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Evaluating Japan's Corporate Income Tax Reform using Firm-specific Effective Tax Rates

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Abstract

This study evaluates Japan's corporate tax reforms in the 2010s by estimating the effective average tax rate (EATR) and effective marginal tax rate (EMTR), common methods for international comparisons, using data on Japanese firms. Japan lowered its statutory tax rate while it expanded the tax base. The estimated EATR and EMTR declined in Japan, though the EATR decreased less than the statutory tax rate. This was due to the depreciation method reform. This study analyzes the differing effects of the tax rate reduction and depreciation method reform by conducting simulations to represent the effects of each reform on the EATR and EMTR. Japan's tax reform in the 2010s lowered the EATR via the lower tax rate, while it raised the EMTR via the depreciation method reform.

JEL classification: H25, H87

Keywords: Corporate income tax, Firm-specific effective tax rates, Effective average tax rates, Effective marginal tax rates

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1. Introduction

This study evaluates Japan's corporate income tax reforms through the 2010s using firm-level financial data to estimate the effective corporate income tax rates. According to Steinmüller et al. (2019), who compare the statutory corporate income tax rates of countries worldwide, from the late 1990s to the early 2010s, Japan had one of the highest statutory tax rates in the world. Therefore, some argued that corporate income tax rates should be lowered to recover from the aftereffects of the Great Recession and strengthen the international competitiveness of companies. Thus, the Japanese government decided to lower the corporate income tax rate starting in FY2012.

The policy goal at the time was to reduce the Ministry of Finance (MOF) -type effective corporate tax rate to the 20% range. This is a tax rate calculated by combining the national and local statutory tax rates and used as an indicator by Japan's MOF for international comparison. The national corporate income tax rate for large corporations with capital of 100 million yen or more was reduced from 30% in FY2011 to 23.2% in FY2018. The local corporate income tax rate was also reduced. Hence, the MOF-type effective corporate income tax rate, which was over 40% in the early 2000s, fell to 29.74% in FY2019.

However, it is unclear whether the decline in the MOF-type effective tax rate led to an econometric decline in the effective corporate income tax rates. This study's primary contribution to the literature is the calculation of the effective average tax rate (EATR) and the effective marginal tax rate (EMTR) developed in the pioneering work by Devereux and Griffith (2003). I use this data to evaluate Japan's corporate tax reforms in the 2010s.

There is a second reason to evaluate Japan's corporate income tax reform in terms of EATR and EMTR. As lowering the tax rates would reduce tax revenue, the Japanese government expanded the tax base by changing the depreciation method. Analyzing this aspect of the tax reform is the second contribution of this study. In FY2007, Japan abolished the old declining-balance method and introduced the "250% declining-balance method" for depreciable assets other than buildings. While this method is a very accelerated depreciation mechanism, it also eroded the tax base. Therefore, it was changed to the "200% declining-balance method" in FY2011, and the legal depreciation method for structures changed from the declining-balance method to the straight-line method in FY2016. However, the MOF-type effective tax rate does not capture these changes in the depreciation system. Instead, I must evaluate them using EATR and EMTR estimates, though doing so requires an analysis of the asset composition of each company.

Starting with Devereux and Griffith (2003), several studies provided EATR and

EMTR estimates for various countries (Suzuki, 2014; Hanappi, 2018; Steinmüller et al., 2019; Millot et al., 2020; Spengel et al., 2020), thereby establishing the estimation method. Egger et al. (2009), Egger and Lorentz (2010), Steinmüller et al. (2019), and Federici et al. (2020) estimate firm-specific EATR and EMTR using financial statement data. The advantage of using financial data for individual companies is that it allows for the consideration of asset composition and funding diversity. Prior studies point out that EATR and EMTR vary by country and firm. While I use methods from these prior studies to estimate the EATR and EMTR, this study contributes to this research stream by estimating the effective corporate tax rates at the firm level using data from the individual financial statements of Japanese listed companies.

In summary, this study estimates the EATR and EMTR by modeling national and local corporate tax rates in accordance with Japanese tax law. Second, the analysis reflects the asset composition and financing of Japanese firms. Third, I assume values for key economic variables, such as the real interest rate and the inflation rate, based on the economic situation in Japan to estimate more realistic EATR and EMTR values. Many previous studies use the same real interest rate and inflation rate for each country for international comparisons. This study compares the more realistic case for Japan to the assumptions often applied for international comparisons.

The remainder of this paper is organized as follows. Section 2 describes the model and data sources, and Section 3 presents the preliminary data. Section 4 provides the estimation results. Section 5 simulates the effects of the corporate income tax reforms, and Section 6 concludes with a summary and discussion of the findings.

2. Model and data

2.1. Model

This study follows Devereux and Griffith (2003) to derive EATR and EMTR. V_t is the net present value of the firm in period *t*,

$$V_t = \frac{\gamma D_t - N_t + V_{t+1}}{1+\rho}, \tag{1}$$

where D_t is the dividend paid in period *t* and N_t is the new equity issued in period *t*. $\gamma = (1-m^d)/(1-c)(1-z)$ is the effect of the tax on one unit of dividend. m^d is the individual income tax rate on dividends, c is the tax credit rate on dividend income, and z is the capital gains tax rate. $\rho = \left(1-m^i\right)i/(1-z)$ is the discount rate for shareholders, where m^i is the personal income tax rate and i is the nominal interest rate.

$\mathrm{i} = (1 + r)(1 + \pi) - 1$, where r is the real interest rate.

I can express dividends, D, as

$$D_t = Q(K_{t-1})(1 - \tau) - I_t + [1 + i(1 - \tau)]B_{t-1} + \tau\emptyset(I_t + K_{t-1}^T) + N_t. \quad (2)$$

In the above expression, $\mathrm{Q}(K)$ is production, K is the capital stock, I is investment, B is debt, and τ is the statutory corporate income tax rate. $\emptyset$ is the depreciation rate and K^T is the value of the capital stock for tax purposes.

To measure EATR, R is the change in the net present value (NPV):

$$\mathrm{R} = \mathrm{d}V_t = \sum_{s=0}^{\infty} \left\{ \frac{\gamma dD_{t+s} - dN_{t+s}}{(1+\rho)^s} \right\}. \quad (3)$$

First, I consider the case when investment is financed by retained earnings. Devereux and Griffith (2003) account for the case when one unit of investment occurs in period *t*, causing the capital stock to increase, and the capital stock returns to its original level in period *t*+1. In this case, with δ as the economic capital depletion rate, the NPV of investment, R^{RE}, is

$$R^{RE} = -\gamma(1 - A) + \frac{\gamma}{1+\rho}\{(1 + \pi)(p + \delta)(1 - \tau) + (1 + \pi)(1 - \delta)(1 - A)\}. \quad (4)$$

Here, A is the discounted present value of the tax savings from depreciation. Assuming the declining-balance method and the straight-line method, they can be expressed as

$$\text{Declining balance method:} \quad \mathrm{A} = \tau\emptyset\left\{1 + \frac{1-\emptyset}{1+\rho} + \left(\frac{1-\emptyset}{1+\rho}\right)^2 + \cdots\right\} = \frac{\tau\emptyset(1+\rho)}{\rho+\emptyset} \quad (5)$$

$$\text{Straight line method:} \quad \mathrm{A} = \emptyset\left\{1 + \left(\frac{1}{1+\rho}\right) + \left(\frac{1}{1+\rho}\right)^2 + \cdots + \left(\frac{1}{1+\rho}\right)^{L-1}\right\} = \frac{\tau\emptyset(1+\rho)}{\rho}\left(1 - \frac{1}{(1+\rho)^L}\right), \quad (6)$$

where L is the useful life of the asset.

