Corporate Tax Incidence: Is Labor Bearing the Burden of Corporate Tax?

Masaki Hotei

Associate professor, Faculty of Economics, Daito Bunka University

Abstract

This paper estimates the effect of the difference in the corporate tax rate (difference between the corporate tax rates in Japan and the average corporate tax rate abroad) on capital per worker and the effect of capital per worker on wages per worker based on a VAR model using a time-series data set of the Japanese manufacturing industry. In addition, the paper estimates how the effect of an increase of 1% in the difference in the corporate tax rate on the wage rate changes over a long period (the dynamic multiplier function). The main findings in this paper are as follows.

First, the estimation results for the VAR model show that an increase in the average difference in the corporate tax rate over the past three years decreases capital per worker. It is also found that a rise in capital per worker in the previous period increases wages per worker. These findings suggest the presence of the following process of the corporate tax incidence: increase in the difference in the corporate tax rate ⇒ decline in capital per worker (decline in labor productivity) ⇒ decline in the wage rate.

Second, the dynamic multiplier estimation based on VAR models with constraints shows that a rise of 1% in the average difference in the corporate tax rate over the past three years causes wages per worker to decline by only 20,000 to 25,000 yen in total over a 16-year period. This finding suggests that the corporate tax burden on workers is small.

Keywords: corporate tax, capital per worker, wage rage
JEL Classification: H22, H25

I. Introduction

Right after Prime Minister Shinzo Abe made a speech in the annual meeting at the World Economic Forum in Davos in January 2014, the Japanese government began to consider a reduction in the corporate tax rate, notifying the aim to reduce the effective corporate tax rate to an internationally-comparable level (in the twenties) in several years in “Basic Policies for the Economic and Fiscal Management and Reform 2014” (Council on Economic and Fiscal Policy, 2014). They embarked on the pro-growth corporate tax reform based on the fundamental rule “tax rate cut cum base broadening”, reducing the effective corporate tax rate from 34.62% to 32.11% in 2015. Furthermore, they reduced it to 29.97% in 2016 and realized their aim in only two years. The Japanese government expected that the pro-growth corporate tax reform would induce firms to increase investments contributing to profitability and raise wages continuously.

To what extent does a decrease in corporate tax rate induce firms to increase wages? (Or to what extent does an increase in corporate tax rate induce firms to decrease wages?) We analyze the effects of a change in corporate tax rate on wages from the point of view of corporate tax incidence. Harberger (1962) develops the general equilibrium model to analyze the incidence of corporate tax in a closed economy. Harberger (1995, 2008) extended this model to an open economy. According to the open-economy Harberger model of general equilibrium tax incidence, an increase in corporate tax rate in the domestic country causes capital to move from the domestic corporate sector to the domestic non-corporate sector and to foreign counties, which reduces capital per worker (labor productivity) in the domestic corporate sector and lowers wages in the domestic country. This decline in wages means that labor bears the burden of corporate tax. In this way, although the economic theory shows that the burden of corporate tax falls on labor, we need to do an empirical analysis to know to what extent labor bears the burden of corporate tax.

We estimate the effect of the difference in the corporate tax rate (difference between the corporate tax rates in Japan and the average corporate tax rate abroad) on capital per worker and the effect of capital per worker on wages per worker based on a VAR model using a time-series data set of the Japanese manufacturing industry over the period 1985-2012. In addition, we estimate how the effect of an increase of 1% in the difference in the corporate tax rate on the wage rate changes over a long period (the dynamic multiplier function). The main findings in this paper are as follows.

First, the estimation results for VAR models show that an increase in the average difference in the corporate tax rate over the past three years decreases capital per worker. It is also found that a rise in capital per worker in the previous period increases wages per worker. These findings suggest that there is the following process of the corporate tax incidence: increase in the difference in the corporate tax rate ⇒ decline in capital per worker (decline in labor productivity) ⇒ decline in the wage rate.

Second, the dynamic multiplier estimation based on VAR models with constraints shows that a rise of 1% in the average difference in the corporate tax rate over the past three years causes wages per worker to decline by only 20,000 to 25,000 yen in total over a 16-year period. This finding suggests that the corporate tax burden on workers is small.

The paper is organized as follows. Section II provides a literature survey. Section III discusses the empirical model and the data used in this paper. Section IV discusses the estimation results for VAR models and the dynamic multiplier estimation. Section V concludes.

II. Literature Review

Since the Harberger model explains the effects of corporate tax on the long-term equilibrium, we have to consider that it takes enough time until corporate tax affects wages in empirically investigating whether labor bears the burden of corporate tax. Previous studies use various methods to capture such effects of corporate tax on the long-term equilibrium.

