B (i).

Hypothesis 2A: *If the borrowing constraint is not binding either before or after reducing capital, the firm's capital reduction in response to the pro forma standard taxation increases its physical capital, output, and debt.*

Hypothesis 2B: *If the borrowing constraint is binding both before and after reducing capital, the firm's capital reduction in response to the pro forma standard taxation decreases its physical capital, output, and debt.*

Hypotheses 2A and 2B are derived from Propositions 3A and 3B, respectively. These two hypotheses allow for making inferences about whether firms face binding financial constraints by examining the effects of capital reduction on firm size.

Hypothesis 3: *If the borrowing constraint is binding before reducing capital, the negative effect of the firm's capital reduction on its physical capital, output, and debt is greater as the initial capital is larger.*

Hypothesis 3 is derived directly from Proposition 3B.

4. Data and Method

4.1 Data and sample selection

The dataset for this study is provided by Tokyo Shoko Research Ltd. (TSR), one of the largest Japanese credit reporting agencies. The dataset covers both listed and unlisted firms in Japan and comprises the basic details, such as yearly sales, of more than one million firms. Among those, around 100,000 firms have detailed annual financial statement information that includes the stated capital, capital reserve, and earned surplus carried forward. All of the data are for commercial use and are not available to the public without cost. We obtain the data directly from TSR through the joint research project between Hitotsubashi University and TSR.

The data range from 1996 to 2006, which is six years before and four years after the announcement of the tax reform in 2002. We exclude the financial crisis period starting in 2007 from our analysis; thus, our estimates are not contaminated by its effects.

In our empirical analysis, we focus on firms with capital above the threshold of JPY 100 million. For each year, we exclude firms whose capital in the previous year was smaller than or equal to the threshold, because the tax reform had virtually no effect on these firms.[12] We also exclude firms belonging to financial industries because they are subject to a number of regulations, including a minimum capital requirement. In addition, we exclude firms belonging to the electricity and gas industries because the pro forma standard taxation is not applied to them and because their tax base under the corporate enterprise tax both before and after the tax reform is revenue. We further exclude firms that are public interest corporations because almost all of them are exempt from pro forma standard taxation even if their capital is above the threshold.[13] Furthermore, because we focus on the paid-out capital reduction our model describes, we exclude firms that conduct the other two types of capital reductions (loss-offsetting and item-changing capital reductions) as already mentioned. We also exclude bankrupt firms after the year of bankruptcy so that we can track firm performance over the sample periods. The total number of

[12] We do not investigate the responses of firms whose capital is at or below the threshold, although the tax reform may discourage them from increasing their capital beyond the threshold.

[13] These firms belong to water, scientific research, professional and technical services; education; learning support; medical; health care and welfare; compound services; waste disposal businesses; political, business, and cultural organizations; religion; foreign governments and international agencies in Japan; government; and service industries unable to be classified.

firm-year observations is around 110,000 over the sample period. The industry composition in our sample is roughly consistent with that in the population of corporate firms.[14]

4.2 Method

4.2.1 Reaction to the introduction of the new tax system

Probability that firms reduce capital: We focus on firms whose capital at the end of year *t*-1 (*t* = 1996, 1997,…, 2006) is above the threshold and examine how the probability that those firms will reduce their capital to a level at or below the threshold in year *t* varies over the sample periods, without controlling for any firm-level characteristics.[15] Thus, we define the variable, $CAPRED1_{it}$ as follows:

$$CAPRED1_{it} = \begin{cases} 1\ if \quad Capital_t \leq 100\ million\ yen \\ 0\ if \quad Capital_t \geq\ Capital_{t-1} \end{cases}.$$

To focus on capital reductions crossing the threshold, we exclude from our sample those firms that reduce their capital within a range above the threshold.

The transition of this unconditional probability of capital reduction is obtained by estimating firm-level equation (6):

$$(6) \qquad CAPRED1_{it} \quad = \sum_{j=1996}^{2006} \beta_j\ YEAR_j + \varepsilon_{it}.$$

[14] The proportions of the number of firms in our sample in each industry in fiscal year 2005 are as follows (the population value is shown in parentheses): agriculture, forestry, and fishery 0.16% (0.33%); mining, stone-quarrying, and gravel-gathering enterprise 0.26% (0.39%); construction 9.89% (5.99%); manufacturing 33.65% (28.70%); telecommunications 9.09% (9.60%); transportation and postal service 4.85% (5.12%); wholesale and retail business 22.63% (23.04%); real estate, rental, and leasing business 7.37% (11.98%); and service except for education, learning support, medical care, and welfare businesses 12.08% (14.84%). Note that we calculate the population values using the number of corporate firms with capital of more than 100 mil. JPY from the "Financial Statement Statistics of Corporations by Industry" provided by the Ministry of Finance JAPAN.

[15] While Saez (2010), Chetty et al. (2011), Kleven and Waseem (2013), Devereux et al. (2014) and Harju et al. (2019) use bunching estimators to estimate the tax rate elasticity of the tax base, we do not use them because the focus of our analysis is not on tax elasticity but on the dynamic response of firms to the introduction of the new tax system.

In this equation, β_j indicates the coefficient of year dummy j ($YEAR_j$). If firms reduce capital to avoid the new tax, the estimated value of β_j (the probability of $CAPRED1_{it} = 1$) should increase after the announcement of the tax system in 2002.

However, firms may reduce capital in the same period to achieve an objective other than avoiding the new tax. In such a case, firms would reduce capital to various levels. We, therefore, conduct a placebo test by arbitrarily setting a counterfactual threshold above the actual level to see whether non-tax-related motives drive firms to reduce capital. Then, we focus on firms whose capital at the end of year *t*-1 (*t* = 1996, 1997,…, 2006) is above the counterfactual threshold and examine how the probability that those firms will reduce their capital to a level at or below it in year *t* varies over the sample periods. Specifically, we define the variable, $CAPRED2_{it}$ as follows:

$$CAPRED2_{it} = \begin{cases} 1\ if \quad 100\ million\ yen < Capital_t \leq 300\ million\ yen \\ 0\ if \qquad\qquad Capital_t \geq\ Capital_{t-1} \end{cases}.$$

To focus on the capital reductions that cross the counterfactual threshold, we exclude from our sample those firms that reduce their capital within a range above it.

Then, we estimate firm-level equation (7):

$$(7) \qquad CAPRED2_{it} \quad = \textstyle\sum_{j=1996}^{2006} \beta_j\ YEAR_j + \varepsilon_{it}.$$

We expect no specific change in the estimated values of β_j (the probability of capital reduction) in Eq. (7) as long as there is no macro trend over the sample period.

Figure 1 summarizes the definitions of CAPRED1 and CAPRED2.

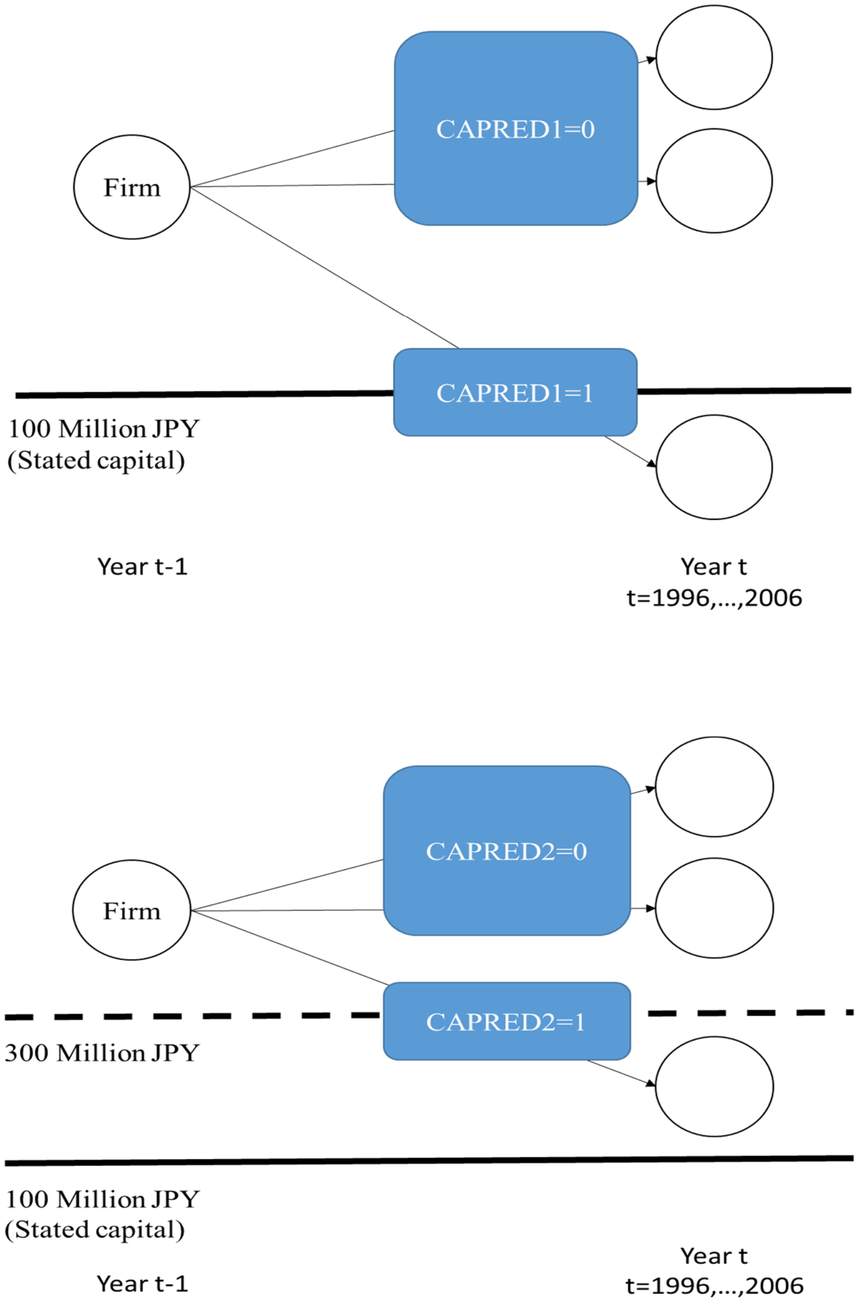


Figure 1: Definition of $CAPRED1$, $CAPRED2$

Ex-ante characteristics of firms that reduce capital: We further augment Eqs. (6) and (7) in the previous subsection with firm characteristics to identify a more detailed mechanism that induces firms to avoid taxes through capital reduction. Hypothesis 1 posits that a low-productivity firm is more likely to reduce capital in response to the pro forma standard taxation. We follow the same sample selection criteria for Eqs. (6) and (7) and separately estimate Eqs. (8) and (9), which incorporate firm *i*'s observable lagged characteristics, X_{it-1}, and unobservable fixed effects, η_i:

(8) $CAPRED1_{it} = \sum_{j=1996}^{2006} \beta_j\, YEAR_j + \sum_{j=1996}^{2006} \gamma_j\ YEAR_j \times X_{it-1} + \eta_i + \varepsilon_{it},$

(9) $CAPRED2_{it} = \sum_{j=1996}^{2006} \beta_j\, YEAR_j + \sum_{j=1996}^{2006} \gamma_j\ YEAR_j \times X_{it-1} + \eta_i + \varepsilon_{it}.$

We consider the following firm characteristics: First, we use firm productivity as the primary determinant of capital reductions in our theoretical analysis (Hypothesis 1). Specifically, we define $VAPE_{it-1}$ as a dummy variable equal to one if firm *i*'s labor productivity in year *t*-1 is above the overall median value for the whole sample and equal to zero if labor productivity in year *t*-1 is less than or equal to the median value.[16] Firm *i*'s labor productivity is calculated as its value added per the number of employees.[17] We calculate value added as the sum of operating profit and wages.

Second, to consider whether a firm can save taxes by reducing capital, we define TAX_{it-1} as a dummy variable equal to one if a capital reduction reduces firm *i*'s hypothetical tax payment based on year *t*-1 data and zero otherwise. The change in the hypothetical tax payment is computed

[16] We use labor productivity as a measure of the firm's productivity instead of total factor productivity (TFP) because our dataset does not contain a good measure of capital stock; hence, we cannot precisely estimate TFP. Note that the time-invariant difference in labor productivity across sectors is absorbed by the firm-level fixed effects in our estimation.

[17] We use the number of employees instead of total hours worked because firm-level data on the latter are not available.

as the difference between the amount a firm has to pay if it receives tax exemptions due to its SME status and the amount it will pay under the pro forma standard taxation. To conduct another placebo test, we calculate TAX_{it-1} before the actual announcement of the new tax system as well, as if the new tax system had been introduced before the actual announcement. If TAX_{it-1} had any impact on the probability of capital reduction before the actual announcement, TAX_{it-1} would capture something other than the introduction of the pro forma standard taxes. Note that to compute the hypothetical tax payment, we assume taxable income does not change due to the capital reduction, although the reduction is likely to decrease taxable income as our theoretical model predicts in the case of the binding borrowing constraint. Therefore, the hypothetical tax payment under tax exemptions for SMEs is likely to be overestimated if the borrowing constraint is binding.