Second, I consider the change in the NPV, F^{NE}, when the investment is financed by issuing new shares.

$$F^{NE} = -(1 - \gamma)(1 - \tau\emptyset) + \frac{(1-\gamma)(1-\tau\emptyset)}{1+\rho} = \frac{-\rho(1-\gamma)(1-\tau\emptyset)}{1+\rho} \quad (7)$$

Third, let F^D be the change in the NPV when the investment is financed by debt.

$$F^D = \gamma(1-\tau\emptyset) - \frac{\gamma(1-\tau\emptyset)[1+i(1-\tau)]}{1+\rho} = \frac{\gamma(1-\tau\emptyset)[\rho-i(1-\tau)]}{1+\rho} \tag{8}$$

In summary, R, the post-tax NPV, is the sum of R^{RE} and F, where $F = 0$ for retained earnings, $F = F^{NE}$ for new stock issuance, and $F = F^D$ for debt.

$$\mathrm{R} = R^{RE} + F \tag{9}$$

Finally, under the above settings, I obtain the cost of capital $\tilde{p}$ when $R = 0$:

$$\tilde{p} = \frac{(1-A)}{(1-\tau)(1+\pi)}\{\rho + \delta(1+\pi) - \pi\} - \frac{F(1+\rho)}{\gamma(1-\tau)(1+\pi)} - \delta. \tag{10}$$

Following King and Fullerton (1984), I define EMTR, where $\tilde{r} = [(1-m^i)i - \pi]/(1-\pi)$. I can then define EATR as in Devereux and Griffith (2003).

$$\mathrm{EMTR} = (\tilde{p} - \tilde{r})/\tilde{p} \tag{11}$$

$$\mathrm{EATR} = \frac{R^* - R}{p/(1+r)}, \tag{12}$$

where R* is the NPV before taxation, and is given by

$$R^* = \frac{p-r}{1+r}. \tag{13}$$

Thus, EMTR and EATR can be calculated given the real interest rate r, inflation rate π, real return on capital before taxation p, statutory tax rate τ, depreciation rate $\emptyset$, economic capital depletion rate δ, and other tax rate parameters $(m^d,\ c,\ z,\ m^i)$.

2.2. Data

Following Egger et al. (2009) and the other studies, I use firm-specific financial data to determine the depreciation rate and economic capital depletion rate for individual firms. However, Egger et al. (2009) do not consider individual firms' asset shares only because they apply industry-specific asset composition to individual firms' asset shares. The financial data of Japanese listed companies are obtained from the DVD version of Nikkei NEEDS Financial Data. The sample for this study includes about 2,000 firms that rose to the First and Second Sections of the Tokyo Stock Exchange, the Mothers section of the Tokyo Stock Exchange, the First and Second Sections of the Osaka Securities Exchange, the First and Second Sections of the Nagoya Stock Exchange, the Fukuoka Stock Exchange, the Sapporo Stock Exchange, and the JASDAQ. I use financial statement data from FY2007 to FY2019 for which these balance sheet asset data are available, as asset data on buildings and structures are not available from financial data prior to FY2006. Since the analysis will be based on fiscal years, the analysis data will be limited to listed companies with fiscal year-end in March, as most companies in Japan close their books at the end of March.

3. Preliminary data

To calculate the firm-specific EATR and EMTR, I use the model parameters defined in the previous section. For the real interest rate r and the inflation rate π, I consider Case 1 and Case 2, as shown in Table 1.

Case 1 ($r = 0.05$ and $\pi = 0.025$) is the assumption used by Devereux and Griffith (2003), Egger et al. (2009), Egger and Lorentz (2010), Steinmüller et al. (2019), and Federici et al. (2020). Case 2 ($r = 0.01944$ and $\pi = 0.00462$) is the assumption representing the Japanese economy. The inflation rate is the average rate from FY2014 to FY2019, calculated from the private sector's business capital investment deflator of the National Accounts gross fixed capital formation in Japan. The real interest rate is calculated using the average Bank of Japan short-term prime rates from FY2014 to FY2019 as the nominal interest rate, taking into account the inflation rate.

The assumption in Case 1 may be important for international comparisons to calculate the differences in EMTR and EATR due to taxation parameters. However, considering the current state of the Japanese economy, I assume that both the real interest rate ($r = 0.05$) and inflation rate ($\pi = 0.025$) are quite low. Thus, I assume that Case 2 captures the current state of the Japanese economy ($r = 0.01944$ and $\pi = 0.00462$).

In addition, most previous studies assume a pre-tax return on capital of $p = 0.2$ (see Table 1). Furthermore, for simplicity, I discard taxation at the individual level by setting $m^d = 0$, $m^i = 0$, $z = 0$, and $c = 0$. In other words, I set $\gamma = 1$, following most studies.

Table 1. Key parameters for studies with firm-specific analysis

	Egger et al. (2009)	Egger and Lorentz (2010)	Steinmüller et al. (2019)	Federici et al. (2020)	This study
Real interest rate r	0.05	0.05	0.05	0.05	Case 1: 0.0500 Case 2: 0.01944
Inflation rate π	0.025	0.025	0	0.025	Case 1: 0.0250 Case 2: 0.00462
Pre-tax return on capital p	0.2	0.2	0.2	0.2	0.2
Rate of economic depreciation for building δ^{BUIL}	0.0361	0.0361	0	0.0361	0.047
Rate of economic depreciation for structures δ^{STRU}	None	None	0	None	0.0564
Rate of economic depreciation for machinery δ^{MACH}	0.1225	0.1225	0	0.01225	0.09489
Rate of economic depreciation for ships and vehicles δ^{VIHI}	None	None	0	None	0.1470
Rate of economic depreciation for tools, furniture, and fixtures δ^{TOOL}	None	None	0	None	0.0838
Rate of economic depreciation for inventories	0	0	0	0	None
Rate of economic depreciation for intangible assets	0.15	0.15	0	0.15	None

Note: In Steinmüller et al.'s (2019) model, the inflation rate and the economic capital depletion rate are zero.

Table 2. Japan's corporate income tax rates

	Before FY2011	FY2012 FY2013	FY2014	FY2015	FY2016 FY2017	FY2018	FY2019
National corporate income tax rate (basic rate) τ_N	30%	25.5%	25.5%	23.9%	23.4%	23.2%	23.2%
Special income tax rate for reconstruction τ_S	0%	10.0%	0%	0%	0%	0%	0%
Local corporate tax rate τ_L	0%	0%	0%	4.4%	4.4%	4.4%	4.4%
Prefectural corporate inhabitant tax rate per income basis τ_P	5.0%	5.0%	5.0%	3.2%	3.2%	3.2%	3.2%
Municipal corporate inhabitant tax rate per income basis τ_M	12.3%	12.3%	12.3%	9.7%	9.7%	9.7%	9.7%
Enterprise tax rate per income τ_E	7.2%	7.2%	7.20%	2.90%	2.90%	2.90%	3.6%
MOF-type effective tax rate	39.54%	37.00%	34.61%	32.1%	29.97%	29.74%	29.74%

Note: Tax rates for large corporations with capital of 100 million yen or more. Enterprise tax rate for income from FY2014 to FY2018 incudes the special local corporate tax rate. The local corporate tax was introduced in 2015. This study also accounts for the special corporate tax for recovery from the Great East Japan Earthquake applied in 2012 and 2013.