Hassett and Mathur (2010) use a country-level panel data set of 65 counties over the period 1981-2005, regressing the average manufacturing wages (logarithmic values) over the most recent five years (the current year and the four previous years) on a four-year lagged corporate tax rate (logarithmic values) as well as several control variables, including value-added per worker (logarithmic values). They convert variables such as wages into U.S dollars using market exchange rates and use three measures of the corporate tax rate: the top statutory tax rate (STR), the effective marginal tax rate (EMTR), and the effective average tax rate (EATR). They find a statistically significant result that an increase in the corporate tax rate causes manufacturing wages to fall.

On the contrary, Gravelle and Hungerford (2012) claim that the market exchange rate affected by financial markets and government policies may not be good indicators of the relative buying power of wage rates in two countries. They do the same analysis as Hassett and Mathur (2010) using wages which are converted to U.S. dollars using the consumption PPP and then converted to inflation-adjusted dollars using the CPI, indicating that the effect of corporate tax rate on wages is much smaller and less robust than in the Hassett and Mathur study. In addition, Clausing (2012) points out that one of the issues with a larger selection of countries is the difficulty of assembling comparable data on wages across countries. Taking this matter into account, she focuses on OECD counties and does the same analysis as Hassett and Mathur (2010) using three different wage measures which are converted to U.S. dollars using PPP and inflation-adjusted hourly wages of 27 counties over the period 1981-2009, average monthly wages of 32 counties over the period 1981-2008, and average annual wages of 26 counties over the period 1990-2009, finding that the effects of corporate tax rates on wages are not statistically significant. In contrast to the Hassett and Mathur study, these studies suggest that labor does not bear the burden of corporate tax.

Furthermore, in order to investigate whether there exits the following process of the corporate tax incidence: rise in the corporate tax rate ⇒ decline in capital per worker (decline in labor productivity) ⇒ decline in the wage rate, Clausing (2012) divides the analysis into two parts: the first part is to analyze whether a rise in the corporate tax rate causes capital per worker to decline, and the second part is to analyze whether a decline in capital per worker causes the wage rate to decline. In the first part, she uses a country-level panel data set of OECD counties and regresses capital per worker (logarithmic values) on the average of the most recent six years (the current year and the five previous years) of the difference in the corporate tax rate as well as GDP per capita to capture the effects of corporate tax on the long-term equilibrium. Clausing defines the difference in the corporate tax rate as the difference between the corporate tax rate in the domestic country and the average corporate tax rate abroad and utilizes several corporate tax measures: the top central government statutory tax rate, the combined central and sub-central statutory tax rate, the effective tax rate (the ratio of corporate tax to pre-tax profit), and the ratio of corporate tax revenues to GDP. The result in this part shows that the effects of the difference in the corporate tax rates on capital per worker are not statistically significant except in some cases. Next, in the second part, Clausing regresses the current wage rate (logarithmic value) on the average capital per worker over the most recent six years (the current year and the five previous years) as well as several control variables including the average years of schooling for the population aged 25 years and above, finding that an increase in capital per worker causes the wage rate to rise. These results suggest that labor does not bear the burden of corporate tax.

Most empirical studies on the incidence of corporate tax on wages separately investigate whether a rise in the corporate tax rate causes the wage rate to decline, whether a rise in the corporate tax rate causes capital per worker to decline, and whether a decrease in capital per worker causes the wage rate to decline. However, since capital per worker and the wage rage are endogenous variables decided simultaneously in the theoretical model of the corporate tax incidence, a change in the wage rate affects capital per worker. In addition, there is a possibility that a change in the wage rage (capital per worker) affects the corporate tax rate in the empirical study. Since labor cost and depreciation are deducted from the taxable income in calculating the corporate tax, a change in the wage rate (capital per worker) is considered to affect the effective tax rate (the ratio of the corporate tax liability to pre - tax profit) and the ratio of the corporate tax revenues to GDP.

In order to solve such an endogeneity problem, Clausing (2012) regards the wage rate, capital per worker, and the difference in the corporate tax rate as endogenous variables, doing the analysis using a VAR (vector auto - regression) model. In a VAR model, each endogenous variable is specified to depend on lagged values of its own variable, the other endogenous variables, and the exogenous variables. She uses a country - level panel data set of OECD counties, estimating VAR models to test Granger causality. Since the results depend on the wage rate (hourly wages, monthly wages, annual wages), the difference in the corporate tax rate (the statutory tax rate, the effective tax rate, the ratio of the corporate tax revenues to GDP), and the number of lags which a VAR model contains, some results show that the corporate tax rate does not affect the wage rate, others show that the corporate tax rate affect the wage rate. These results indicate that the incidence of the corporate tax on wages are not clear.