Third, to account for firms' difficulty obtaining debt financing after a capital reduction, we use their ex-ante capital. Firms with greater capital are unlikely to reduce their capital to the threshold; this is because if the borrowing constraint is binding, debt financing becomes more difficult or costly. We define $CAPITAL_{it-1}$ as the natural logarithm of firm *i*'s capital at the end of year *t*-1.

Fourth, to account for size, we define EMP_{it-1} as the natural logarithm of the number of firm *i*'s employees at the end of year *t*-1.

Fifth, to account for the firms' internal financing ability to conduct a paid-out capital reduction, we use $CASHRATIO_{it-1}$, which denotes the ratio of firm *i*'s cash holdings to total assets at the end of year *t*-1. Given that there are a small number of outliers in the data, we winsorize the top 1% for $CASHRATIO_{it-1}$.

We expect that these firm characteristics will have a significant and greater effect on *CAPRED1* after the announcement of the pro forma standard taxation than before.

4.2.2 Impacts of reducing capital on firm growth and finance

Average impacts: We conduct a DID estimation using firms that reduced capital as the treated group and those that did not as the control group to investigate how a tax-induced capital reduction affects firms' subsequent growth and financing. Hypothesis 2A posits that a firm's size and debt are likely to increase if the borrowing constraint is not binding, while Hypothesis 2B posits that size and debt are likely to decrease if the borrowing constraint is binding. The DID analysis enables us to remove a macro trend from the effects of capital reduction subsequent to the tax reform announcement by comparing the change in behavior of the two groups.

Whether a firm is treated (i.e., whether a firm reduces capital) is not randomly assigned but depends on firm characteristics, as our theoretical model predicts. To remove the bias arising from such selection, we match the control firms with the treated firms using the following propensity score matching (PSM) procedure.

First, we construct a dataset that is comprised of treated firms that reduce their capital from a level above the actual threshold to a level at or below it in year *t* ($CAPRED1_{it} = 1$) and control firms that do not reduce their capital from a level above the actual threshold in year *t* ($CAPRED1_{it} = 0$). Second, we exclude firms with more than JPY 1 billion in capital at the end of year *t*-1 to take care of the outliers associated with a substantial capital reduction. Third, we also exclude from the control group firms that increased their capital in year *t* so that firms in this group are not specifically "growing," and we can be conservative concerning the estimated effects of capital reduction. Thus, the control sample comprises firms that do not change their capital.

Next, we focus on *t* = 2002, 2003, 2004, 2005, 2006 as the years when the treated firms reduce their capital in response to the announcement of the new tax system. We exclude firms that increased their capital above the actual threshold during periods *t*+1 to *t*+2 from the treated sample

(8 observations are eliminated), and exclude from the control sample firms that reduced their capital to at or below the actual threshold during periods t+1 to t+2 (1,059 observations are eliminated); thus, we can clearly identify the impact of a capital reduction. Then, we estimate the Probit model in Eq. (10) for each year:

$$(10)\ \Pr(CAPRED1_{it} = 1) = \Pr(\beta X_{it-1} > -\varepsilon_{it}),\ \varepsilon_{it} \sim N(0,1)\ \ for\ each\ \ t = 2002, \ldots, 2006,$$

where the vector of firm characteristic variables, X_{it-1} consists of $VAPE_{it-1}$, TAX_{it-1}, $CAPITAL_{it-1}$, EMP_{it-1}, and $CASHRATIO_{it-1}$. Then, using the estimated conditional probabilities of capital reduction as propensity scores, we match the treated firms with the control firms in the same year.

Finally, using the matched sample, we estimate the following DID of the four groups of 11 outcome variables (Y) between the treated (T) and control groups (C) over the pre-event and post-event periods.

$$\mathrm{DID} = \frac{1}{N}\sum\nolimits_{i \in T} \left(Y_{i,post} - Y_{i,pre}\right) - \frac{1}{N}\sum\nolimits_{j \in C} \left(Y_{j,post} - Y_{j,pre}\right)$$

Thus, to track the change in the DID effect over multiple periods, we restrict our sample to firms that survive up to t+2.[18] Note that firms in the control group might reduce their taxable value added because, under the new taxation system, they incur an additional tax proportional to the value added. Therefore, our DID estimates for value added might capture the impact of the new tax on control firms' behavior, and, hence, underestimate the true impact on the tax-induced capital reduction. In this sense, our estimates for value added are conservative ones.

[18] By restricting our sample to survivors, we are likely to be conservative about the negative effects of capital reduction on firm size and performance, because exiting firms tend be smaller and more poorly performed.

Thus, to measure growth in terms of firm size as the first group of the outcome variables, we use the natural logarithms of total assets ($ASSET_{it}$), tangible fixed assets (TAN_{it}),[19] the number of employees (EMP_{it}), and sales ($SALES_{it}$). The second group of variables accounts for firm financing activities, measured by the natural logarithm of total debt ($DEBT_{it}$) and the ratio of total debt to total assets ($DEBTRATIO_{it}$). The third group of variables accounts for the detailed items included in the firms' total assets and the composition of their asset portfolios, measured by the ratio of cash holdings to total assets ($CASHRATIO_{it}$) and the ratio of tangible fixed assets to total assets ($TANRATIO_{it}$). The fourth group accounts for firm performance. We use the natural logarithm of operating profit ($PROFIT_{it}$) and the natural logarithm of value added (VA_{it}) to measure performance.[20] We replace firm operating profit and value added with zero if they are negative and calculate the logarithm of one plus their value. We also use the ratio of operating profits to total assets (ROA_{it}) and the ratio of value added to sales ($VARATIO_{it}$). For each variable, we estimate the DID between the treatment and control groups from year *t*-1 to year *t*, *t*+1, and *t*+2, where *t* denotes the year when the treated firms reduce capital.

Thus, to remove the effects of outliers, we winsorize the top 1% for $DEBTRATIO_{it}$, $TANRATIO_{it}$, and $CASHRATIO_{it}$, and the top and bottom 1% for ROA_{it} and $VARATIO_{it}$. We further winsorize the top and bottom 1% for the difference in $ASSET_{it}$, TAN_{it}, EMP_{it}, $SALES_{it}$, $DEBT_{it}$, $PROFIT_{it}$, and VA_{it}.

Heterogeneous impacts: The impacts of capital reduction on firm growth and financing are likely to vary, depending on firms' ex-ante characteristics. We focus on the existence or absence of borrowing constraints and initial capital size.

[19] We use tangible fixed assets as a proxy for physical capital because the precise information of physical capital is not available.
[20] Operating profit differs from after-tax profit in that the former is not reduced by interest on debt and taxes.

Based on Hypotheses 2A and 2B, we divide the matched sample for the DID estimation into two subsamples using a proxy for the degree of financial constraint the treated firm faces and compare the impact of capital reduction on growth and financing between the two groups. Given the data available, we follow Rajan and Zingales (1998) who use the dependence on external financing (the RZ index) as a proxy for a financial constraint. The RZ index is an industry-level variable and is computed as the median value of the ratio of the difference between capital expenditure and cash flow to capital expenditure over the firms in each industry. We use the RZ index that Hosono and Takizawa (2015) calculate using the sample of Japanese listed firms over the 1981–2007 period. We expect that the effects of reducing capital on size and debt are greater as the dependence on external financing is higher.

Based on Hypothesis 3, we focus on firms with greater dependence on external financing and compare the effects of reducing capital to at or below the threshold value between firms whose capital before capital reduction is larger than the median value and those whose capital before capital reduction is smaller than the value. We expect that the effects of reducing capital on size and debt are greater as the size of the capital reduction increases.

5. Empirical Results

5.1 Summary Statistics

Table 2 reports the variable summary statistics for the observations used in our analysis of what types of firms reduce their capital.

Table 2: Summary statistics

1996-2006

		Firms with stated capital above 100 mil. JPY in year t-1	Firms with stated capital above 300 mil. JPY in year t-1	Difference	
CAPRED1(t) or CAPRED2(t)	Mean	0.0024	0.0005	0.0020	***
	S.D.	0.0493	0.0221	0.0002	
VAPE(t-1)	Mean	0.5012	0.6134	-0.1122	***
	S.D.	0.5000	0.4870	0.0024	
TAX(t-1)	Mean	0.4744	0.5325	-0.0581	***
	S.D.	0.4993	0.4989	0.0024	
CAPITAL(t-1)	Mean	6.5945	7.4292	-0.8347	***
	S.D.	1.5586	1.4067	0.0072	
EMP(t-1)	Mean	5.3486	5.7461	-0.3975	***
	S.D.	1.4153	1.4384	0.0069	
CASHRATIO(t-1)	Mean	0.1295	0.1192	0.0102	***
	S.D.	0.1201	0.1158	0.0006	
	Obs	111,889	69,807		

Notes: We show not standard deviations but standard errors in the column of Difference. *** indicates significance at the 1% level.

Table 2 shows the statistics for the two subsamples: firms with capital above the actual threshold (JPY 100 million) in year t-1 and those with capital above the hypothetical threshold (JPY 300 million) in year t-1. The mean value for *CAPRED1* is larger than that for *CAPRED2*. This indicates that the relative frequency of capital reductions crossing the real threshold is greater than that of capital reductions crossing the placebo threshold (not crossing the real threshold), which may arise from different characteristics between these subsamples. Firms with capital above JPY 100 million at the end of year t-1 have a smaller mean value of *VAPE*, *TAX*, *CAPITAL*, and *EMP* than firms with capital above JPY 300 million at the end of year t-1. However, the former firms have a larger mean value of *CASHRATIO* (cash-to-asset ratio) than the latter.

Table 3 shows the descriptive statistics for the hypothetical tax burden for firms with capital above the actual threshold at the end of year t-1 over the sample period.

Table 3: Descriptive statistics of hypothetical tax burden

Firms with stated capital above 100 mil. JPY in year t-1 (Obs: 111,889, Unit: million JPY)						
		Mean	S.D.	Min	Med	Max
Tax burden under pro forma standard taxation	a. total=b+c+d	734.23	5705.39	0.20	87.03	474894
	b. Value-added	16.89	87.29	0	2.33	5820
	c. Paid-up capital	13.94	51.28	0.20	1.20	850
	d. Income	703.39	5600.60	0	76.73	468317
Tax burden under tax preferences for SMEs	e. Income	743.22	5917.69	0	81.07	494831
Difference	f. e-a	8.99	224.62	-1911	0.24	19938

For the mean values, we find that, under the pro forma standard taxation, firms have to pay about JPY 17 million as tax on value added, about JPY 14 million as tax on paid-up capital, and JPY 703 million as tax on income. Thus, they have to pay about JPY 734 million in total. However, under the tax preferences for SMEs, firms have to pay about JPY 743 million as tax on income, a difference in the total amount of tax of about JPY 9 million. This difference indicates that the tax burden increases on average if firms with capital above JPY 100 million reduce their capital to a level at or below the threshold. However, as mentioned in Section 4.2.1, this difference is likely to be overestimated because the estimated amount of tax payment under the SME exemption does not reflect the effect of the capital reduction on taxable income. Given this caveat, we still use TAX as an explanatory variable in analyzing the capital reduction because this variable is likely to be correlated with the real tax benefits from capital reduction across firms.

5.2 Reaction to the introduction of the new tax system

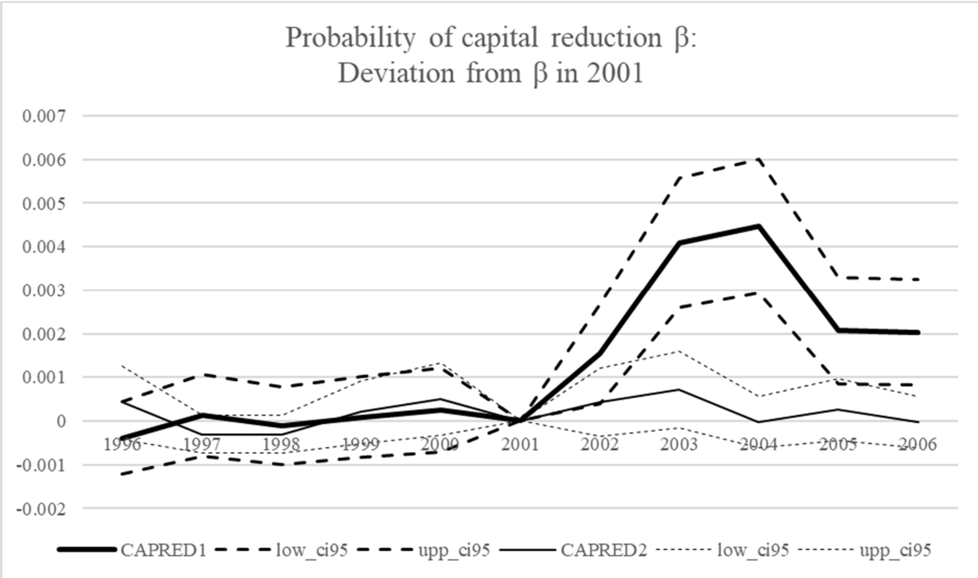


Figure 2: Probability of capital reduction

Notes: low_ci95 and upp_ci95 denote the lower and upper limit values of the 95% confidence interval, respectively.