For the statutory tax rate τ, I apply the Japanese MOF-type effective tax rate.

$$\tau = \frac{\tau_N(1+\tau_S+\tau_L+\tau_P+\tau_M)+\tau_E}{1+\tau_E} \tag{14}$$

Here, are the national corporate income tax rate (basic rate) is τ_N, the special income tax rate for reconstruction is τ_S, the local corporate tax rate is τ_L, the prefectural corporate inhabitant tax rate is τ_P, the municipal corporate inhabitant tax rate per income basis is τ_M, and the enterprise tax rate for per income is τ_E.[1] The taxable base of the special income tax for reconstruction, local corporate tax, prefectural corporate inhabitant tax, and municipal corporate inhabitant tax per income basis is the amount of national corporate tax. The enterprise tax rate is in the denominator because enterprise tax is

[1] The national corporate tax has a reduced tax rate in addition to the basic tax rate. The reduced tax rate is applied to the income of 8 million yen or less per year for small and medium-sized corporations. As I target listed firms for analysis, I use the basic tax rate. In addition, some local governments implemented excess taxation that raises the corporate inhabitant tax rate and the enterprise tax rate; however, I do not consider excess taxation and use the standard tax rate, which is the basic tax rate stipulated in the local tax law.

recognized as a deductible expense in the tax code (see Table 2 for specific tax rates). For example, for FY2019, the basic national corporate tax rate was 23.2%, the local corporate tax rate was 10.3%, the corporate inhabitant tax rate was 12.9%, and the enterprise tax rate was 3.6%. In this case, the MOF-type effective tax rate was 29.74% ≈ {(23.2% (1 + 4.4% + 12.9%) + 3.6%)} / (1 + 3.6%). The tax rate from 2007 to 2011, before the tax rate reduction reform, was 39.54% ≈ {(30.0% (1 + 17.3%) + 7.2%)} / (1 + 7.2%).

Next, I give the depreciation rate for each asset. The depreciable assets I analyze here are buildings (*BUIL*); structures (*STRU*); machinery and equipment (*MACH*); ships and vehicles (*VIHI*); and tools, furniture, and fixtures (*TOOL*), with depreciation rates for tax purposes of $\emptyset^{BUIL}$, $\emptyset^{STRU}$, $\emptyset^{MACH}$, $\emptyset^{VIHI}$ and $\emptyset^{TOOL}$, respectively. Egger et al. (2009) and Egger and Lorentz (2010) include intangible assets in their analysis. However, I am interested in the economic effects of the depreciation reform, so I limit the analysis to depreciable assets in Japan. Egger et al. (2009) and Egger and Lorentz (2010) do not include vehicles and tools and equipment in their asset classification.

Table 3 summarizes the legal depreciation methods in Japan. Buildings are consistently depreciated by the straight-line method. Structures, machinery, and equipment; ships and vehicles; and tools, furniture, and fixtures changed from the old declining-balance method to the 250% declining-balance method in FY2007, and then to the 200% declining-balance method in FY2011. In addition, for structures, the declining-balance method was changed to the straight-line method in FY2016.

Table 3. Japan's legal depreciation methods

	Before FY2006	FY2007 to FY2010	FY2011 to FY2015	FY2016 to FY2019
Buildings	SLM	SLM	SLM	SLM
Structures	Old DBM	250%DBM	200%DBM	SLM
Machinery and equipment				200%DBM
Ships and vehicles				
Tools, furniture and fixtures				

Note: DBM is declining-balance method and SLM is straight-line method.

The depreciation rate of the 250% declining-balance method introduced in FY2007, which replaced the old declining-balance method, is 2.5 times the depreciation rate of the straight-line method. I calculate the average useful life L of each asset listed in the Japanese National Tax Agency's table by asset: 24.54 years for buildings; 27.18 years for structures; 7.55 years for ships and vehicles; and 6.02 years for tools, furniture, and fixtures. The depreciation rates for each asset using the straight-line method $\emptyset_S$ is $1/L$: $\emptyset_S^{BUIL} = 0.040749$, $\emptyset_S^{STRU} = 0.036786$, $\emptyset_S^{MACH} = 0.102078$, $\emptyset_S^{VIHI} =$

0.132383, and $\emptyset_{S}^{TOOL} = 0.166154$.

Therefore, the depreciation rates of each asset by the 250% declining-balance method $\emptyset_{D250}$ are $\emptyset_{D250}^{STRU} = 0.091965$, $\emptyset_{D250}^{MACH} = 0.255194$, $\emptyset_{D250}^{VIHI} = 0.330957$, and $\emptyset_{D250}^{TOOL} = 0.415385$. The depreciation rate for the 200% declining-balance method $\emptyset_{D200}$ is twice the rate for the straight-line method: $\emptyset_{D200}^{STRU} = 0.073572$, $\emptyset_{D200}^{MACH} = 0.204155$, $\emptyset_{D200}^{VIHI} = 0.264766$, and $\emptyset_{D200}^{TOOL} = 0.332308$.

In addition, the model provides the economic capital depletion rate δ. Let the economic capital depletion rates for each asset be δ^{BUIL}, δ^{STRU}, δ^{MACH}, δ^{VIHI}, and δ^{TOOL}. Using the estimated economic capital depletion rates by asset in Japan by Nakamura et al. (2017), I set $\delta^{BUIL} = 0.047$, $\delta^{STRU} = 0.0564$, $\delta^{MACH} = 0.09489$, $\delta^{VIHI} = 0.1470$, and $\delta^{TOOL} = 0.08838$. However, note that Nakamura et al. (2017) estimate economic capital depletion rates by capital good using real capital stock by industry based on listed firms' financial data. Table 1 summarizes the economic capital depletion rates from previous studies.

I use the balance sheet amounts for BUIL, STRU, MACH, VIHI, and TOOL and define the asset shares Θ as follows, where *j* denotes the subscript of the firm.

$$\Theta_j^{BUIL} = \frac{BUIL_j}{BUIIL_j + STRU_j + MACH_j + VIHI_j + TOOL_j} \tag{15}$$

$$\Theta_j^{STRU} = \frac{STRU_j}{BUIIL_j + STRU_j + MACH_j + VIHI_j + TOOL_j} \tag{16}$$

$$\Theta_j^{MACH} = \frac{MACH_j}{BUIIL_j + STRU_j + MACH_j + VIHI_j + TOOL_j} \tag{17}$$

$$\Theta_j^{VIHI} = \frac{VIHI_j}{BUIIL_j + STRU_j + MACH_j + VIHI_j + TOOL_j} \tag{18}$$

$$\Theta_j^{TOOL} = \frac{TOOL_j}{BUIIL_j + STRU_j + MACH_j + VIHI_j + TOOL_j} \tag{19}$$

$$\Theta_j^{BUIL} + \Theta_j^{STRU} + \Theta_j^{MACH} + \Theta_j^{VIHI} + \Theta_j^{TOOL} = 1 \tag{20}$$

Table 4 reports the asset shares estimated from FY2007 to FY2019. These average percentages do not fluctuate significantly from year to year.