On the other hand, Arulampalam et al. (2012) classify the incidence of the corporate income tax on wages into two categories: the indirect incidence and the direct incidence. The indirect incidence assumes companies operating in perfect competition like the open - economy Harberger model and has an effect on wages through reducing capital per worker (labor productivity). The direct incidence assumes companies operating in imperfect competition and has an effect on wages through directly reducing the quasi - rent paid out in wages over which the worker and the company can bargain. In order to capture the effect of direct incidence, they uses a firm - level panel data set of 9 EU counties over the period 1996 - 2005, regressing the annual labor cost per employee (logarithmic values) on the tax liability per employee (logarithmic values) as well as the control variables including the value - added per employee (logarithmic values) to proxy labor productivity which reflects the effect of the indirect incidence. Arulampalam et al. treat the tax liability as endogenous and uses instruments: the statutory tax rate (STR), the effective marginal tax rate (EMTR), the effective average tax rate (EATR), etc. They find that an increase of 1 dollar in the tax liability per employee reduces annual labor cost per employee by 49 cents.

III. Empirical Model and Data

III-1. Empirical Model

In this section, we explain the empirical model to analyze the effect of the difference in the corporate tax rate on wages using a time-series data set of the Japanese manufacturing industry. Although we use a VAR model following Clausing (2012), we treat the difference in the corporate tax rate as an exogenous variable. Since labor cost and depreciation are deducted from the taxable income in calculating the corporate tax, the ratio of the corporate tax liability to pre-tax profit and the ratio of the corporate tax revenues to GDP, which are used in Clausing's study, are affected by the wage rate (capital per worker). Therefore, we use the statutory tax rate (STR), the effective marginal tax rate (EMTR), and the effective average tax rate (EATR) because these variables are used as instrument variables for the tax variable in Arulampalam et al. (2012). Our empirical specifications are as follows:

$$\left(\frac{K}{L}\right)_t = \alpha_1 + \beta_{1K}\left(\frac{K}{L}\right)_{t-1} + \beta_{1W}Wages_{t-1}$$
$$+\beta_{1T}Ave\_D\_TaxRate + \beta_{1Y}GDPC_{t-1} + \gamma_1 Dummy09 + \varepsilon_{1,t} \quad (1)$$

$$Wages_t = \alpha_2 + \beta_{2K}\left(\frac{K}{L}\right)_{t-1} + \beta_{2W}Wages_{t-1}$$
$$+\beta_{2T}Ave\_D\_TaxRate + \beta_{2Y}GDPC_{t-1} + \gamma_2 Dummy09 + \varepsilon_{2,t} \quad (2)$$

where K/L = capital per worker (manufacturing), $Wages$ = wage rate (manufacturing), $Ave\_D\_TaxRate$ = the average difference in the corporate tax rate over the past three years, $GDPC$ = real GDP per capita, $Dummy09$ = dummy variable equal to 1 for an observation in 2009, and ε = error term.

We use a simple VAR model with the first period lagged variables because the sample size of data used in this paper is small. In the regression equation (1) which explains capital per worker, the current capital per worker is related to the lagged capital per worker, the lagged wage rate, the average difference in the corporate tax rate over the past three years (to capture the effects of the corporate tax on the long-term equilibrium), the lagged value-added per capita (used in Clausing's study), and the dummy variable for 2009 (to capture the effect of economic downturn). In the regression equation (2) which explains wage rate, the current wage rate is related to the same independent variables as in the equation (1). We assume that the error terms in these equations do not have serial correlations and follow the normal distribution with zero means, using a maximum-likelihood method to estimate this model.

Since an increase in the difference in the corporate tax rate causes capital to move from the domestic corporate sector to the foreign counties, the expected sign of the coefficient on the difference in the corporate tax rate in the equation (1) is negative ($\beta_{1T} < 0$). In addition, since an increase in capital per worker (labor productivity) causes wages to rise, the expected sign of the coefficient on capital per worker in the equation (2) is positive ($\beta_{2K} > 0$). Furthermore, since an increase in the difference in the corporate tax rate (a rise in the corporate tax rate) causes rents paid out in wages to decrease, the expected sign of the coefficient on the difference in the corporate tax rate in the equation (2) is negative ($\beta_{2T} < 0$).

We estimate a VAR model to investigate whether these expected signs are correct. We also estimate how the effects of an increase of 1% in the difference in the corporate tax rate on capital per worker and on the wage rate change in a long period (the dynamic multiplier function).