Figure 2 illustrates the estimated β_j (the probability of capital reduction in year *j*) for *j* = 1996–2006, from both Eqs. (6) and (7). Here, we use the estimated coefficient β_{2001} as a benchmark for the estimates in the other years. Thus, the estimate in each year is measured as the deviation from β_{2001}, and the confidence band is constructed specifically for $(\beta_j - \beta_{2001})$. Figure 2 shows that regardless of whether we use $CAPRED1_{it}$ or $CAPRED2_{it}$ as the dependent variable, there is no specific trend in the estimated $(\beta_j - \beta_{2001})$ prior to *j* = 2001. This finding means that firms experienced no systematic change in the probability of reducing their capital before the announcement of the new tax system. Notably, the estimated $(\beta_j - \beta_{2001})$ after *j* = 2001 is positive and significantly different from zero in the case of $CAPRED1_{it}$. Given that the estimates in the case of $CAPRED2_{it}$ have no specific trend after 2001, the hike in $(\beta_j - \beta_{2001})$ for the case of $CAPRED1_{it}$ is not related to a macro trend but reflects the firms' intention to avoid the new tax.

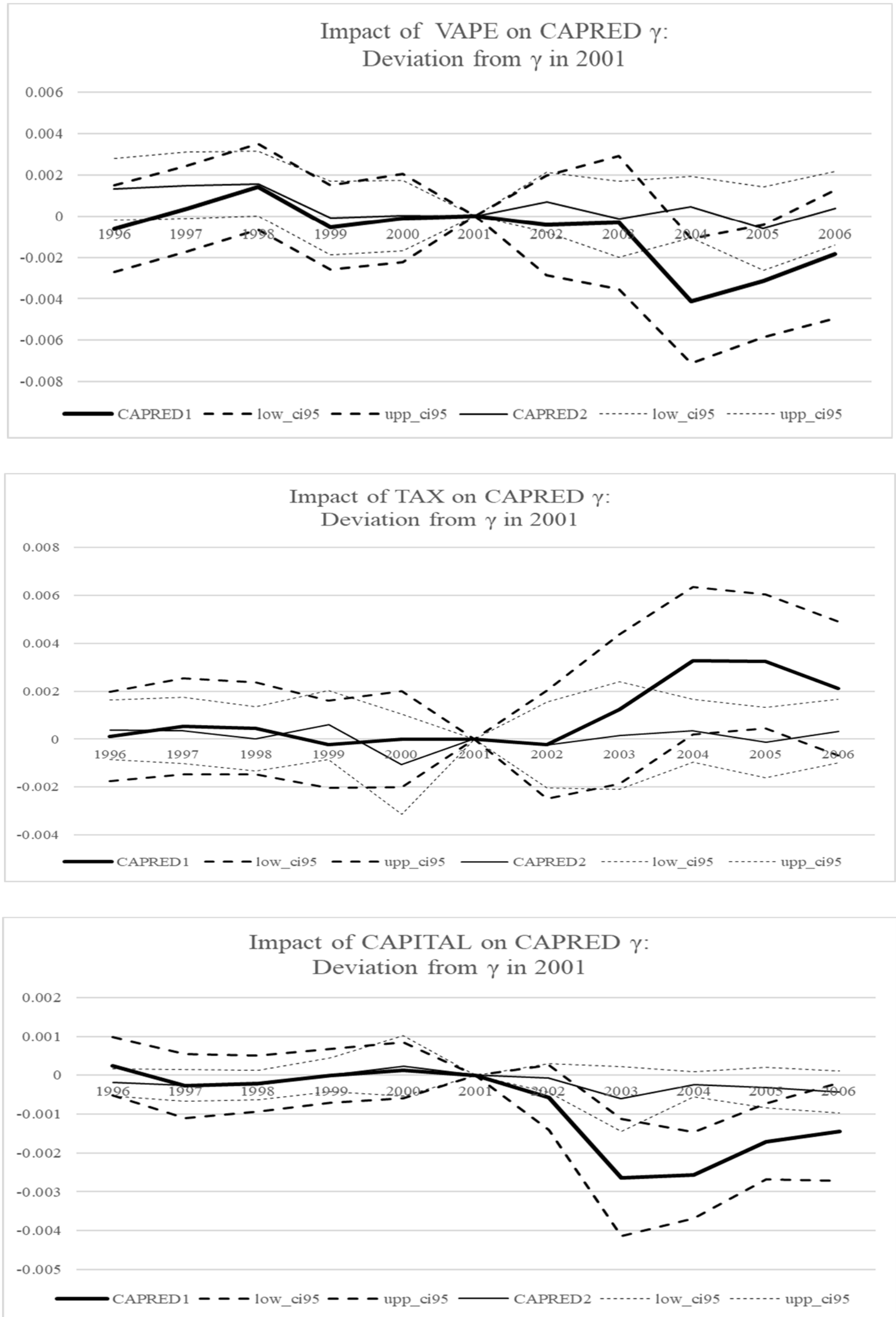


Figure 3 (a): Impact of firm attributes

Notes: low_ci95 and upp_ci95 denote the lower and upper limit values of the 95% confidence interval, respectively.

5.2.1 Which firms were more incentivized to avoid tax through capital reduction?

The three panels in Figure 3 (a) show the estimated γ_j associated with $VAPE_{it-1}$, $CAPITAL_{it-1}$, and TAX_{it-1}, respectively, for *j* = 1996–2006 in Eqs, (8) and (9). As in the previous subsection, we use the estimated coefficient γ_{2001} as a benchmark for the estimates in the other years. First, we find that there is no specific trend prior to the announcement in either Eqs. (8) or (9) in the estimated $(\gamma_j - \gamma_{2001})$ associated with these three characteristics.

However, the estimated $(\gamma_j - \gamma_{2001})$ shows a significant change after 2001 only in the case of $CAPRED1_{it}$. Given that the estimates for $CAPRED2_{it}$ have no specific trend after 2001, the significant change in the impact of the three characteristics in the case of $CAPRED1_{it}$ is not related to a macro trend but to the firms' tax avoidance behavior. That is, firms with lower labor productivity ($VAPE_{it-1}$), a positive potential tax benefit (TAX_{it-1}), and smaller capital ($CAPITAL_{it-1}$) in year *t*-1 tend to avoid taxes by reducing their capital.[21] The negative impact of $VAPE_{it-1}$ is especially consistent with Hypothesis 1: low-productivity firms are more likely to reduce capital because they have fewer investment opportunities and do not need to keep a large amount of capital, which helps in raising external financing.

[21] To check the validity of using the current dummy variable for labor productivity, we alternatively use its quartile dummies. Specifically, we use the first quartile dummy as a benchmark and include the other three quartile dummies as the explanatory variables for the probability of capital reduction after the tax reform. Although we do not show the regression results in this study, we find that the third and fourth quartile dummies are negative and more significant than the second quartile dummy. This result indicates that firms with labor productivity larger than or equal to the median value are less likely to reduce their capital after the tax reform.

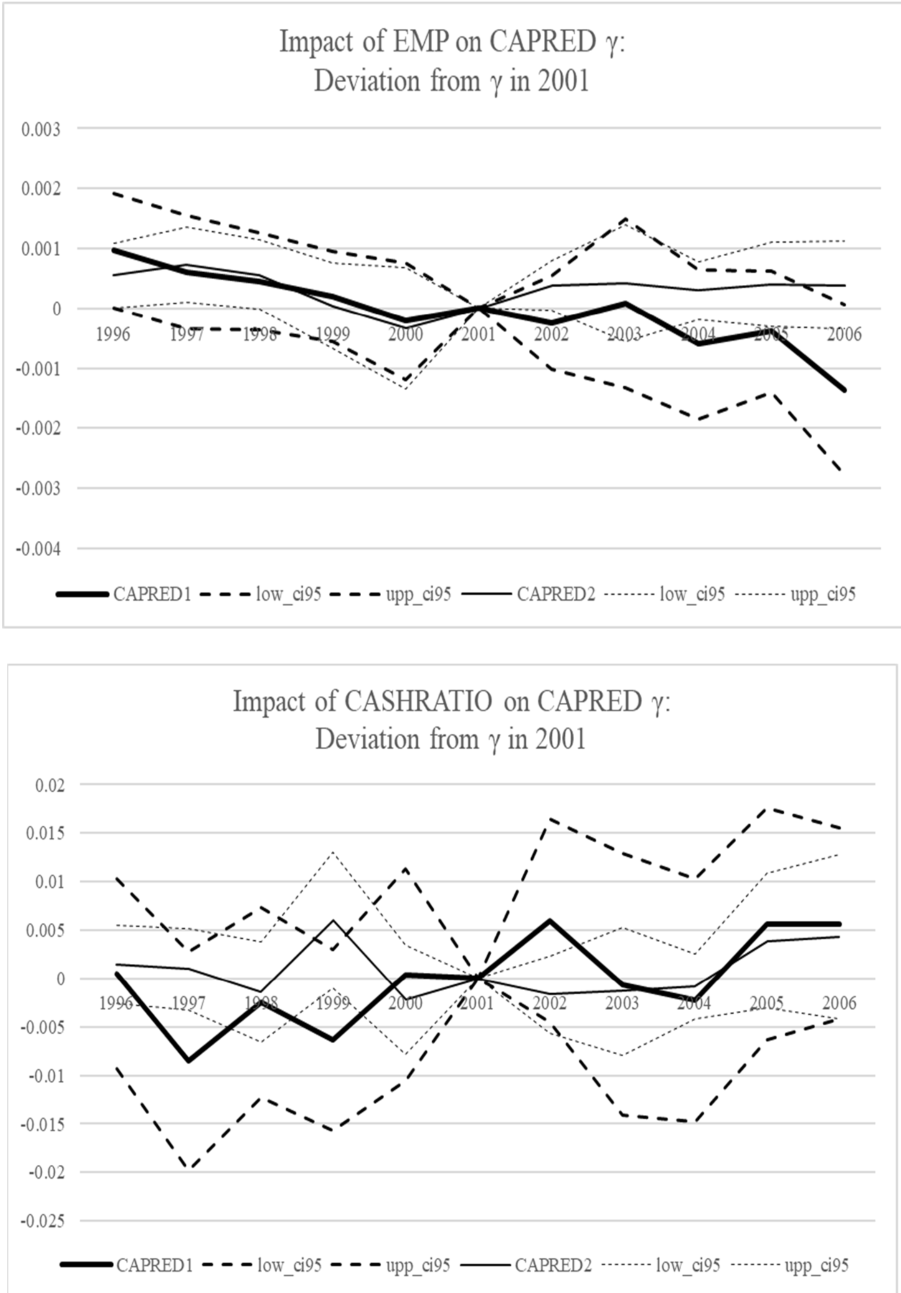


Figure 3 (b): Impact of firms' attributes

Notes: low_ci95 and upp_ci95 denote the lower and upper limit values of the 95% confidence interval, respectively.

Figure 3 (b) shows the estimated γ_j associated with EMP_{it-1} and $CASHRATIO_{it-1}$ for j = 1996–2006 in the cases of Eqs. (8) and (9). As expected, there is no specific trend in the estimated ($\gamma_j - \gamma_{2001}$) associated with these two characteristics before 2001 for $CAPRED1_{it}$ and $CAPRED2_{it}$. The estimated ($\gamma_j - \gamma_{2001}$) does not show a significant change for $CAPRED1_{it}$ after 2001.