Table 4. Asset shares Θ and debt ratio b

	Θ^{BUIL}	Θ^{STRU}	Θ^{MACH}	Θ^{VIHI}	Θ^{TOOL}	b
Minimum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10th percentile	0.2740	0.0000	0.0000	0.0000	0.0099	0.0000
20th percentile	0.4102	0.0000	0.0000	0.0000	0.0194	0.0036
30th percentile	0.5095	0.0077	0.0010	0.0000	0.0290	0.0424
40th percentile	0.6000	0.0150	0.0182	0.0001	0.0402	0.0939
50th percentile	0.6785	0.0223	0.0679	0.0007	0.0542	0.1512
60th percentile	0.7519	0.0302	0.1551	0.0014	0.0738	0.2127
70th percentile	0.8220	0.0404	0.2535	0.0027	0.1095	0.2784
80th percentile	0.8839	0.0563	0.3542	0.0054	0.1822	0.3597
90th percentile	0.9378	0.0893	0.4791	0.0163	0.3846	0.4755
Maximum	1.0000	0.8730	1.0000	1.0000	1.0000	0.9829
Average	0.6362	0.0430	0.1683	0.0162	0.1363	0.1960
Standard deviation	0.2580	0.0799	0.2039	0.0857	0.2072	0.1901
No. of firms	27,750	27,750	27,750	27,750	27,750	27,750

Source: Author's calculations.

Using the above data, I calculate the depreciation rate ϕ_j , the economic capital depletion rate δ_j , and the discounted present value A_j of the tax savings from depreciation for individual firms.

$$\phi_j = \Theta_j^{BUIL}\phi^{BUIL} + \Theta_j^{STRU}\phi^{STRU} + \Theta_j^{MACH}\phi^{MACH} + \Theta_j^{VIHI}\phi^{VIHI} + \Theta_j^{TOOL}\phi^{TOOL} \quad (21)$$

$$\delta_j = \Theta_j^{BUIL}\delta^{BUIL} + \Theta_j^{STRU}\delta^{STRU} + \Theta_j^{MACH}\delta^{MACH} + \Theta_j^{VIHI}\delta^{VIHI} + \Theta_j^{TOOL}\delta^{TOOL} \quad (22)$$

$$A_j = \Theta_j^{BUIL}A^{BUIL} + \Theta_j^{STRU}A^{STRU} + \Theta_j^{MACH}A^{MACH} + \Theta_j^{VIHI}A^{VIHI} + \Theta_j^{TOOL}A^{TOOL} \quad (23)$$

As the financial data do not reveal the amount of new shares issued to finance investment, as in Egger et al. (2009) and other studies, I limit the financing of firms to retained earnings and debt financing. For debt financing, I consider the debt ratio b_j,

$$b_j = \frac{SL_j + LL_j}{TA_j}, \quad (24)$$

where SL_j is short-term loans and bonds; LL_j is long-term loans, bonds, and convertible bonds; and TA_j is total assets (limited to $0<b_j<1$), obtained from the financial data. Table 3 reports the debt ratios estimated from FY2007 to FY2019. In FY2008, the average debt ratio was 22.09%, but in FY2018, it decreased to 18.60%. Hence, I can assume that companies are increasingly financing themselves through retained earnings.

The debt ratio indicates the ratio of assets financed by debt, but not necessarily the debt financing portion of the investment funds. However, it is difficult to obtain the debt financing share of investment funds from financial statement data. Therefore, I consider the investment funds raised by debt to be a percentage of the debt ratio.

By using the above data and parameters, I can calculate the firm-specific EMTRs and EATRs. Tables 5 and 6 report the EATR estimation results for Cases 1 and 2, respectively, while Tables 7 and 8 report the EMTR estimation results for Cases 1 and 2, respectively.

Table 5. Estimation results: EATR, Case 1 ($r = 0.05$ and $\pi = 0.025$)

EATR	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Minimum	0.1985	0.1985	0.1985	0.1985	0.2029	0.1887	0.1887	0.1755	0.1618	0.1502	0.1502	0.1490	0.1490
10th percentile	0.2259	0.2297	0.2305	0.2317	0.2373	0.2209	0.2195	0.2038	0.1876	0.1740	0.1753	0.1721	0.1727
20th percentile	0.2342	0.2360	0.2372	0.2380	0.2425	0.2264	0.2258	0.2104	0.1942	0.1811	0.1812	0.1795	0.1795
30th percentile	0.2384	0.2399	0.2408	0.2418	0.2451	0.2290	0.2287	0.2134	0.1973	0.1841	0.1840	0.1824	0.1824
40th percentile	0.2415	0.2426	0.2435	0.2440	0.2471	0.2309	0.2306	0.2153	0.1992	0.1860	0.1860	0.1842	0.1844
50th percentile	0.2441	0.2451	0.2457	0.2462	0.2484	0.2322	0.2319	0.2167	0.2005	0.1874	0.1873	0.1857	0.1857
60th percentile	0.2465	0.2472	0.2477	0.2479	0.2496	0.2332	0.2331	0.2176	0.2016	0.1885	0.1884	0.1869	0.1869
70th percentile	0.2483	0.2487	0.2490	0.2494	0.2504	0.2340	0.2339	0.2186	0.2025	0.1892	0.1892	0.1878	0.1877
80th percentile	0.2498	0.2500	0.2501	0.2503	0.2510	0.2346	0.2346	0.2193	0.2032	0.1899	0.1898	0.1884	0.1884
90th percentile	0.2508	0.2509	0.2509	0.2510	0.2514	0.2351	0.2350	0.2198	0.2037	0.1903	0.1903	0.1888	0.1888
Maximum	0.2576	0.2567	0.2575	0.2571	0.2587	0.2408	0.2408	0.2249	0.2087	0.2008	0.2010	0.1997	0.1997
Average	0.2408	0.2420	0.2426	0.2431	0.2455	0.2294	0.2289	0.2135	0.1975	0.1844	0.1845	0.1828	0.1828
Standard deviation	0.0112	0.0103	0.0101	0.0098	0.0089	0.0084	0.0090	0.0089	0.0088	0.0088	0.0085	0.0088	0.0087
No. of firms	2,053	2,065	2,073	2,078	2,091	2,114	2,147	2,143	2,174	2,190	2,210	2,218	2,194

Source: Author's calculations.