III-2. Data

This subsection describes the data used in this paper. First of all, we use the difference in the corporate tax rate concerning three corporate tax measures calculated by Klemm (2005): the statutory tax rate (STR), the effective marginal tax rate (EMTR), and the effective average tax rate (EATR) of 19 developed countries over the period 1982-2005,[1] calculating these corporate tax measures over the period 2006-2012 referring to statutory tax rates and depreciation allowances (kind of allowance, depreciation rate, and life-time of asset) provided by Spengel et al. (2014).[2] The STR is the combined central and sub-central statutory tax rate adjusted for central government deductibility of sub-central taxation. In deriving the formulas for the EMTR and the EATR, Devereux et al. (2002) considered a simple one period investment, in which a firm increases its capital stock for one period only.[3] The EMTR is defined as $EMTR = (\tilde{p} - r) / \tilde{p}$ where $\tilde{p}$ = cost of capital with tax (taxation at the shareholder level is ignored) and r = cost of capital without tax (real interest rate). The cost of capital is defined as the financial return for which NPV (net present value) of the investment equals

---

[1] Klemm (2005) updates three tax measures calculated by Devereux et al. (2002). 19 developed countries are as follows: Australia, Austria, Belgium, Canada, Finland, France, Great Britain, Germany, Greece, Ireland, Italy, Japan, Netherland, Norway, Portugal, Spain, Sweden, Switzerland, and the United States of America.

[2] Although Spengal et al. (2014) assumed that the life-time of machinery was 7 years to calculate a depreciation rate (straight line method) if it is not available, we assume that the life-time of machinery is 8 years as Klemm (2005) does. Because the statutory tax rates and depreciation allowances in Australia are not provided by Spengal et al. (2014), we refer to those items provided by CBT (Oxford University Centre for Business Taxation). We calculate the corporate tax rates in Switzerland over the whole period using the statutory tax rate provided by the OECD. We also calculate the corporate tax rate for industrial buildings in Japan over the period 1998-2012 referring to Suzuki (2009).

[3] This approach is based on Devereux and Griffith (2003).

zero. The EATR is defined as $EATR = (R^{*} - R)/[p/(1 + r)]$ where R^{*} = NPV of the investment without tax, R = NPV of the investment with tax, and p = financial return ($p > \tilde{p}$). We use the calculations based on a one period investment in machinery or industrial buildings, financed by equity or retained earnings.[4] The difference in the corporate tax rate is defined as the difference between the corporate tax rate in Japan and the average corporate tax rate of the other 18 developed countries.

Next, in order to calculate capital per worker, wage rate, and value-added per capita in Japan, we use real net capital stock (manufacturing), the number of workers (manufacturing), nominal labor cost (manufacturing), and real value-added (all industries) provided by RIETI (2015). Nominal labor cost is cash earnings such as scheduled cash earnings, non-scheduled cash earnings (overtime pay), and special cash earnings (bonuses, allowances, etc.). Capital per worker is calculated by dividing real net capital stock by the number of workers. The wage rate is calculated by dividing nominal labor cost by the number of workers and then is converted to a real value using CPI provided by Ministry of Internal Affairs and Communications. Real value-added per capita is calculated by dividing real value-added by population provided by the OECD. We can use a time-series data set over the period 1985-2012 (28 years) in this analysis.

Since the aggregated values in "JIP Database 2015" provided by RIETI includes the domestic non-corporate sector as well as domestic corporate sector, although they cannot capture capital (labor) movement from the domestic corporate sector to domestic non-corporate sector, they can capture capital movement from the domestic corporate sector to foreign countries.

---

[4] Under the mentioned above conditions, the cost of capital with tax is expressed as follows:

$$\tilde{p} = \frac{(1-A)}{(1-\tau)}\{r+\delta\} - \delta$$

where τ=corporate tax rate, A=present discounted value of depreciation allowance and δ=economic depreciation rate. Using this expression, we express the EMTR as follows:

$$EMTR = \frac{(r+\delta)(\tau - A)}{(r+\delta)(1-A) - \delta(1-\tau)}$$

In addition, NPV of a one period investment without tax and with tax are respectively expressed as follows:

$$R^{*} = \frac{p-r}{1+r} \quad \text{and} \quad R = \frac{1}{1+r}\{(p+\delta)(1-\tau) - (r+\delta)(1-A)\}$$

Using these expressions, we express the EATR as follows:

$$EATR = \tau - \frac{rA - \delta(\tau - A)}{p}$$

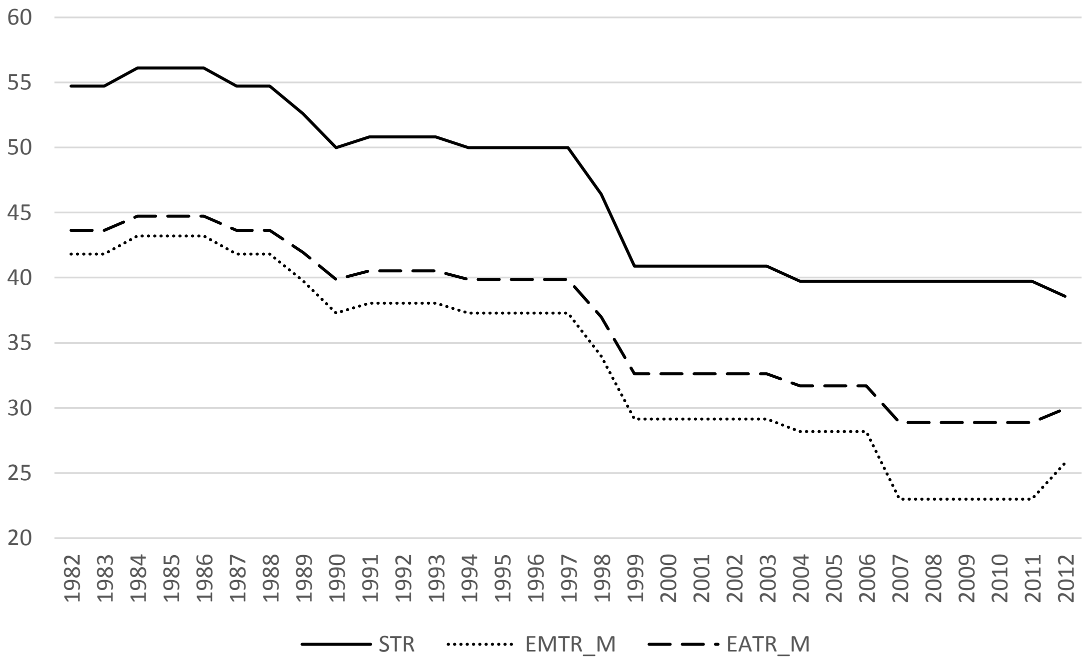
In order to calculate the EMTR and the EATR, we assume an economic depreciation rate (for machinery) of 12.25%, an economic depreciation rate (for industrial buildings) of 3.61%, an annual inflation rate of 3.5%, a real interest rate of 10%, and a financial return of 20% for all countries and all years.

III-3. Descriptive Statistics for Main Variables

Figure 1 shows the change in the statutory tax rate (STR), the effective marginal tax rate for machinery (EMTR_M), and the effective average tax rate for machinery (EATR_M) in Japan. The STR, which was 56.1% in 1984, declined by about 5% over the period 1989-1990 and remained flat at 50% till 1997. It declined again by about 9% over the period 1998-1999 and remained flat at a level smaller than 40% since 2004. The EMTR_M is always far below the STR due to the tax-shield of depreciation allowance. Although the difference between the STR and the EMTR_M remained around 12% till 2006, it increased to 17% over the period 2007-2011. The EMTR_M declines in this period because depreciation rate increased from 2 times (1/life-time of asset) to 2.5 times (1/life-time of asset). EMTR_M rose in 2012 because the depreciation rate decreased from 2.5 times (1/life-time of asset) to 2 times (1/life-time of asset). Although the EATR_M is always below STR in the same way, it is above the EMTR_M by 1.5-5.9%.

Figure 2 shows the change in the statutory tax rate (STR), the effective marginal tax rate for industrial buildings (EMTR_B), and the effective average tax rate for industrial buildings (EATR_B). The change in the STR is drawn again compared with the change in the EMTR_B and the EATR_B. Although the EMTR_B is always below the STR, the difference between the STR and the EMTR_B is only 1-2%, which is much smaller than the difference between

Figure 1 Change in STR, EMTR_M, and EATR_M (Unit: %)



the STR and the EMTR_M. This is because the depreciation rate (the tax - shield) for industrial buildings is much smaller than machinery and because the economic depreciation rate for industrial buildings is smaller than machinery. In the same way, the difference between the STR and the EATR_B is too small. In addition, there is almost no difference between the EATR_B and the EMTR_B. These findings indicate that the Japanese corporate tax system treats investment in industrial buildings much worse than machinery.

Figure 3 shows the change in the difference in the corporate tax rate (D_TaxRate). The D_TaxRate is defined as the difference between the corporate tax rate in Japan and the average corporate tax rate in the other 18 developed countries. Although every D_TaxRate tended to increase till 1993 (it decreased temporarily over the period 1989 - 1990), it tended to decrease since 1994, declining significantly over the period 1998 - 1999. It tended to increase gradually since 2000. The change in the D_TaxRate is very different from the change in the corporate tax rate shown in Figure 1 - 2.

Table 1 shows the difference in the corporate tax rate (D_TaxRate) in 1982, 1993, 1999, and 2012. In focusing on the values in 2012, the difference in the statutory tax rate (D_STR), the difference in the effective marginal tax rate for machinery (D_EMTR_M), the difference in the effective average tax rate for machinery (D_EATR_M), the difference in the effective marginal tax rate for industrial buildings (D_EMTR_B), and the difference in the effective average tax rate for industrial buildings (D_EATR_B) are 11.12%, 9.02%, 8.87%, 11.70%, and 11.16%, respectively. This indicates that the corporate tax rates in Japan are higher than the average corporate tax rate in the other 18 developed countries by 9 - 12%. Although the

Figure 2 Change in STR, EMTR_B, and EATR_B (Unit: %)