5.3 Impact on firm growth and financing

Table 4: Probit estimation

	Dependent variable: CAPRED1(t)									
	2002		2003		2004		2005		2006	
VAPE(t-1)	-0.40	*	0.07		-0.40	***	-0.16		0.001	
	(0.23)		(0.14)		(0.15)		(0.17)		(0.16)	
TAX(t-1)	-0.14		0.17		0.320	**	0.30	*	0.28	*
	(0.19)		(0.13)		(0.13)		(0.16)		(0.16)	
CAPITAL(t-1)	-0.90	***	-1.04	***	-0.53	***	-0.36	**	-0.50	***
	(0.26)		(0.16)		(0.13)		(0.16)		(0.16)	
EMP(t-1)	-0.27	***	0.09		-0.26	***	-0.07		-0.14	**
	(0.09)		(0.07)		(0.06)		(0.08)		(0.07)	
CASHRATIO(t-1)	0.60		-1.07	*	-0.76		1.07	**	-0.16	
	(0.67)		(0.62)		(0.53)		(0.54)		(0.66)	
constant	0.23		-0.34		-1.57		-3.32		-2.11	
	(212.31)		(166.86)		(137.17)		(179.68)		(212.96)	
Industry dummies	Yes		Yes		Yes		Yes		Yes	
Log likelihood	-104.13		-203.60		-219.44		-128.21		-130.00	
Obs	4,129		4,721		5,227		4,494		4,758	
Treated	21		42		46		23		23	
Controls	4,108		4,679		5,181		4,471		4,735	

***, **, and * indicate significance at the 1%, 5%, and 10% levels. Standard errors are in parentheses.

Table 5: Balancing property

2002-2006

	Unmatched sample					Matched sample			
	Mean		T test			Mean		T test	
	Treated	Controls	Diff.	Std. Error		Treated	Controls	Diff.	Std. Error
VAPE(t-1)	0.316	0.423	-0.107	0.040	***	0.316	0.303	0.013	0.053
TAX(t-1)	0.529	0.378	0.151	0.039	***	0.529	0.529	0.000	0.057
CAPITAL(t-1)	5.142	5.691	-0.549	0.048	***	5.142	5.174	-0.032	0.054
EMP(t-1)	4.270	4.910	-0.640	0.088	***	4.270	4.408	-0.138	0.138
CASHRATIO(t-1)	0.152	0.140	0.012	0.010		0.152	0.159	-0.007	0.015
construction	0.277	0.133	0.145	0.027	***	0.277	0.258	0.019	0.050
manufacturing	0.181	0.323	-0.143	0.038	***	0.181	0.142	0.039	0.042
information	0.013	0.073	-0.061	0.021	***	0.013	0.013	0.000	0.013
transportation	0.032	0.050	-0.018	0.018		0.032	0.045	-0.013	0.022
wholesales	0.335	0.265	0.070	0.036	**	0.335	0.329	0.006	0.054
real estate	0.052	0.061	-0.009	0.019		0.052	0.058	-0.006	0.026
corporate_service	0.032	0.034	-0.002	0.015		0.032	0.026	0.006	0.019
restaurant	0.006	0.015	-0.009	0.010		0.006	0.013	-0.006	0.011
personal_service	0.045	0.019	0.026	0.011	**	0.045	0.077	-0.032	0.027
other_service	0.026	0.022	0.004	0.012		0.026	0.039	-0.013	0.020
Obs	155	26,364				155	155		

****, **, and * indicate significance at the 1%, 5%, and 10% levels.*

5.3.1 Average impacts

Table 4 summarizes the results of the probit estimations that we use to match the treated firms with the control firms. From the estimated coefficients of VAPE, TAX, and CAPITAL, we can confirm that firms with lower labor productivity, a positive tax benefit, and less capital are more likely to reduce their capital, which is consistent with the findings presented in the previous subsection. Table 5 summarizes the balancing property before and after the matching. After matching, differences in the mean values of the characteristics in year *t*-1 between the treated and control firms are statistically insignificant. These results show that the matched samples are well balanced in terms of their ex-ante characteristics.

Table 6: DID estimations

Panel A. Size

Outcome	Treated	Controls	Difference	Std. Error	
ASSET(t) - (t-1)	-0.057	0.024	-0.081	0.022	***
ASSET(t+1) - (t-1)	-0.081	0.050	-0.131	0.031	***
ASSET(t+2) - (t-1)	-0.098	0.061	-0.159	0.038	***
TAN(t) - (t-1)	-0.021	0.024	-0.044	0.034	
TAN(t+1) - (t-1)	-0.085	0.076	-0.161	0.050	***
TAN(t+2) - (t-1)	-0.102	0.062	-0.164	0.066	**
EMP(t) - (t-1)	-0.034	0.012	-0.046	0.018	***
EMP(t+1) - (t-1)	-0.064	0.028	-0.092	0.027	***
EMP(t+2) - (t-1)	-0.086	0.038	-0.124	0.035	***
SALES(t) - (t-1)	-0.057	0.013	-0.070	0.022	***
SALES(t+1) - (t-1)	-0.065	0.036	-0.100	0.033	***
SALES(t+2) - (t-1)	-0.107	0.047	-0.154	0.044	***

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel B. Financing

Outcome	Treated	Controls	Difference	Std. Error	
DEBT(t) - (t-1)	-0.045	0.025	-0.070	0.031	**
DEBT(t+1) - (t-1)	-0.072	0.054	-0.126	0.042	***
DEBT(t+2) - (t-1)	-0.100	0.056	-0.156	0.050	***
DEBTRATIO(t) - (t-1)	0.012	0.002	0.010	0.010	
DEBTRATIO(t+1) - (t-1)	0.008	0.007	0.000	0.011	
DEBTRATIO(t+2) - (t-1)	0.003	0.008	-0.005	0.012	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel C. Asset portfolio

Outcome	Treated	Controls	Difference	Std. Error	
CASHRATIO(t) - (t-1)	0.009	-0.005	0.015	0.008	*
CASHRATIO(t+1) - (t-1)	-0.0002	-0.016	0.015	0.009	
CASHRATIO(t+2) - (t-1)	-0.0005	-0.016	0.015	0.011	
TANRATIO(t) - (t-1)	-0.0004	0.004	-0.004	0.008	

TANRATIO(t+1) - (t-1)	-0.001	0.001	-0.001	0.010	
TANRATIO(t+2) - (t-1)	0.005	-0.005	0.010	0.011	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel D. Performance

Outcome	Treated	Controls	Difference	Std. Error	
PROFIT(t) - (t-1)	-0.206	0.409	-0.615	0.183	***
PROFIT(t+1) - (t-1)	-0.269	0.385	-0.654	0.210	***
PROFIT(t+2) - (t-1)	-0.395	0.420	-0.816	0.228	***
VA(t) - (t-1)	-0.108	0.369	-0.477	0.185	**
VA(t+1) - (t-1)	-0.121	0.403	-0.524	0.216	**
VA(t+2) - (t-1)	-0.078	0.450	-0.528	0.233	**
ROA(t) - (t-1)	-0.005	0.011	-0.016	0.005	***
ROA(t+1) - (t-1)	-0.006	0.011	-0.017	0.005	***
ROA(t+2) - (t-1)	-0.005	0.008	-0.013	0.006	**
VARATIO(t) - (t-1)	0.00001	0.012	-0.012	0.006	**
VARATIO(t+1) - (t-1)	-0.0001	0.010	-0.010	0.007	
VARATIO(t+2) - (t-1)	0.008	0.010	-0.002	0.008	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Table 6 summarizes the DID estimation results. Each panel shows the DID estimates for firm size, financing, asset portfolio, and performance. First, Panel A shows that the capital reduction during 2002–2006 resulted in lower subsequent growth and shrinkage in various dimensions of firm size. This shrinkage means that the capital reduction during 2002–2006, which was largely induced by the new taxation, has a negative impact on firm growth. This result supports Hypothesis 2B and indicates the presence of the borrowing constraint. Notably, regardless of the size measure, the negative effects of capital reduction on size tend to increase over time. This finding indicates that these negative effects are not mechanical because of payment of a one-shot dividend at the time of the capital reduction. Moreover, the quantitative impacts of a capital reduction on firm size are substantial. Firms that reduce their capital decrease their assets, tangible fixed assets, number of employees, and sales by 15.9 percentage points (%pts), 16.4%pts, 12.4%pts, and 15.4%pts , respectively, for two years after the capital reduction more than those that do not reduce their capital. These numbers are relatively small compared with the average rate of decrease in capital for the treated group of 42%. Firms may take more than two years to make these adjustments. Moreover, avoiding the taxation results in a relatively large after-tax cash flow, which, in turn, may partly offset the tightening effect of capital reduction.

Second, Panel B shows that a capital reduction causes a decrease in total debt (DEBT), again consistent with Hypothesis 2B, which argues that capital affects the cost or availability of external financing. However, the ratio of total debt to total assets (DEBTRATIO) is not statistically significant. This finding means that the reduction rate in total debt induced by capital reduction is as large as that in total assets.[22]

Third, Panel C shows that the shares of cash holdings and tangible assets in total assets (CASHRATIO and TANRATIO, respectively) do not change after the capital reduction (except for a difference in CASHRATIO in year *t*). These results show that the reduction does not affect firm asset structures because every type of asset decreases almost proportionately to total assets.

Fourth, Panel D shows that the impacts of capital reduction on firm performance as measured by the level of operating profit (PROFIT) and value added (VA) are negative and significantly different from zero. Firm performance measured by the ratio of operating profit to total assets (ROA) and the ratio of value added to sales (VARATIO) also decreases after the capital reduction, which indicates the reduction rate in firm operating profit (and value added in year *t*) is larger than that in total assets (and sales).[23] The shrinkage in firm size induced by the capital

[22] The introduction of an allowance for corporate equity (ACE) in Belgium, where a part of the return on equity is deducted from taxable income, induced firms to reduce their leverage ratio (Hebous and Ruf, 2017; Moore, 2014; Princen, 2012). Although the introduction of the pro forma standard taxation with a tax on value added including interest paid in Japan is expected to induce firms in the control group in our sample to reduce DEBTRATIO, they do not, as Table 6 shows.

[23] Given that operating profits are the sum of after-tax profits, interest paid, and taxes, operating profits may well decrease if interest paid and taxes decrease sufficiently even if after-tax profit increases.

reduction also has some sizable negative impacts on performance, at least over the three-year window.

Table 7: DID estimation by dependence on external finance

Panel A. Size

	Firms with higher RZ index (Obs=74)					Firms with lower RZ index (Obs=78)				
Outcome	Treated	Controls	Difference	Std.Error		Treated	Controls	Difference	Std.Error	
ASSET(t) - (t-1)	-0.092	0.019	-0.111	0.033	***	-0.018	0.025	-0.043	0.029	
ASSET(t+1) - (t-1)	-0.117	0.052	-0.169	0.044	***	-0.044	0.039	-0.084	0.044	*
ASSET(t+2) - (t-1)	-0.137	0.052	-0.188	0.053	***	-0.055	0.062	-0.116	0.055	**
TAN(t) - (t-1)	-0.042	0.064	-0.106	0.052	**	0.007	-0.015	0.022	0.045	
TAN(t+1) - (t-1)	-0.076	0.114	-0.190	0.069	***	-0.086	0.035	-0.121	0.073	*
TAN(t+2) - (t-1)	-0.078	0.077	-0.156	0.094	*	-0.105	0.042	-0.148	0.094	
EMP(t) - (t-1)	-0.048	0.013	-0.061	0.026	**	-0.022	0.007	-0.028	0.023	
EMP(t+1) - (t-1)	-0.099	0.031	-0.131	0.037	***	-0.033	0.017	-0.050	0.039	
EMP(t+2) - (t-1)	-0.147	0.056	-0.203	0.048	***	-0.037	0.010	-0.047	0.051	
SALES(t) - (t-1)	-0.084	0.017	-0.101	0.032	***	-0.035	0.001	-0.036	0.032	
SALES(t+1) - (t-1)	-0.090	0.041	-0.132	0.047	***	-0.040	0.017	-0.058	0.048	
SALES(t+2) - (t-1)	-0.148	0.073	-0.221	0.061	***	-0.072	0.007	-0.079	0.063	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel B. Financing

	Firms with higher RZ index (Obs=74)					Firms with lower RZ index (Obs=78)				
Outcome	Treated	Controls	Difference	Std.Error		Treated	Controls	Difference	Std.Error	
DEBT(t) - (t-1)	-0.091	0.013	-0.104	0.047	**	0.001	0.025	-0.023	0.040	
DEBT(t+1) - (t-1)	-0.132	0.050	-0.182	0.061	***	-0.035	0.040	-0.075	0.056	
DEBT(t+2) - (t-1)	-0.149	0.037	-0.186	0.068	***	-0.070	0.057	-0.127	0.070	*
DEBTRATIO(t) - (t-1)	0.016	-0.006	0.022	0.017		0.009	0.009	0.001	0.013	
DEBTRATIO(t+1) - (t-1)	0.005	0.002	0.003	0.015		0.006	0.011	-0.005	0.016	
DEBTRATIO(t+2) - (t-1)	0.006	-0.001	0.006	0.018		-0.002	0.014	-0.015	0.017	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel C. Asset portfolio