Table 6. Estimation results: EATR, Case 2 ($r = 0.01944$ and $\pi = 0.00462$)

EATR	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Minimum	0.3241	0.3241	0.3241	0.3241	0.3253	0.3040	0.3040	0.2841	0.2632	0.2454	0.2454	0.2435	0.2436
10th percentile	0.3339	0.3353	0.3356	0.3360	0.3378	0.3157	0.3151	0.2943	0.2726	0.2540	0.2544	0.2519	0.2522
20th percentile	0.3369	0.3375	0.3378	0.3381	0.3395	0.3175	0.3173	0.2967	0.2749	0.2564	0.2564	0.2544	0.2544
30th percentile	0.3382	0.3387	0.3390	0.3392	0.3403	0.3183	0.3182	0.2976	0.2758	0.2574	0.2573	0.2553	0.2553
40th percentile	0.3392	0.3395	0.3397	0.3399	0.3408	0.3188	0.3187	0.2980	0.2763	0.2578	0.2578	0.2558	0.2558
50th percentile	0.3399	0.3401	0.3403	0.3404	0.3410	0.3190	0.3189	0.2983	0.2766	0.2582	0.2581	0.2562	0.2562
60th percentile	0.3405	0.3406	0.3407	0.3407	0.3411	0.3191	0.3190	0.2984	0.2767	0.2583	0.2583	0.2563	0.2563
70th percentile	0.3408	0.3408	0.3409	0.3409	0.3412	0.3192	0.3192	0.2985	0.2768	0.2584	0.2584	0.2564	0.2564
80th percentile	0.3409	0.3410	0.3410	0.3410	0.3414	0.3193	0.3193	0.2987	0.2769	0.2585	0.2585	0.2566	0.2566
90th percentile	0.3411	0.3411	0.3411	0.3411	0.3416	0.3195	0.3195	0.2989	0.2771	0.2588	0.2588	0.2569	0.2568
Maximum	0.3455	0.3456	0.3455	0.3452	0.3466	0.3240	0.3239	0.3029	0.2809	0.2640	0.2641	0.2621	0.2620
Average	0.3386	0.3389	0.3391	0.3393	0.3401	0.3181	0.3179	0.2973	0.2755	0.2571	0.2572	0.2551	0.2552
Standard deviation	0.0036	0.0032	0.0032	0.0031	0.0029	0.0028	0.0030	0.0029	0.0029	0.0029	0.0028	0.0029	0.0029
No. of firms	2,053	2,065	2,073	2,078	2,091	2,114	2,147	2,143	2,174	2,190	2,210	2,218	2,194

Source: Author’s calculations.

Table 7. Estimation results: EMTR, Case 1 ($r = 0.05$ and $\pi = 0.025$)

EMTR	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Minimum	-0.7750	-1.0355	-0.8540	-0.8331	-0.9823	-0.8542	-0.8081	-0.7064	-0.6176	-0.5293	-0.5161	-0.5246	-0.5332
10th percentile	0.0671	0.0309	0.0476	0.0574	0.0834	0.0710	0.0720	0.0604	0.0399	0.0371	0.0389	0.0328	0.0286
20th percentile	0.1407	0.1098	0.1270	0.1409	0.1594	0.1389	0.1448	0.1299	0.1070	0.0972	0.0988	0.0926	0.0872
30th percentile	0.1877	0.1630	0.1765	0.1839	0.2042	0.1831	0.1908	0.1706	0.1482	0.1348	0.1404	0.1314	0.1290
40th percentile	0.2176	0.2042	0.2163	0.2238	0.2399	0.2201	0.2230	0.2028	0.1784	0.1638	0.1685	0.1632	0.1592
50th percentile	0.2495	0.2373	0.2448	0.2523	0.2693	0.2485	0.2489	0.2291	0.2038	0.1867	0.1905	0.1873	0.1842
60th percentile	0.2775	0.2681	0.2738	0.2811	0.2939	0.2714	0.2719	0.2512	0.2262	0.2075	0.2105	0.2080	0.2058
70th percentile	0.3001	0.2946	0.3016	0.3052	0.3161	0.2928	0.2926	0.2699	0.2463	0.2276	0.2289	0.2259	0.2247
80th percentile	0.3212	0.3199	0.3244	0.3271	0.3364	0.3125	0.3119	0.2878	0.2617	0.2421	0.2429	0.2408	0.2399
90th percentile	0.3424	0.3431	0.3458	0.3463	0.3520	0.3260	0.3260	0.3009	0.2756	0.2540	0.2546	0.2525	0.2521
Maximum	0.3684	0.3677	0.3689	0.3683	0.3743	0.3452	0.3458	0.3199	0.2952	0.2733	0.2720	0.2703	0.2823
Average	0.2143	0.2048	0.2141	0.2203	0.2360	0.2158	0.2179	0.1988	0.1755	0.1611	0.1639	0.1594	0.1562
Standard deviation	0.1437	0.1413	0.1361	0.1332	0.1276	0.1200	0.1168	0.1106	0.1065	0.0989	0.0976	0.0997	0.1020
No. of firms	2,053	2,065	2,073	2,078	2,091	2,114	2,147	2,143	2,174	2,190	2,210	2,218	2,194

Source: Author's calculations.

Table 8. Estimation results: EATR, Case 2 ($r = 0.01944$ and $\pi = 0.00462$)

EMTR	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Minimum	-0.5734	-0.7188	-0.6273	-0.6134	-0.7217	-0.6304	-0.5993	-0.5248	-0.4584	-0.3919	-0.3829	-0.3886	-0.3949
10th percentile	0.0799	0.0519	0.0626	0.0733	0.1015	0.0868	0.0874	0.0796	0.0629	0.0583	0.0601	0.0570	0.0495
20th percentile	0.1419	0.1169	0.1310	0.1408	0.1598	0.1442	0.1473	0.1355	0.1164	0.1066	0.1103	0.1039	0.1013
30th percentile	0.1851	0.1631	0.1746	0.1815	0.1989	0.1812	0.1883	0.1709	0.1507	0.1411	0.1460	0.1390	0.1354
40th percentile	0.2116	0.1999	0.2099	0.2156	0.2300	0.2137	0.2161	0.1988	0.1787	0.1651	0.1689	0.1644	0.1610
50th percentile	0.2396	0.2284	0.2354	0.2418	0.2572	0.2381	0.2397	0.2218	0.2005	0.1857	0.1891	0.1859	0.1833
60th percentile	0.2640	0.2560	0.2610	0.2666	0.2794	0.2595	0.2604	0.2433	0.2208	0.2045	0.2068	0.2046	0.2023
70th percentile	0.2855	0.2806	0.2867	0.2895	0.2993	0.2782	0.2795	0.2593	0.2378	0.2215	0.2226	0.2198	0.2181
80th percentile	0.3040	0.3032	0.3068	0.3091	0.3176	0.2957	0.2962	0.2744	0.2516	0.2340	0.2346	0.2331	0.2323
90th percentile	0.3217	0.3224	0.3248	0.3248	0.3310	0.3074	0.3072	0.2851	0.2617	0.2430	0.2432	0.2414	0.2410
Maximum	0.3514	0.3498	0.3495	0.3490	0.3616	0.3302	0.3303	0.3053	0.2886	0.2647	0.2658	0.2644	0.2756
Average	0.2103	0.2022	0.2099	0.2150	0.2292	0.2116	0.2133	0.1968	0.1766	0.1638	0.1663	0.1624	0.1598
Standard deviation	0.1217	0.1188	0.1152	0.1129	0.1083	0.1016	0.0996	0.0937	0.0900	0.0836	0.0825	0.0842	0.0861
No. of firms	2,053	2,065	2,073	2,078	2,091	2,114	2,147	2,143	2,174	2,190	2,210	2,218	2,194

Source: Author’s calculations.

4. EATRs and EMTRs in the 2010s

This section presents the results of analyzing the data in Section 3 using the model presented in Section 2 to evaluate Japan's corporate income tax reform in the 2010s. First, I compare the estimated average EATR and EMTR with the change in the MOF-type effective tax rates. Second, I analyze the changes in the distributions of EATR and EMTR.