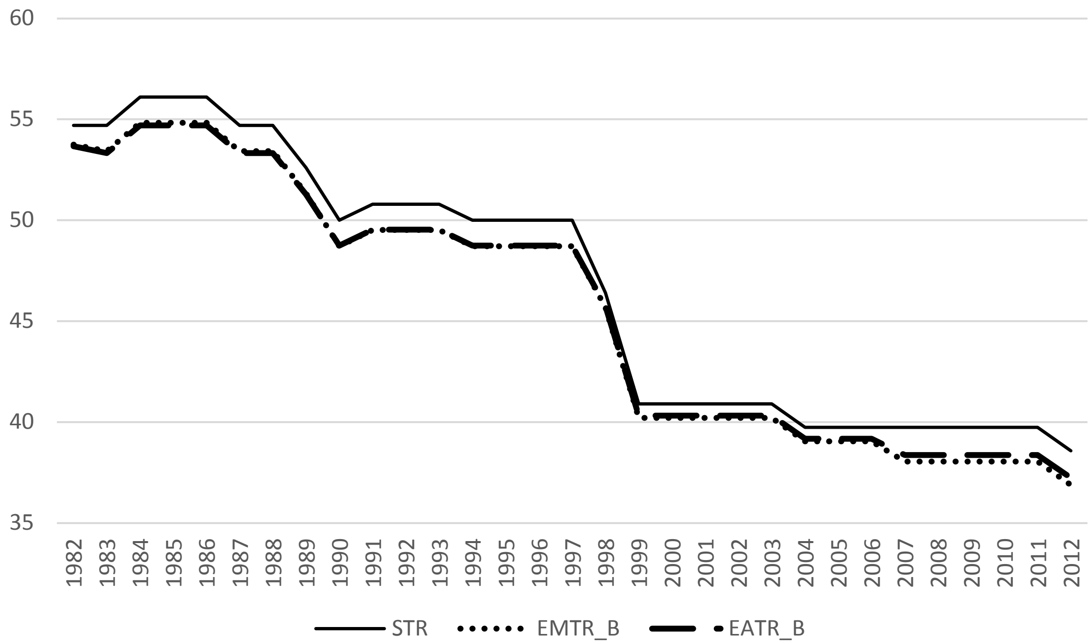


Figure 3 Change in D_TaxRate (Unit: %)

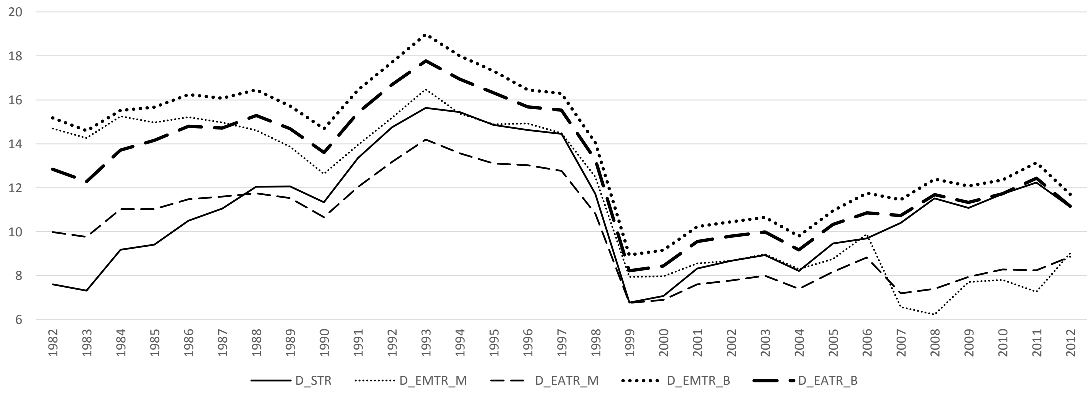


Table 1 Change in D_TaxRate (Unit: %)

Year	D_STR	D_EMTR_M	D_EATR_M	D_EMTR_B	D_EATR_B
1982	7.60	14.69	9.98	15.18	12.84
1993	15.63	16.48	14.19	18.98	17.77
1999	6.77	7.95	6.77	8.94	8.22
2012	11.12	9.02	8.87	11.70	11.16

difference in the EMTR and the EATR decreases from 1982 to 2012 (the decline in the difference in EATR is very small), the difference in the STR increase during that period. We find that the Japanese corporate tax system treats investment in industrial buildings much worse than machinery in comparison with the other 18 developed counties since the difference in the corporate tax rate for industrial buildings is higher than the difference in the corporate tax rate for machinery by several percent.

Figure 4 shows the change in manufacturing capital per worker (K/L) and wages per worker (Wages). Capital per worker (left axis) has a rising trend, increasing from 8.33 (in 1982) to 23.79 (in 2012) million yen. In addition, wages per worker (right axis) also has a rising trend over the whole period except around 2009, which is more moderate than that of capital per worker, increasing from 4.03 (in 1982) to 5.69 (in 2012) million yen.