	Firms with higher RZ index (Obs=74)					Firms with lower RZ index (Obs=78)				
Outcome	Treated	Controls	Difference	Std.Error		Treated	Controls	Difference	Std.Error	
CASHRATIO(t) - (t-1)	0.008	0.002	0.006	0.012		0.009	-0.012	0.020	0.011	*
CASHRATIO(t+1) - (t-1)	0.002	-0.019	0.021	0.012	*	-0.005	-0.012	0.008	0.013	
CASHRATIO(t+2) - (t-1)	0.002	-0.011	0.013	0.014		-0.008	-0.021	0.013	0.016	
TANRATIO(t) - (t-1)	0.004	0.008	-0.003	0.010		-0.006	0.00002	-0.006	0.012	
TANRATIO(t+1) - (t-1)	0.012	0.006	0.006	0.014		-0.013	-0.005	-0.007	0.014	
TANRATIO(t+2) - (t-1)	0.016	0.002	0.014	0.016		-0.002	-0.012	0.010	0.016	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel D. Performance

	Firms with higher RZ index (Obs=74)					Firms with lower RZ index (Obs=78)				
Outcome	Treated	Controls	Difference	Std.Error		Treated	Controls	Difference	Std.Error	
PROFIT(t) - (t-1)	-0.238	0.422	-0.660	0.249	***	-0.181	0.396	-0.577	0.277	**
PROFIT(t+1) - (t-1)	-0.339	0.308	-0.647	0.308	**	-0.179	0.458	-0.637	0.299	**
PROFIT(t+2) - (t-1)	-0.655	0.378	-1.033	0.330	***	-0.164	0.450	-0.614	0.327	*
VA(t) - (t-1)	-0.095	0.491	-0.586	0.270	**	-0.147	0.250	-0.397	0.263	
VA(t+1) - (t-1)	-0.232	0.368	-0.600	0.322	*	-0.031	0.428	-0.459	0.302	
VA(t+2) - (t-1)	-0.241	0.436	-0.677	0.337	**	0.056	0.447	-0.391	0.336	
ROA(t) - (t-1)	-0.007	0.011	-0.019	0.006	***	-0.003	0.012	-0.014	0.007	**
ROA(t+1) - (t-1)	-0.006	0.010	-0.017	0.007	**	-0.004	0.012	-0.016	0.008	**
ROA(t+2) - (t-1)	-0.009	0.012	-0.021	0.009	**	-0.003	0.003	-0.006	0.008	
VARATIO(t) - (t-1)	-0.002	0.015	-0.016	0.009	*	-0.001	0.010	-0.011	0.007	
VARATIO(t+1) - (t-1)	-0.004	0.007	-0.011	0.009		0.001	0.013	-0.011	0.010	
VARATIO(t+2) - (t-1)	0.005	0.009	-0.005	0.011		0.009	0.010	-0.001	0.013	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

5.3.2 Cross-sectional heterogeneity with respect to the impact on firm growth and finance

Table 7 shows the results from the DID estimation determined by the level of dependence on external financing. We divide the 155 treated firms into those that are associated with higher and lower industry-level RZ indexes based on the median value of the treated firms (0.35). The control firms are also divided into these two categories, depending on whether their matched treated firm belongs to the higher or lower RZ-index industries. First, Panels A and B show that the DID estimates of the capital reduction for all measures of size and total debt are negative and statistically significant only for firms with a higher industry-level RZ index. Most of the DID estimates are not statistically different from zero for firms that belong to an industry with a lower RZ index. Second, Panel D shows that although the impacts of capital reduction on performance (PROFIT and ROA) are negative and statistically significant for both the higher and lower RZ-index industries, the quantitative impacts in the former are larger than in the latter. Furthermore, the negative impact on VARATIO is statistically significant only for higher RZ industries. These contrasting results between the higher and lower RZ-index industries indicate that due to the capital reduction, firms with greater dependence on external financing experience lower growth in size and debt financing as well as lower performance than do firms with less dependence. These results, especially for firms with higher industry-level RZ indexes, are consistent with Hypothesis 2B.

Table 8: DID estimation by capital reduction size

Panel A. Size

	Firms with higher RZ index (Obs=74)									
	Firms that conduct a larger capital reduction (Obs=34)					Firms that conduct a smaller capital reduction (Obs=40)				
Outcome	Treated	Controls	Difference	Std. Error		Treated	Controls	Difference	Std. Error	
ASSET(t) - (t-1)	-0.113	0.038	-0.151	0.052	***	-0.074	0.003	-0.077	0.041	*
ASSET(t+1) - (t-1)	-0.156	0.091	-0.246	0.070	***	-0.084	0.019	-0.103	0.057	*
ASSET(t+2) - (t-1)	-0.189	0.091	-0.279	0.082	***	-0.093	0.019	-0.111	0.068	
TAN(t) - (t-1)	-0.085	0.130	-0.215	0.099	**	-0.005	0.009	-0.013	0.046	
TAN(t+1) - (t-1)	-0.126	0.185	-0.312	0.130	**	-0.034	0.054	-0.087	0.065	
TAN(t+2) - (t-1)	-0.159	0.195	-0.354	0.162	**	-0.010	-0.023	0.013	0.103	
EMP(t) - (t-1)	-0.065	0.016	-0.081	0.038	**	-0.033	0.011	-0.044	0.036	
EMP(t+1) - (t-1)	-0.114	0.014	-0.128	0.054	**	-0.087	0.046	-0.133	0.051	**
EMP(t+2) - (t-1)	-0.213	0.059	-0.272	0.077	***	-0.090	0.054	-0.144	0.061	**
SALES(t) - (t-1)	-0.088	0.013	-0.101	0.044	**	-0.081	0.020	-0.101	0.046	**
SALES(t+1) - (t-1)	-0.076	0.077	-0.153	0.067	**	-0.103	0.011	-0.114	0.067	*
SALES(t+2) - (t-1)	-0.149	0.114	-0.262	0.086	***	-0.147	0.039	-0.186	0.088	**

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel B. Financing

	Firms with higher RZ index (Obs=74)									
	Firms that conduct a larger capital reduction (Obs=34)					Firms that conduct a smaller capital reduction (Obs=40)				
Outcome	Treated	Controls	Difference	Std. Error		Treated	Controls	Difference	Std. Error	
DEBT(t) - (t-1)	-0.107	0.043	-0.150	0.070	**	-0.078	-0.013	-0.065	0.064	
DEBT(t+1) - (t-1)	-0.171	0.109	-0.279	0.092	***	-0.099	-0.0002	-0.099	0.080	
DEBT(t+2) - (t-1)	-0.206	0.100	-0.306	0.102	***	-0.101	-0.017	-0.084	0.092	
DEBTRATIO(t) - (t-1)	0.019	0.001	0.018	0.032		0.013	-0.012	0.025	0.015	
DEBTRATIO(t+1) - (t-1)	0.003	0.010	-0.008	0.024		0.007	-0.005	0.011	0.018	
DEBTRATIO(t+2) - (t-1)	-0.005	0.003	-0.008	0.029		0.014	-0.004	0.018	0.022	

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel C. Asset portfolio

	Firms with higher RZ index (Obs=74)								
	Firms that conduct a larger capital reduction (Obs=34)					Firms that conduct a smaller capital reduction (Obs=40)			
Outcome	Treated	Controls	Difference	Std. Error		Treated	Controls	Difference	Std. Error
CASHRATIO(t) - (t-1)	0.015	-0.006	0.021	0.023		0.002	0.009	-0.007	0.012
CASHRATIO(t+1) - (t-1)	0.001	-0.012	0.013	0.016		0.002	-0.026	0.029	0.019
CASHRATIO(t+2) - (t-1)	-0.012	-0.004	-0.009	0.019		0.014	-0.017	0.032	0.019
TANRATIO(t) - (t-1)	-0.014	0.014	-0.028	0.016	*	0.019	0.002	0.017	0.013
TANRATIO(t+1) - (t-1)	0.003	0.005	-0.002	0.023		0.019	0.007	0.012	0.016
TANRATIO(t+2) - (t-1)	0.010	0.012	-0.002	0.028		0.021	-0.006	0.028	0.018

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel D. Performance

	Firms with higher RZ index (Obs=74)								
	Firms that conduct a larger capital reduction (Obs=34)					Firms that conduct a smaller capital reduction (Obs=40)			
Outcome	Treated	Controls	Difference	Std. Error		Treated	Controls	Difference	Std. Error
PROFIT(t) - (t-1)	-0.459	0.458	-0.917	0.360	**	-0.050	0.392	-0.441	0.346
PROFIT(t+1) - (t-1)	-0.741	0.397	-1.138	0.441	**	0.002	0.232	-0.230	0.427
PROFIT(t+2) - (t-1)	-0.805	0.605	-1.410	0.464	***	-0.528	0.185	-0.712	0.467
VA(t) - (t-1)	-0.369	0.618	-0.987	0.374	**	0.138	0.384	-0.246	0.386
VA(t+1) - (t-1)	-0.609	0.601	-1.210	0.443	***	0.088	0.170	-0.081	0.459
VA(t+2) - (t-1)	-0.532	0.711	-1.243	0.472	**	0.007	0.202	-0.195	0.476
ROA(t) - (t-1)	-0.011	0.014	-0.025	0.010	**	-0.004	0.009	-0.013	0.008
ROA(t+1) - (t-1)	-0.012	0.011	-0.023	0.011	**	-0.002	0.010	-0.011	0.010
ROA(t+2) - (t-1)	-0.017	0.019	-0.036	0.013	***	-0.002	0.006	-0.008	0.011
VARATIO(t) - (t-1)	-0.007	0.023	-0.031	0.015	**	0.003	0.008	-0.004	0.011
VARATIO(t+1) - (t-1)	-0.018	0.017	-0.034	0.014	**	0.009	-0.001	0.010	0.012
VARATIO(t+2) - (t-1)	0.006	0.024	-0.018	0.018		0.003	-0.003	0.007	0.013

***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Table 8 shows the results of the DID estimation that depends on the size of the capital reduction for firms with higher dependence on external financing. Specifically, we focus on the 74 treated firms with higher industry-level RZ indexes and divide them into two groups that depend on whether capital at the end of year *t*-1 is greater or less than the median level of the treated firms (JPY 150 million). Then, we divide the control firms into these two categories, depending on whether their matched treated firm's capital reduction is large or small. The impacts of capital reduction on all measures of size, total debt, and performance are negative and significant for firms that conduct a large capital reduction, while most of the impacts are not statistically different from zero for firms that conduct a small capital reduction. These results are consistent with Hypothesis 3, which indicates firms that engage in a large capital reduction encounter higher financial costs and experience lower growth in size and debt finance as well as lower performance than do firms that engage in a small capital reduction.

6. Conclusion

As an example of a size-dependent tax system associated with financial activities, we use the introduction of a pro forma standard taxation system in Japan, which exempts firms (SMEs) whose stated capital is at or below a threshold from taxation. We empirically examine how firms react to this institutional change and how such a reaction systematically affects their financing and real outcomes.

The estimation guided by our theoretical model, which features the firms' borrowing constraint, provides the following results. First, firms that originally held capital above the threshold become more likely to reduce their capital to or below the actual threshold level after the announcement of the new tax system. Second, firms with lower labor productivity, positive potential tax benefits, and smaller capital are more likely to do so. Third, firms that reduce their capital show lower ex-post growth in asset size, number of employees, and sales, the magnitude of which become larger over time. Quantitatively, firms that reduce their capital and yet survive for at least two years subsequent to the reduction on average decrease their assets, number of employees, and sales by 15.9%pts, 12.4%pts, and 15.4%pts, respectively, more than those that do not change their capital. Fourth, capital reduction has a negative impact on total debt. Meanwhile, there are no significant impacts on the cash-to-total asset ratio, debt-to-asset ratio, and ratio of tangible fixed assets to total assets. Fifth, firms that reduce their capital also show lower ex-post performance in operating profit and value added. Finally, firms that belong to industries with greater dependence on external financing, especially firms that conduct a larger capital reduction, show more significant decreases in their size and debt. These results are consistent with the theory that borrowing constraints are affected by capital. The results show that the size-dependent tax policy induces firm capital reductions, which has substantial negative impacts on firm growth and distorts financing.

This study shows that finance-based size-dependent tax policies can have a significant impact on firm growth and financing as firms decide whether to reduce their capital by considering the tradeoff between more severe borrowing constraints (if any) and a smaller tax burden. The results obtained in this study suggest that such indirect effects of a finance-based size-dependent policy on firm dynamics should be considered when designing tax policy. Moreover, governments should understand that an institutional change in their tax systems generates a heterogeneous reaction from firms, as detailed above, and, thus, have heterogeneous impacts on firm dynamics.

As important future research questions, it is desirable to check the external validity of our results focusing on other finance-based size-dependent tax policies in Japan and other countries.[24] We should also note that while we shed new lights on a dark side of finance-based size-dependent

[24] In Japan, the size-dependent policy based on the stated capital is used in the national tax system as well as in the local tax system this study focuses on. After the introduction of the pro forma standard taxation in 2004, the central government expanded tax preferences for SMEs, which are firms with capital at or below the threshold, in the corporate income tax system. For example, in 2009, the government lowered the corporate income tax rate on the part of the SMEs' income that is less than or equal to 8 million JPY. From 2012 to 2018, the government gradually decreased the deductible limit for losses carried forward applying to large corporations.

tax policies, we do not effectively evaluate their effects on saving compliance costs and other possible benefits on SMEs, which are left for future researches.