Figure 1 illustrates the average EATR and EMTR for Case 1 and Case 2, and the MOF-type effective tax rates. The MOF-type effective tax rate, which was over 40% in FY2011, fell below 30% in FY2016 after the corporate income tax reform starting in FY2012. The rate was 39.54% before the tax rate reduction and 29.74% thereafter, a decrease of 9.8 percentage points. I will examine how the effective tax rate changed as a result of the tax rate reduction as well as the reform of the depreciation method.

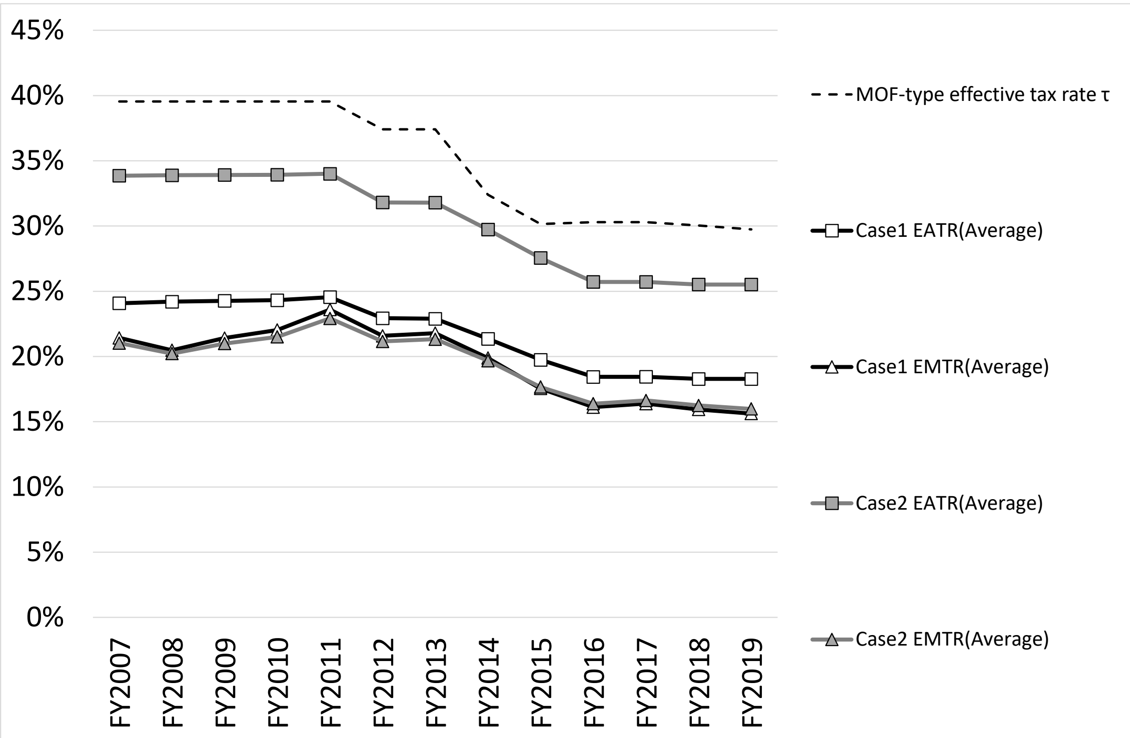

Figure 1. EATR, EMTR, and MOF-type effective tax rates.
Source: Author’s calculations.

The magnitude of the EATR is quite different for Case 1 and Case 2 due to the differing assumptions of the real interest rate and the inflation rate. The EATRs of Case 2, which reflects the actual Japanese economy, is lower than the EATRs of Case 1, which applies the real interest rate and inflation rate common in international comparisons. This is because the lower the real interest rate and inflation rate are, the lower the EATRs are. The EATRs differ significantly between Case 1 and Case 2, but the EMTRs are not significantly different.

The average EATR before the tax reform in Case 1 is about 24%, and after the tax reform, it was about 18%, a decrease of 6 percentage points. Compared to the 9.8 percentage point decline in the MOF-type effective tax rate, the smaller decline in EATR occurred because the depreciation reforms expanded the tax base. On the other hand, the EMTRs are lower than the EATRs. Before the tax reform, the average EMTR was about 21%; after the tax reform, it was about 16%, a decrease of 5%. Here, too, the MOF-type effective tax rate is smaller than the reduction. In line with the decline in the MOF-type effective tax rate, the average EMTR also generally declined, but it did rise in some fiscal years. For example, the increase in EMTR in FY2011 is due to the introduction of the 200% declining-balance method to replace the 250% declining-balance method.

I should note that the EATRs and EMTRs in Figure 1 are the average changes. In this study, I estimate the effective tax rates of individual firms. The differences in asset composition and financing of individual firms create the distributions in the estimated EATR and EMTR.

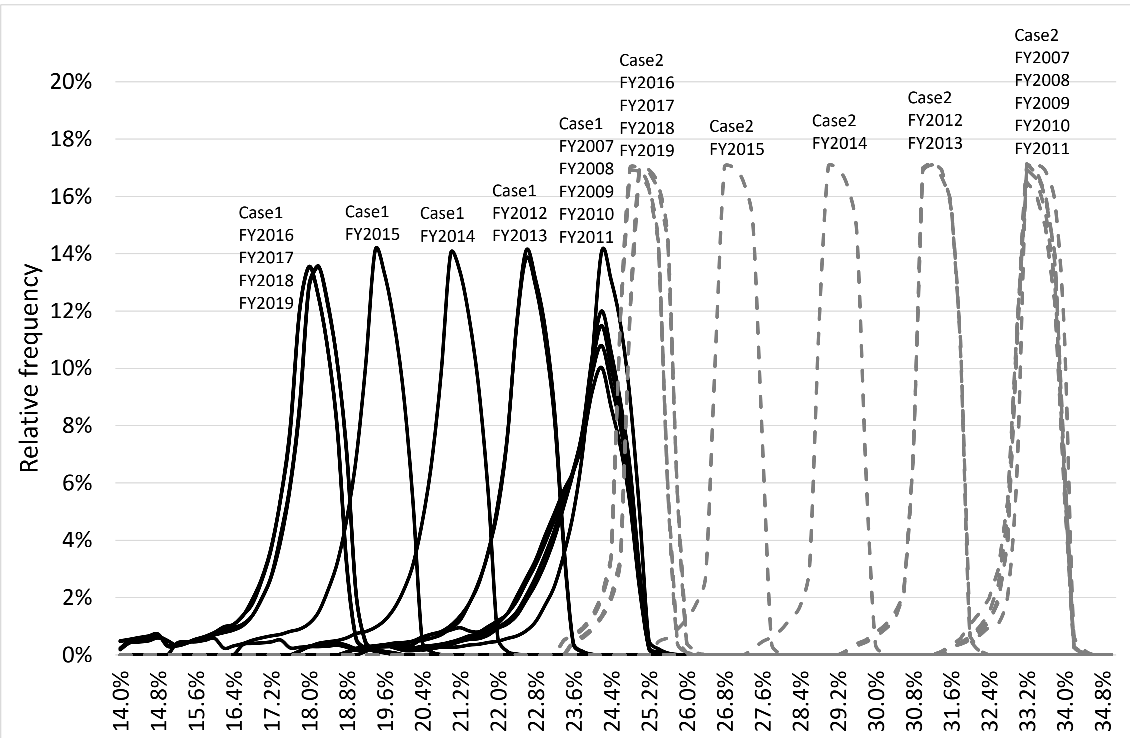

Figure 2. Distribution of EATR.