However, as Table 2 shows, the average annual change rate of capital per worker (K/L) and wages per worker (Wages) is not constant over the whole period. Although the average change rate of capital per worker slightly increased from 3.71% (in the 1980s) to 4.8% (in the 1990s), it decreased to 2.63% in the 2000s (except in 2009), further decreasing to -0.04% in the 2010s (except in 2010). On the other hand, although the average change rate of wage per worker significantly decreased from 2.13% (in the 1980s) to 0.54% (in the 1990s), it slightly increased to 1.06% in the 2000s (except in 2009), further increasing to 2.27% in the 2010s (except in 2010). In this way, the average change rate of wages per worker has a different tendency from that of capital per worker.

Table 3 summarizes the descriptive statistics for main variables (1985-2012). As we

Figure 4 Change in manufacturing K/L and Wages (Unit: 1 million yen)

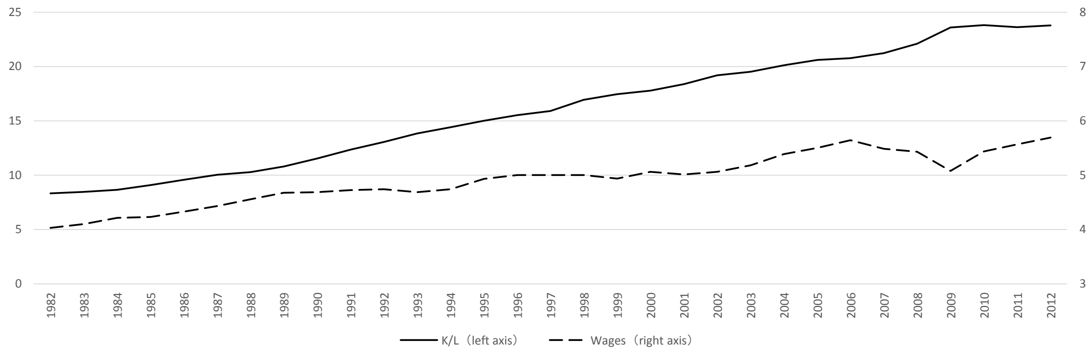


Table 2 Average annual change rate of manufacturing K/L and Wages (Unit: %)

Period	K/L	Wages
1983-1989	3.71	2.13
1990-1999	4.80	0.54
2000-2008	2.63	1.06
2009	6.58	-6.72
2010	0.88	6.83
2011-2012	-0.04	2.27

Table 3 Descriptive statistics for main variables (1985-2012)

Variable		Unit	Obs	Mean	SD	Min	Max
K/L	Real capital per worker (manufacturing)	1 million yen	28	16.79	4.77	9.08	23.80
Wages	Real wages per worker (manufacturing)	1 million yen	28	5.01	0.40	4.23	5.69
L_GDPC	Lagged real value-added per capita	1 million yen	28	3.81	0.42	2.86	4.42
Ave_D_STR	Difference in STR (average over past 3 years)	%	28	11.07	2.42	7.39	15.31
Ave_D_EMTR_M	Difference in EMTR (machinery, average over past 3 years)	%	28	11.82	3.29	6.84	15.68
Ave_D_EATR_M	Difference in EATR (machinery, average over past 3 years)	%	28	10.14	2.24	7.09	13.64
Ave_D_EMTR_B	Difference in EMTR (buildings, average over past 3 years)	%	28	13.96	2.83	9.44	18.23
Ave_D_EATR_B	Difference in EATR (buildings, average over past 3 years)	%	28	12.97	2.63	8.74	17.13

explained in the section on the empirical model, we use the average difference in the corporate tax rate over the past three years (Ave_D_TaxRate) because it takes enough time until corporate tax affects capital (wages). The mean of the average difference in the statutory tax rate (Ave_D_STR), the effective marginal tax rate for machinery (Ave_D_EMTR_M), the effective average tax rate for machinery (Ave_D_EATR_M), the effective marginal tax rate for industrial buildings (Ave_D_EMTR_B), and the effective average tax rate for industrial buildings (Ave_D_EATR_B) are 11.07%, 11.82%, 10.14%, 13.96%, and 12.97%, respectively. This indicates that the average difference in the corporate tax rate for industrial buildings is much higher than machinery. In addition, the mean of manufacturing capital per worker (K/L), manufacturing wages per worker (Wages), and the lagged real value - added per capita (L_GDPC) are 16.79, 5.01, and 3.81 million yen, respectively.