REFERENCES

Almeida, H., Vyacheslav F., Kronlund, M., 2016. The real effects of share repurchases. J. Financ. Econ. 119(1), 168–85. https://doi.org/10.1016/j.jfineco.2015.08.008.

Almunia, M., Lopez-Rodriguez, D., 2018. Under the radar: The effects of monitoring firms on tax compliance. Am. Econ. J- Econ. Polic. 10(1), 1–38. https://doi.org/10.1257/pol.20160229.

Bernanke, B., Gertler, M., Gilchrist, S., 1999. The financial accelerator in a quantitative business cycle framework, In: Handbook of Macroeconomics. North Holland, pp. 1341–93.

Bergner, S., Brautigam, R., Evers, M.T., Spengel, C., 2017. The use of SME tax incentives in the European Union. SSRN Electronic Journal, ZEW - Centre for European Economic Research Discussion Paper No. 17-006. https://doi.org/10.2139/ssrn.2910339.

Buera, F.J., Kaboski, J.P., Shin, Y., 2011. Finance and development: A tale of two sectors. Am. Econ. Rev. 101 (5), 1964–2002. https://doi.org/10.1257/aer.101.5.1964.

Buera, F.J., Shin, Y., 2013. Financial frictions and the persistence of history: A quantitative exploration. J. Polit. Econ. 121 (2), 221–272. https://doi.org/10.1086/670271.

Chetty, R., Friedman, J.N., Olsen, T., Pistaferri, L., 2011. Adjustment costs, firm responses, and micro vs. macro labor supply elasticities: Evidence from Danish tax records. Q. J. Econ. 126(2), 749–804. https://doi.org/10.1093/qje/qjr013.

Crawford, C., Freedman, J., 2010. Small business taxation, in: Adam, S., Besley, T., Blundell, R., Bond, S., Chote, R., Gammie, M., Johnson, P., Myles, G., Poterba, J.M., (Eds.), Dimensions of Tax Design: The Mirrlees Review. Oxford Legal Studies Research Paper No. 25/2011. Oxford University Press, London. https://www.ifs.org.uk/uploads/mirrleesreview/dimensions/ch11.pdf

Devereux, M.P., Liu, L., Loretz, S., 2014. The elasticity of corporate taxable income: New evidence from UK tax records. Am. Econ. J-Econ. Polic. 6(2), 19–53. https://doi.org/10.1257/pol.6.2.19.

Garicano, L., Lelarge, C., Van Reenen, J., 2016. Firm size distortions and the productivity distribution: Evidence from France. Am. Econ. Rev. 106 (11), 3439–79. https://doi.org/10.1257/aer.20130232.

Gourio, F., Roys, N., 2014. Size-dependent regulations, firm size distribution, and reallocation. Quant. Econ. 5(2), 377–416. https://doi.org/10.3982/qe338.

Guner, N., Ventura, G., Xu, Y., 2008. Macroeconomic implications of size-dependent policies. Rev. Econ. Dynam. 11(4), 721–44. https://doi.org/10.1016/j.red.2008.01.005.

Harju, J., Matikka, T., Rauhanen, T., 2019. Compliance costs vs. tax incentives: Why do entrepreneurs respond to size-based regulations? J. Public Econ. 173, 139–164. https://doi.org/10.1016/j.jpubeco.2019.02.003

Hebous, S., Ruf, M., 2017. Evaluating the effects of ACE systems on multinational debt financing and investment. J. Public Econ. 156, 131–49. https://doi.org/10.1016/j.jpubeco.2017.02.011.

Hosono, K., Takizawa, M., 2015. Misallocation and establishment dynamics. Discussion Papers

15011. Research Institute of Economy, Trade and Industry (RIETI). https://ideas.repec.org/p/eti/dpaper/15011.html

Hosono, K., Takizawa, M., Yamanouchi, K., 2017. Competition, uncertainty, and misallocation. Discussion Papers 17071. Research Institute of Economy, Trade and Industry (RIETI). https://ideas.repec.org/p/eti/dpaper/17071.html

Kanbur, R., Keen, M., 2014. Thresholds, informality, and partitions of compliance. Int. Tax Public Financ. 21(4), 536–59. https://doi.org/https://doi.org/10.1007/s10797-014-9314-3.

Keen, M., Mintz, J., 2004. The optimal threshold for a value-added tax. J. Public Econ. 88 (3-4), 559–76. https://doi.org/10.1016/s0047-2727(02)00165-2.

Kleven, H.J., Waseem, W., 2013. Using notches to uncover optimization frictions and structural elasticities: Theory and evidence from Pakistan. Q. J. Econ. 128(2), 669–723. https://doi.org/10.1093/qje/qjt004.

Liu, L., Lockwood, B., Almunia, M., Tam, E.H.F., 2018. VAT Notches, Voluntary Registration, and Bunching: Theory and UK Evidence (version November 2018). The University of Warwick.

https://warwick.ac.uk/fac/soc/economics/staff/blockwood/vat_notches_nov2018.pdf.

Matsuyama, K., 2008. Aggregate implications of credit market imperfections, in: Acemoglu, D., Rogoff, K., Woodford, M. (eds.) NBER Macroeconomics Annual 2007. University of Chicago Press, Chicago, pp. 1–60.

Moore, N., 2014. Taxes and corporate financing decisions evidence from the Belgian Ace reform. SSRN Electronic Journal. Ruhr Economic Paper No. 533. https://doi.org/10.2139/ssrn.2579681.

OECD. 2015. Taxation of SMEs in OECD and G20 Countries." OECD Tax Policy Studies. https://doi.org/10.1787/9789264243507-en.

Onji, K., 2009. The response of firms to eligibility thresholds: Evidence from the Japanese value-added tax. J. Public Econ. 93(5-6), 766–75. https://doi.org/10.1016/j.jpubeco.2008.12.003.

Princen, S., 2012. Taxes do affect corporate financing decisions: The case of Belgian ACE (version January 2012). CESifo Working Paper Series No. 3713. https://ssrn.com/abstract=1992330.

Rajan, R., Zingales, L., 1998. Financial dependence and growth. Am. Econ. Rev. 88(3), 559–86. https://www.jstor.org/stable/116849.

Saez, E., 2010. Do taxpayers bunch at kink points? Am. Econ. J-Econ. Policy. 2(3), 180–212. https://doi.org/10.1257/pol.2.3.180.

Online Appendix A: Classification of capital reduction

Table A1 shows the conditions used to classify capital reduction into three types.

TABLE A1: CONDITIONS FOR CLASSIFYING CAPITAL REDUCTION

	A. Earned surplus carried forward at the end of year *t*-1	B. Change in adjusted capital surplus/Decrease in stated capital (the absolute value) in year *t*	C. Change in earned surplus – Net profit in year *t*
1. Paid out	A≥ 0	B< 1	-
	A< 0	B< 1	C≤ 0
2. Loss-offsetting	A< 0	B< 1	C> 0
3. Item-changing	-	B= 1	-
4. Others	-	B> 1	-

Notes: Capital surplus = Capital reserve + Other capital surplus; Adjusted capital surplus = Capital surplus – Treasury stock; Earned surplus = Earned reserve + Voluntary earned reserve + Earned surplus carried forward

Source: Authors' definition

Paid out capital reduction

A paid out capital reduction is defined as the amount of capital reduced to refund cash to shareholders. We regard a firm as conducting a paid out capital reduction in year *t* if the following conditions are satisfied: 1. earned surplus carried forward at the end of year *t*-1 is positive or equal to zero (A≥0) and 2. adjusted capital surplus (capital surplus - treasury stock) increases less than the amount of the stated capital reduction in year *t*

(B<1). Condition 2 indicates that at least part of the capital reduction is not added to the capital surplus but is returned to shareholders. In addition, we also regard a firm as conducting a paid out capital reduction if the following conditions are satisfied: 1. earned surplus carried forward at the end of year *t*-1 is negative (A<0), 2. adjusted capital surplus increases less than the amount of the stated capital reduction in year *t* (B<1), and, 3. earned surplus does not increase in year *t* before net profit in year *t* is added to it (C≤0). Conditions 2 and 3 indicate that at least part of the capital reduction is not used to offset accumulated losses but is returned to shareholders.

Loss-offsetting capital reduction

A loss-offsetting capital reduction is defined as the amount of capital reduced to offset accumulated losses. We regard a firm as conducting a loss-offsetting capital reduction in year *t* if the following conditions are satisfied: 1. earned surplus carried forward at the end of year *t*-1 is negative (A<0), 2. adjusted capital surplus increases less than the amount of the stated capital reduction in year *t* (B<1), and 3. earned surplus increases in year *t* before net profit in year *t* is added to it (C>0). Conditions 2 and 3 indicate that at least part of the capital reduction is not added to the capital surplus but used to offset accumulated losses.

Item-changing capital reduction

An item-changing capital reduction is defined as the amount of capital reduced to increase capital surplus by exactly the same amount. We regard a firm as conducting an item-changing capital reduction in year t if the following condition is satisfied: adjusted capital surplus increases by exactly the same amount as the stated capital reduction in year t (B=1). This condition indicates that part of the capital reduction is not returned to shareholders but added to the capital surplus.

Online Appendix B: Proofs of Propositions

Proof of Proposition 1A.

We obtain the after-tax profit under the tax system (Eq. (5)), from Eqs. (1), (3) and (4), as shown in Eq. (A1):

(A1) $\pi = (1-\tau_L-\tau_V)\left(\mathrm{A}k^{\alpha}l^{\beta}m^{\gamma}-\mathrm{pm}\right)-(1-\tau_L)\{(\delta+\mathrm{r})\mathrm{k}+\mathrm{wl}\}-(\tau_L r+\tau_E)\mathrm{e}.$

This problem can be decomposed in two steps. First, we solve for the optimal *l* and *m* given *k*, and then we solve for the optimal *k*. The first step leads to the output and after-tax profit as a function of *k* as shown in Eqs. (A2) and (A3):

(A2) $$y=\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}} a^{\frac{1}{1-\beta-\gamma}} \left(\frac{\alpha}{\delta+r}\right)^{\frac{-\alpha}{1-\beta-\gamma}} k^{\frac{\alpha}{1-\beta-\gamma}},$$

and

(A3) $$\pi=(1-\beta-\gamma)(1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}} a^{\frac{1}{1-\beta-\gamma}} \left(\frac{\alpha}{\delta+r}\right)^{\frac{-\alpha}{1-\beta-\gamma}} k^{\frac{\alpha}{1-\beta-\gamma}}$$

$$-(1-\tau_L)\{(\delta+\mathrm{r})\mathrm{k}+(1+\mathrm{r})\mathrm{f}\}-(\tau_L r+\tau_E)e,$$

where

(A4) $$a = A\left(\frac{\alpha}{\delta+r}\right)^{\alpha}\left(\frac{\gamma}{p}\right)^{\gamma}\left(\frac{\beta}{w}\right)^{\beta}.$$

Given e, the firm chooses k to maximize Eq. (A3) under the borrowing constraint (Eq. (2)). If the constraint is not binding, the first order condition (FOC) is shown in Eq. (A5):

(A5) $$\mathrm{k}^{u}(a) = \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{1-\gamma}{1-\alpha-\beta-\gamma}} a^{\frac{1}{1-\alpha-\beta-\gamma}}\left(\frac{\alpha}{\delta+r}\right),$$

where the superscript u denotes the unconstrained optimum. If the borrowing constraint is binding, Eq. (2) holds with equality

(A6) $$k^{c} = \lambda e,$$

where the superscript c in Eq. (A6) denotes the constrained optimum.

While $k^{u}(a)$ is an increasing function of a with $k^{\mathrm{u}}(0) = 0$, k^{c} does not depend on a, and $k^{c} > 0$, which indicates there is a threshold value of a (i.e., $\bar{a}$) that equates $k^{u}(a)$ and k^{c}. Substituting Eq. (A4) into Eq. (A5), we get

$$\bar{a}(e) = (\lambda e)^{1-\alpha-\beta-\gamma} \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\gamma-1} \left(\frac{\alpha}{\delta+r}\right)^{-(1-\alpha-\beta-\gamma)},$$

which leads to the threshold value of A, where

(A7) $$\bar{A}(e) = (\lambda e)^{1-\alpha-\beta-\gamma} \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\gamma-1} \left(\frac{\alpha}{\delta+r}\right)^{-(1-\beta-\gamma)} \left(\frac{\gamma}{p}\right)^{-\gamma} \left(\frac{\beta}{w}\right)^{-\beta}.$$

It is clear from Eq. (A7) that $\bar{A}(e)$ is an increasing function of e.

QED.