Source: Author’s calculations. Case 1 is a solid line and Case 2 is a dotted line.

Figure 2 illustrates the distributions of EATR for each year in Case 1 and Case 2. There is a significant difference in the location of the EATR distribution between Case 1 and Case 2; the EATR distribution is moving toward lower tax rates as the MOF-type effective tax rate decreases due to the tax reform.

Figure 3 shows the distributions of EMTR for each year in Case 1 and Case 2. Unlike the EATR, there is no significant difference in the location of the EMTR distribution between the cases. Compared to the EATR distribution, the EMTR distribution is skewed to the right. The reason for this is that the distribution of the debt ratio is skewed and the cost of capital from retained earnings is smaller than the cost of capital from debt financing.

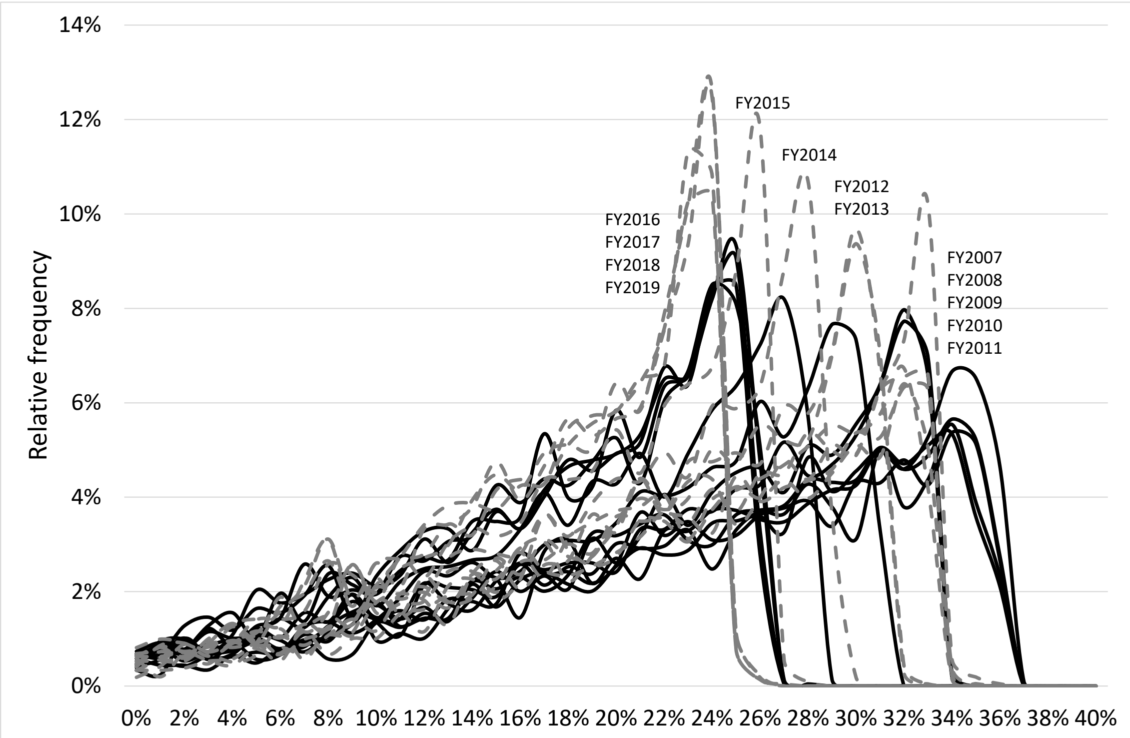

Figure 3. Distribution of EMTR.

Source: Author’s calculations. Case 1 is a solid line and Case 2 is a dotted line.

5. Effects of the tax reform on the EATR and EMTR

The EATR and EMTR estimation results in the previous section show a mixture of the tax rate reduction and depreciation reform. Therefore, I decompose Japan's corporate income tax reforms in the 2010s into tax rate reductions and changes in depreciation methods and analyze the impact of these changes on EATR and EMTR with a simulation analysis using Case 2 of FY2010, before the start of Japan's corporate income tax reform as the baseline. I apply the same real interest rate and inflation rate as in Case 2 ($r = 0.01944$ and $\pi = 0.00462$). Scenario 1 assumes the same depreciation method as in the baseline, but the MOF-type effective tax rate is set at 29.74% in FY2019. Scenario 2 assumes the MOF-type effective tax rate as in the baseline, but the depreciation method for structures is the straight-line method, which represents the depreciation reform in FY2016. In Scenario 3, the MOF-type effective rate is the same as in the baseline, but the depreciation method for depreciable assets other than buildings is the 200% declining-balance method. This represents the depreciation reform in FY2011. By considering these scenarios, I can extract the pure effects of Japan's corporate income tax reform on EATRs and EMTRs. Table 9 summarizes the baseline and various scenarios.

Table 9. Simulation Scenarios and Baseline

	Baseline Case 2 FY2010	Scenario 1	Scenario 2	Scenario 3
MOF-type effective tax rate τ	39.54%	29.74%	39.54%	39.54%
Depreciation method for BUIL	SLM	SLM	SLM	SLM
Depreciation method for STRU	250%DBM	250%DBM	SLM	200%DBM
Depreciation method for MACH	250%DBM	250%DBM	250%DBM	200%DBM
Depreciation method for VIHI	250%DBM	250%DBM	250%DBM	200%DBM
Depreciation method for TOOL	250%DBM	250%DBM	250%DBM	200%DBM
Real interest rate r (Case 2)	0.01944	0.01944	0.01944	0.01944
Inflation rate π (Case 2)	0.00462	0.00462	0.00462	0.00462

Note: DBM is declining-balance method and SLM is straight-line method.

Tables 10 and 11 provide the simulation results for EATR and EMTR. I evaluate the tax reform by looking at the change in average EATR and EMTR using baseline as a reference. First, Scenario 1, which examines the MOF-type effective tax rate, shows lower values for both EATR and EMTR. The MOF-type effective tax rate decreases by 9.8 percentage points, but comparing the baseline with Scenario 1, the EATR decreases by 8.46 percentage points (from 33.93% to 25.47%) and the EMTR by 6.45 percentage points (from 21.50% to 15.05%). Both reductions are less than the MOF-type effective tax rate, while the EMTR reduction is less than the EATR reduction.

Table 10. EATR simulation results

Statistic	Baseline	Scenario1	Scenario2	Scenario3
Minimum	0.3241	0.2423	0.3241	0.3253
10th percentile	0.3360	0.2520	0.3364	0.3375
20th percentile	0.3381	0.2537	0.3387	0.3395
30th percentile	0.3392	0.2546	0.3397	0.3403
40th percentile	0.3399	0.2552	0.3404	0.3407
50th percentile	0.3404	0.2557	0.3408	0.3410
60th percentile	0.3407	0.2559	0.3410	0.3411
70th percentile	0.3409	0.2562	0.3412	0.3412
80th percentile	0.3410	0.2563	0.3413	0.3414
90th percentile	0.3411	0.2563	0.3417	0.3416
Maximum	0.3452	0.2592	0.3494	0.3467
Average	0.3393	0.2547	0.3397	0.3401
Standard deviation	0.0031	0.0025	0.0032	0.0028
No. of firms	2,078	2,078	2,078	2,078

Source: Author's calculations.