Proof of Proposition 1B.

Replacing τ_L, τ_V, and e in Proposition 1A with τ_H, 0, and $\bar{e}$, respectively, we obtain Proposition 1B, where

(A8) $$\bar{\bar{A}}(\bar{e}) = (\lambda \bar{e})^{1-\alpha-\beta-\gamma} \left(\frac{\alpha}{\delta+r}\right)^{-(1-\beta-\gamma)} \left(\frac{\gamma}{p}\right)^{-\gamma} \left(\frac{\beta}{w}\right)^{-\beta}.$$

QED.

Proof of Corollary 1.

From Eqs. (A7) and (A8),

$$\frac{\bar{A}(e)}{\bar{\bar{A}}(\bar{e})} = \left(\frac{e}{\bar{e}}\right)^{1-\alpha-\beta-\gamma} \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\gamma-1} > 1$$

because $e > \bar{e}$ and $\tau_V > 0$.

QED.

Proof of Proposition 2A.

Suppose that the borrowing constraint is not binding either before or after the capital reduction. Then, substituting Eq. (A4) into Eq. (A2), we obtain the pre-capital reduction profit as shown in Eq. (A9):

(A9) $\pi_U^{pre} = (1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta-\gamma}}(1-\alpha-\beta-\gamma)a^{\frac{1}{1-\alpha-\beta-\gamma}} - (\tau_L r + \tau_E)e.$

The post-capital reduction profit is expressed in Eq. (A10):

(A10) $\pi_U^{post} = (1-\tau_H)(1-\alpha-\beta-\gamma)a^{\frac{1}{1-\alpha-\beta-\gamma}} - \tau_H r\bar{e}$

The change in profit is represented by Eq. (A11):

(A11) $\Delta\pi_U = \pi_U^{post} - \pi_U^{pre}$

$$= (1-\alpha-\beta-\gamma)a^{\frac{1}{1-\alpha-\beta-\gamma}}\left\{(1-\tau_H)-(1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta-\gamma}}\right\}$$

$$-\tau_H r\bar{e} + (\tau_L r + \tau_E)e.$$

Under Assumption 1, the value in the bracket in (A11) is negative, and indicates that if $-\tau_H r\bar{e} + (\tau_L r + \tau_E)e > 0$, there is a threshold value of a, $\hat{a}(e,\bar{e})$, such that $\Delta\pi_U > 0$ for $a < \hat{a}(e,\bar{e})$ and $\Delta\pi_U \leq 0$ if $a \geq \hat{a}(e,\bar{e})$. However, if $-\tau_H r\bar{e} + (\tau_L r + \tau_E)e \leq 0$, then $\Delta\pi_U < 0$ for any a. The associated threshold value of A is

(A12) $\hat{A}(e,\bar{e}) =$

$$\left[\frac{-\{-\tau_H r\bar{e}+(\tau_L r+\tau_E)e\}}{(1-\alpha-\beta-\gamma)\left\{(1-\tau_H)-(1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta-\gamma}}\right\}}\right]^{1-\alpha-\beta-\gamma} \left(\frac{\alpha}{\delta+r}\right)^{-\alpha}\left(\frac{\beta}{w}\right)^{-\beta}\left(\frac{\gamma}{p}\right)^{-\gamma}.$$

Since the denominator in the square bracket in Eq. (A12) is negative, it is evident that $\hat{\boldsymbol{A}}(\boldsymbol{e},\bar{e})$ is increasing in *e* and decreasing in $\bar{e}$.

QED.

Proof of Proposition 2B.

First, note that under Assumption 1, as shown in Eq. (A13)

(A13) $$(1-\tau_L-\tau_V)^{1-\gamma} > (1-\tau_L)^{\beta}(1-\ \tau_H)^{1-\beta-\gamma},$$

because $\frac{(1-\tau_L)^{\alpha+\beta}(1-\tau_H)^{1-\alpha-\beta-\gamma}}{(1-\tau_L)^{\beta}(1-\tau_H)^{1-\beta-\gamma}} = \left(\frac{1-\tau_L}{1-\tau_H}\right)^{\alpha}$ >1. Next, substituting Eq. (A6) into Eq. (A3), we obtain the pre-capital reduction profit as

$$\pi_C^{pre} = (1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(1-\beta-\gamma)a^{\frac{1}{1-\beta-\gamma}}\left(\frac{\alpha}{\delta+r}\right)^{\frac{-\alpha}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}} - (\tau_L r+\tau_E)e.$$

The post-capital reduction profit is

$$\pi_C^{post} = (1-\tau_H)(1-\beta-\gamma)a^{\frac{1}{1-\beta-\gamma}}\left(\frac{\alpha}{\delta+r}\right)^{\frac{-\alpha}{1-\beta-\gamma}}(\lambda\bar{e})^{\frac{\alpha}{1-\beta-\gamma}} - \tau_H r\bar{e} - (1-\tau_H)(1+\mathrm{r})\mathrm{f} - \tau_H r\bar{e}.$$

The change in profit shown in Eq. (A14) is

(A14) $\Delta\pi_C = \pi_C^{post} - \pi_C^{pre} = (1-\beta-\gamma)a^{\frac{1}{1-\beta-\gamma}}\left(\frac{\alpha}{\delta+r}\right)^{\frac{-\alpha}{1-\beta-\gamma}}\left[(1-\tau_H)(\lambda\bar{e})^{\frac{\alpha}{1-\beta-\gamma}} - (1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}}\right] - \tau_H r\bar{e} + (\tau_L r + \tau_E)e.$

Note that from Eq. (A13), the value in the square bracket in Eq. (A14) is negative. Suppose, first, that $(\tau_L r + \tau_E)e > \tau_H r\bar{e}$; then, $\Delta\pi_C > 0$ if $a < \tilde{a}(e,\bar{e})$, and $\Delta\pi_C < 0$ if $a > \tilde{a}(e,\bar{e})$, where

$$\tilde{a}(e,\bar{e}) = (1-\beta-\gamma)^{-(1-\beta-\gamma)}\left(\frac{\alpha}{\delta+r}\right)^{\alpha}$$

$$\left[\frac{-\{-\tau_H r\bar{e} + (\tau_L r + \tau_E)e\}}{(1-\tau_H)(\lambda\bar{e})^{\frac{\alpha}{1-\beta-\gamma}} - (1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}}}\right]^{1-\beta-\gamma}.$$

Suppose next that $(\tau_L r + \tau_E)e \leq \tau_H r\bar{e}$, then $\Delta\pi_C < 0$ for any a. The associated threshold value of A is

$$\tilde{A}(e,\bar{e}) = (1-\beta-\gamma)^{-(1-\beta-\gamma)}\left(\frac{\beta}{w}\right)^{-\beta}\left(\frac{\gamma}{p}\right)^{-\gamma}$$

$$\left[\frac{-\{-\tau_H r\bar{e} + (\tau_L r + \tau_E)e\}}{(1-\tau_H)(\lambda\bar{e})^{\frac{\alpha}{1-\beta-\gamma}} - (1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}}}\right]^{1-\beta-\gamma}.$$

Differentiating $\tilde{A}(e,\bar{e})$ with respect to e yields

$$\frac{\partial \tilde{A}(e,\bar{e})}{\partial \mathrm{e}}$$

$$= (1-\beta-\gamma)^{-(1-\beta-\gamma)}\left(\frac{\beta}{w}\right)^{-\beta}\left(\frac{\gamma}{p}\right)^{-\gamma}(1-\beta$$

$$-\gamma)\left[\frac{-\{-\tau_H r\bar{e}+(\tau_L r+\tau_E)e\}}{(1-\tau_H)(\lambda\bar{e})^{\frac{\alpha}{1-\beta-\gamma}}-(1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}}}\right]^{-\beta-\gamma}$$

$$\left\{(1-\tau_H)(\lambda\bar{e})^{\frac{\alpha}{1-\beta-\gamma}}-(1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}}\right\}^{-2}$$

$$\left[-(\tau_L r+\tau_E)\left\{(1-\tau_H)(\lambda\bar{e})^{\frac{\alpha}{1-\beta-\gamma}}-(1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}}\right\}-\right.$$

$$\left.\{-\tau_H r\bar{e}+(\tau_L r+\tau_E)e\}\left(\frac{\alpha}{1-\beta-\gamma}\right)\left\{-(1-\tau_L-\tau_V)\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\beta}{1-\beta-\gamma}}(\lambda e)^{\frac{\alpha}{1-\beta-\gamma}-1}\right\}\lambda\right].$$

If $(\tau_L r+\tau_E)e<\tau_H r\bar{e}$, then $\frac{\partial \tilde{A}(e,\bar{e})}{\partial e}>0$. If $(\tau_L r+\tau_E)e\geq\tau_H r\bar{e}$, then $\frac{\partial \tilde{A}(e,\bar{e})}{\partial e}$ may be positive, zero, or negative.

QED.

Proof of Proposition 3A.

Let k_U^{pre} and k_U^{post} denote the optimal capital stock before and after capital reduction, respectively, in the case where the borrowing constraint is not binding. From Eq. (A4), we obtain Eq. (A15)

$$\text{(A15)}\quad k_U^{pre} = \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{1-\gamma}{1-\alpha-\beta-\gamma}} a^{\frac{1}{1-\alpha-\beta-\gamma}} \left(\frac{\alpha}{\delta+r}\right) < k_U^{post} = a^{\frac{1}{1-\alpha-\beta-\gamma}} \left(\frac{\alpha}{\delta+r}\right).$$

Substituting Eq. (A4) into Eq. (A2) yields Eq. (A16):

$$\text{(A16)}\qquad y_U^{pre} = \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta-\gamma}} a^{\frac{1}{1-\alpha-\beta-\gamma}}.$$

Similarly,

$$\text{(A17)}\qquad y_U^{post} = a^{\frac{1}{1-\alpha-\beta-\gamma}}.$$

Comparing Eqs. (A16) and (A17) yields $y_U^{pre} < y_U^{post}$.

Let D_U^{pre} and D_U^{post} denote the firm's debt before and after capital reduction, respectively. Then, from Eq. (A15) and $e > \bar{e}$, we obtain

$$D_U^{pre} = k_U^{pre} - e < D_U^{post} = k_U^{post} - \bar{e}$$

QED.

Proof of Proposition 3B

First, let k_C^{pre} and k_C^{post} denote the optimal capital stock before and after capital reduction, respectively, in the case where the borrowing constraint is binding. From Eq. (A6) and its post-capital reduction counterpart, we obtain Eq, (A18):

(A18) $$\frac{k_c^{post}}{k_c^{pre}} = \frac{\bar{e}}{e} < 1$$

Substituting Eq. (A6) into Eq. (A2) yields

$$y_c^{pre} = \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right) \quad a^{\frac{1}{1-\beta-\gamma}} \left(\frac{\alpha}{\delta+r}\right)^{\frac{-\alpha}{1-\beta-\gamma}} (\lambda e)^{\frac{\alpha}{1-\beta-\gamma}}.$$

Similarly,

$$y_c^{post} = a^{\frac{1}{1-\beta-\gamma}} \left(\frac{\alpha}{\delta+r}\right)^{\frac{-\alpha}{1-\beta-\gamma}} (\lambda \bar{e})^{\frac{\alpha}{1-\beta-\gamma}}.$$

Comparing the two equations above yields Eq. (A19):

(A19) $$\frac{y_c^{post}}{y_c^{pre}} = \left[\frac{\left(\frac{\bar{e}}{e}\right)^{\alpha}}{\left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\beta}}\right]^{\frac{1}{1-\beta-\gamma}} < 1 \text{ if and only if } \left(\frac{1-\tau_L-\tau_V}{1-\tau_L}\right)^{\beta} > \left(\frac{\bar{e}}{e}\right)^{\alpha}.$$

Next, let D_C^{pre} and D_C^{post} denote the firm's debt before and after capital reduction, respectively. Then, we obtain Eq. (A20):

(A20) $$\frac{D_C^{post}}{D_C^{pre}} = \frac{k_C^{post} - \bar{e}}{k_C^{pre} - \mathrm{e}} = \frac{(\lambda-1)\bar{e}}{(\lambda-1)e} = \frac{\bar{e}}{e} < 1$$

QED.

Online Appendix C: Simulation results of the extended model

Setup

We extend the model in two ways. First, we introduce a fixed operating cost f that generates negative profits for very low-productivity firms and allows such firms to avoid corporate income taxes. The financial intermediaries lend financial resources that account for f to the firm. The f and its associated interest rate payment, $(1 + r)f$, are regarded as operating and financial costs and, hence, are tax deductible.