Table 11. EMTR simulation results

Statistic	Baseline	Scenario1	Scenario2	Scenario3
Minimum	-0.6134	-0.3599	-0.6134	-0.5436
10th percentile	0.0733	0.0428	0.0858	0.0928
20th percentile	0.1408	0.0918	0.1475	0.1545
30th percentile	0.1815	0.1215	0.1878	0.1967
40th percentile	0.2156	0.1481	0.2199	0.2287
50th percentile	0.2418	0.1681	0.2457	0.2524
60th percentile	0.2666	0.1880	0.2712	0.2767
70th percentile	0.2895	0.2064	0.2926	0.2981
80th percentile	0.3091	0.2225	0.3122	0.3167
90th percentile	0.3248	0.2354	0.3279	0.3308
Maximum	0.3490	0.2558	0.3567	0.3604
Average	0.2150	0.1505	0.2205	0.2274
Standard deviation	0.1129	0.0822	0.1105	0.1067
No. of firms	2,078	2,078	2,078	2,078

Source: Author's calculations.

For Scenario 2, which changes the depreciation method for structures from the 250% declining-balance method to the straight-line method, there is little change in the EATR but an increase of 1 percentage points in the average EMTR (from 21.50% to 22.05%). This is because the straight-line depreciation method is less favorable than the 250% declining-balance method. This effect is limited to companies that own structures.

Scenario 3, which changes the depreciation method for structures; machinery and equipment; vehicles and transportation equipment; and tools, furniture, and fixtures from the 250% declining-balance method to the 200% declining-balance method, results in little change in the EATR but a 1.24 percentage point increase in the average EMTR (from 21.5% to 22.74%). This impact on EMTR is larger than Scenario 2. The MOF-type effective tax rate affects both the EATR and EMTR, but the depreciation method affects EMTR.

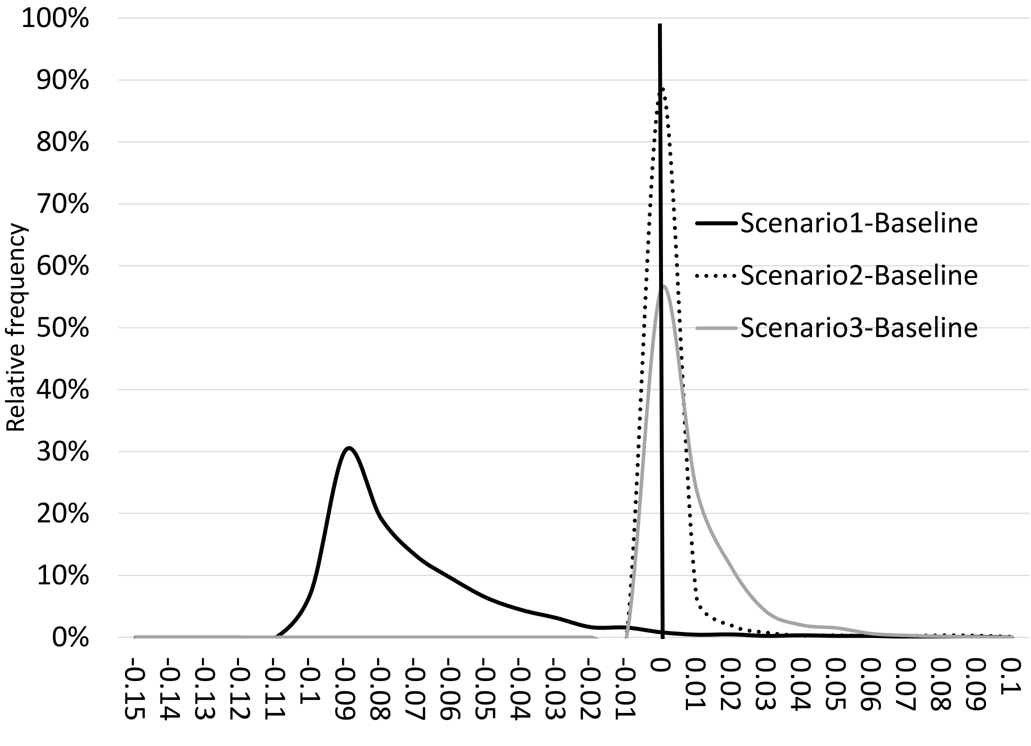

Figure 4. Distribution of EMTR changes from the baseline with each Scenario.
Source: Author's calculations.

Figure 4 depicts the change in the EMTR distribution from the baseline with each scenario, minus the baseline EMTR. Scenario 1 is a large negative shift in the distribution because the tax rate reduction changes the EMTR of all firms. Scenarios 2 and 3 move the distribution in the positive direction, though Scenario 3 moves more than

Scenario 2 does. Scenario 2 represents the change in depreciation method for structures only, while Scenario 3 represents the change the depreciation method for non-buildings. Therefore, the difference between Scenarios 2 and 3 is caused by the difference in the depreciable assets under reform. Scenario 3, which represents a reform to a larger range of assets than Scenario 2 thus has a larger impact on EMTR than Scenario 2.

6. Conclusion

This study evaluated Japan's corporate income tax reform in the 2010s by estimating the EATR and EMTR for individual Japanese firms. As in many countries, Japan reduced the statutory tax rate and simultaneously expanded the tax base by reforming the allowable depreciation methods. The MOF-type effective tax rate is a combination of statutory tax rates, and although it is possible to measure the effect of the tax rate reduction, it is impossible to measure the change in the depreciation method. Therefore, it is necessary to estimate the EATR and EMTR to evaluate the tax reform.

The EATR and EMTR estimates, first presented by Devereux and Griffith (2003), have been used for international comparisons, such as by the OECD (2020). On the other hand, several studies estimate the EATR and EMTR using individual firm data, as in Egger et al. (2009). In line with these previous studies, I estimate the EATR and EMTR for individual Japanese firms and evaluate Japan's corporate income tax reform.

The magnitude of the EATR depends on the assumption of the real interest rate and inflation rate. When these rates are low, which is similar to the situation in Japan's economy, the EATR will be high. On the other hand, these factors have little effect on the EMTR. The EATR does not decline as much as the reduction in the MOF-type effective tax rate, as the depreciation methods were changed and the tax base expanded. Although the reduction in the MOF-type effective tax rate lowered the EMTR, the change in the depreciation method increased the EMTR in some cases.

The tax reforms include a mixture of both tax rate reductions and changes in depreciation methods. Therefore, I analyzed the effects of tax reform by decomposing these reforms. The baseline year is FY2010, the year before the tax reform, and ran simulations for both the tax rate cut and the change in depreciation method. The tax rate reduction lowered the EATR and EMTR. The change in depreciation method had little impact on the EATR, but a significant impact on the EMTR. The change from the 250% to the 200% declining-balance method for depreciable assets other than buildings raised the EMTR for companies owning these assets. A switch from the 250% declining-balance method to the straight-line method for structures raised the EMTR of companies owning structures.

Thus, Japan's corporate income tax reforms in the 2010s raised the EMTRs by broadening the tax base through the revision of depreciation methods, although the EATRs declined due to the lower tax rates. The overall effect of the corporate income tax reform is that the effect of the tax rate reduction exceeded that of the depreciation method reforms, and thus the EMTR also declined.

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