Next, we allow the borrowing constraint to depend on the firm's cash flow as well as its capital by following the formulation used in Buera et al. (2011). Thus, we assume that if the firm reneges on the borrowing contract and the rental contract of physical capital, it can keep only the fraction $(1 - \phi)$ of the revenue net of labor payments, intermediate payments, and taxes, as well as the undepreciated physical capital. Under this new setting, for the borrowing and rental contracts to be incentive compatible, the following inequality (Eq. (A21)) must hold, and now replaces constraint (2):

(A21) $$y - (r + \delta)k - wl - pm - (1 + r)f - T + (1 + r)e$$

$$\geq (1 - \phi)(y - wl - pm - T + (1 - \delta)k)$$

Constraint (A21) means that if the firm can decrease tax payments by reducing capital, then the firm's borrowing constraint loosens due to higher after-tax cash flow, although the capital reduction itself tightens the constraint.

This extended model has two sources of nonlinearity. One comes from the nonlinear tax rate on corporate income (4) and the other from the borrowing constraint (A21). Due to these two sources of nonlinearity, we need to rely on a numerical method to characterize the solution.

Parameters

We set the production technology parameters to match the evidence from Japan. Specifically, we use the estimates by Hosono, Takizawa, and Yamanouchi (2017), who use plant-level data from Japanese manufacturing industries and estimate the production function and markup for each 4-digit industry. Their average estimates show $(\alpha, \beta, \gamma) = (0.06, 0.41, 0.53) * \left(1 - \frac{1}{3.4}\right)$; thus, the return to scale in variable factors is 0.706. We set the depreciation rate and interest rate at conventional values, $(r, \delta) = (0.065, 0.1)$.

We set the tax rates to the actual rates after the introduction of the pro forma standard taxation: $(\tau_L, \tau_V, \tau_E, \tau_H) = (0.4239, 0.0048, 0.002, 0.4479)$.[1]

The borrowing constraint parameter is hard to set; thus, we use two alternative values: $\phi = 0.5$ and 0.6. We fix the threshold value of capital ($\bar{e}$) and set the initial capital (e) and productivity (A) at a range of values because the decision whether to reduce capital and the consequences of reducing capital depend on these key parameters. Specifically, we examine the following three cases: In Cases 1 and 2, we see how the changes in after-tax profit and firm size due to capital reduction depend on productivity (A) by fixing the initial capital (e). In Case 1, we set $\phi = 0.6$ so that the borrowing constraint is not binding either when capital is kept at the initial level or when capital is reduced to the threshold level for the range of A where the firm gains from reducing capital. In Case 2, we set $\phi = 0.5$ so that the borrowing constraint is binding in both cases for the relevant range of A. In Case 3, we see how the changes in after-tax profit and firm size due to capital reduction depend on the initial capital (e) by fixing productivity (A). In this case, we set $\phi = 0.5$ so the borrowing constraint is binding in both cases for the range of e that we consider.

[1] Note that τ_L and τ_H are simple sums of the local tax rates and the national tax rate on corporate income. Although local tax payments are deductible from the base of national corporate income tax, there is no simple formula for this reduction after the introduction of pro forma standard taxes.

In Cases 1 and 2, we vary the productivity parameter A in the range of $A \in [0.6, 0.9]$.[2] We set the fixed cost *f* as 0.15, which results in $\pi < 0$ for very low values of A and $\pi > 0$ for middle-to-high values of A in the range of A under consideration. The other factor prices, w and p, affect the results only by scaling A. We borrow them from Hosono et al. (2017): $(\mathrm{w}, \mathrm{p}) = (0.193, 0.193)$.[3] We set the initial capital as $\mathrm{e} = 0.14$, the threshold value as $\bar{\mathrm{e}} = 0.13$, and the borrowing constraint parameter as $\phi = 0.6$ (in Case 1) or 0.5 (in Case 2). In Case 3, we adopt the same values of *f*, (w, p), and $\bar{\mathrm{e}}$ as in Cases 1 and 2, set A=0.7, $\phi = 0.5$, and vary the initial capital e in the range of $\mathrm{e} \in [\,0.14, 0.16]$.

Solution Method

We describe how we consider the nonlinearity of taxes on corporate income. Assuming that $\pi^{pre} > 0$, we obtain the optimal k as Eq. (A22):

(A22) $$\mathrm{k}^{+}(\mathrm{A}, \mathrm{e}) = \min\{\mathrm{k}^{u}(A),\ k^{c}(A, e)\},$$

[2] We set this range of productivity because it turns out that in this range, the borrowing constraint is not binding either before or after capital reduction in Case 1 and it is binding both before and after capital reduction in Case 2.

[3] These parameters were set to standardize the profit function.

where the superscript indicates that the optimal k is derived under the (tentative) assumption that $\pi^{pre} > 0$. We check this assumption by calculating π^{pre} using k^{+}, which we denote by $\pi^{pre}(k^{+})$.

We repeat the process above assuming that $\pi^{pre} < 0$ and obtain the optimal k denoted by k^{-}. We calculate $\pi^{pre}(k^{-})$.

Finally, we obtain the optimal k as follows.

(A23) $k(A,e) = \mathrm{k}^{+}(A,e)\ if\ \pi^{pre}(k^{+}(A,e)) > 0,$

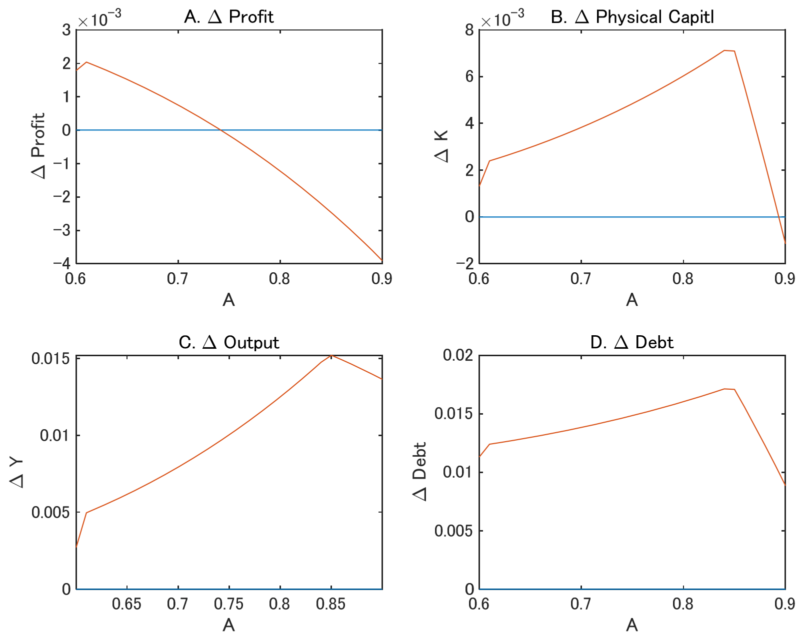
$k^{-}(A,e)\ if\ \pi^{pre}(k^{-}(A,e)) < 0.$

If $\pi^{pre}(k^{+}(A,e)) < 0$ or $\pi^{pre}(k^{-}(A,e)) > 0$, then the solution does not exist. Our numerical analyses show that the solution exists as far as the parameters we set.

Numerical Solution

Figure 1 depicts the difference in the endogenous variables; that is, after-tax profit (π), physical capital (*k*), output (*y*), and debt (*k*+*f*-*e*) between the case of reducing capital from *e* to $\bar{e}$ and the case of keeping capital at the initial level (*e*) against productivity (*A*) (in Cases 1 and 2) or initial capital (*e*) (in Case 3).

Case 1. $\phi = 0.6, \bar{e} = 0.13, \mathrm{e} = 0.14$



Case 2. $\phi = 0.5, \bar{e} = 0.13, \mathrm{e} = 0.14$

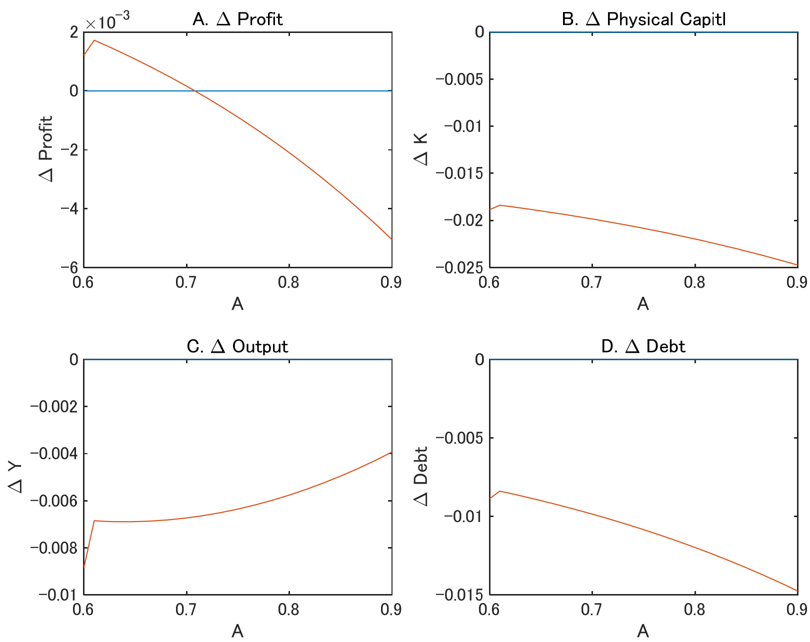


Figure A1. Numerical Examples

Case 3. $\phi = 0.5$, $\bar{e} = 0.13$, $A = 0.7$

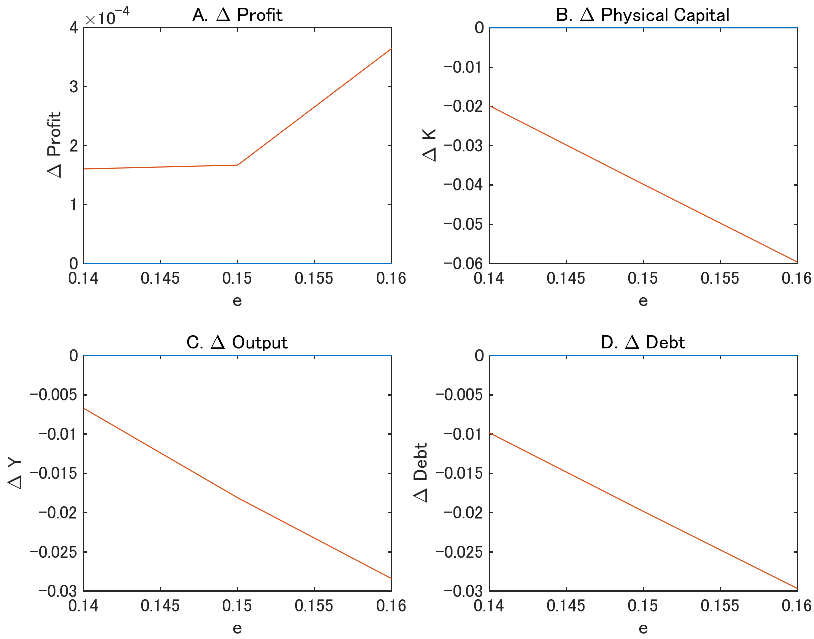


Figure A1. Numerical Examples (Continued)

In Case 1 ($\phi = 0.6$), the borrowing constraint is not binding regardless of whether it reduces capital. The capital reduction increases after-tax profits for $A \leq 0.74$, which is consistent with Proposition 2A. In this range of productivity, physical capital, output, and debt increases are all consistent with Proposition 3A.

In Case 2 ($\phi = 0.5$), the borrowing constraint is binding regardless of whether it reduces capital. The capital reduction increases after-tax profits for $0.60 \leq A \leq 0.70$, which is consistent with Proposition 2B.[4] In this range of productivity, physical capital,

[4] For $A = 0.6$, the firm runs deficits regardless of whether it reduces capital, and yet the effect of the capital reduction on after-tax profit is positive. We find that this situation is so unless the productivity is very low (unless $A \leq 0.52$) and, hence, the deficit is

output, and debt decrease by reducing capital, which is consistent with Proposition 3B.[5] The firm's borrowing constraint tightens after it reduces capital because the tightening effect of smaller capital outweighs the loosening effect of larger after-tax profit under the set parameters.

In Case 3, the changes in the same endogenous variables from reducing capital are depicted against the initial value of capital (e). The after-tax profit increases by reducing capital for all the ranges of the initial capital (e) we consider. The borrowing constraint is always binding for this range of e. The negative effects of reducing capital on physical capital, output, and debt increase as the initial capital (e) is larger, which is consistent with Proposition 3B.

In sum, the numerical solutions of the extended model that we obtain under plausible parameter sets are consistent with the analytical solutions of the basic model (except for very low-productivity firms that run huge deficits).

huge. If the productivity is very low ($A \leq 0.52$) and, consequently, the firm runs a huge deficit, the capital reduction tightens the borrowing constraint Eq. (6) to a large extent to outweigh the tax benefits, which, in turn, decreases after-tax profits.

[5] The parameters we set satisfy the conditions of our simple model under which output decreases after capital reduction in Proposition 3B.