IV. Results

IV-1. Estimation Results for VAR models

We run five VAR models to consider the 5 different tax rates. Table 4 reports the estimation results for VAR models.[5] Column (1) is the estimates for the model using the average difference in the STR. In the equation for K/L, the estimate of the coefficient on Ave_D_STR, as we expected, is negative and statistically significant, indicating that a rise of 1% in the average difference in the STR over the past three years decreases capital per worker by 39,000 yen. Focusing on the other variables, we find that the estimates of coefficients on L_K/L and L_GDPC are positive and statistically significant and that the estimate of the coefficient on L_Wages is negative and statistically significant. These results indicate that an increase in lagged capital per worker (lagged value-added per capita) increases current capital per worker and that an increase in lagged wages per worker decreases current capital per worker. In addition, the estimate of the coefficient on Dummy09 is positive and statistically significant, indicating that the economic downturn in 2009 increased capital per worker.

On the other hand, in the equation for Wages, the estimate of the coefficient on L_K/L, as we expected, is positive and statistically significant, indicating that an increase of 1 million yen in lagged capital per worker increases current wages per worker by 43,000 yen. Contrary to our expectation, the estimate of the coefficient on Ave_D_STR is not statistically significant. This implies that we cannot observe the direct incidence, which has an effect on wages through directly reducing the quasi-rent paid out in wages over which the worker and the company can bargain, using industry-level data. Focusing on the other variables, we find that the estimate of the coefficient on L_Wages is positive and statistically significant. This result indicates that an increase in lagged wages per worker increases current wages. In addition, the estimate of the coefficient on Dummy09 is negative and statistically significant, indicating that the economic downturn in 2009 decreased wages per worker. Furthermore, the estimate of the coefficient for L_GDPC is not statistically significant, indicating that lagged value-added per capita does not affect current wages per worker.

Concerning columns (2) to (5), we will explain nothing but the effect of the average difference in the corporate tax rate in the equation for K/L because the effects of the other variables in the equation explaining K/L and those of variables in the equation for Wages are similar to in the case of column (1). Column (2) is the estimates for the model using the

[5] As we explained in the section on the empirical model, some conditions are satisfied to use a VAR model. First one is that the error terms have no serial correlation. Second one is that the error terms follow the normal distribution with zero mean. We did an LM test for the former and Jaque-Bera test for the latter, confirming that these conditions were satisfied. We also confirmed that stationarity conditions for VAR models were satisfied. In addition, as the sample size was small, we adjusted the degree of freedom to estimate the error variance-covariance matrix using the average number of parameters over the two equations.

Table 4 Estimation results for VAR models

		(1)	(2)	(3)	(4)	(5)
		TaxRate=STR	TaxRate=EMTR_M	TaxRate=EATR_M	TaxRate=EMTR_B	TaxRate=EATR_B
Eq. K/L	L_K/L	0.913 ***	0.893 ***	0.900 ***	0.904 ***	0.904 ***
		(41.75)	(29.18)	(34.67)	(39.04)	(39.16)
	L_Wages	-0.702 *	-0.499	-0.600	-0.640 *	-0.658 *
		(-1.87)	(-1.37)	(-1.62)	(-1.77)	(-1.81)
	Ave_D_TaxRate	-0.039 **	-0.042	-0.049 *	-0.042 **	-0.043 **
		(-2.07)	(-1.53)	(-1.79)	(-2.13)	(-2.16)
	L_GDPC	1.524 ***	1.287 ***	1.424 ***	1.379 ***	1.430 ***
		(4.19)	(3.86)	(4.00)	(4.27)	(4.29)
	Dummy09	0.974 ***	0.965 ***	0.961 ***	1.007 ***	0.994 ***
		(4.95)	(4.68)	(4.75)	(5.17)	(5.10)
	Constant	0.029	0.305	0.179	0.567	0.439
		(0.03)	(0.29)	(0.18)	(0.55)	(0.44)
Eq. Wages	L_K/L	0.043 ***	0.043 ***	0.044 ***	0.044 ***	0.044 ***
		(4.48)	(3.32)	(3.92)	(4.30)	(4.37)
	L_Wages	0.706 ***	0.661 ***	0.679 ***	0.690 ***	0.698 ***
		(4.31)	(4.27)	(4.26)	(4.35)	(4.38)
	Ave_D_TaxRate	0.007	0.004	0.006	0.007	0.008
		(0.83)	(0.32)	(0.55)	(0.76)	(0.86)
	L_GDPC	-0.191	-0.131	-0.159	-0.160	-0.175
		(-1.21)	(-0.92)	(-1.03)	(-1.13)	(-1.20)
	Dummy09	-0.420 ***	-0.423 ***	-0.421 ***	-0.426 ***	-0.424 ***
		(-4.90)	(-4.83)	(-4.83)	(-4.98)	(-4.97)
	Constant	1.484 ***	1.500 ***	1.484 ***	1.408 ***	1.412 ***
		(3.61)	(3.30)	(3.45)	(3.12)	(3.23)
	Log likelihood	45.649	44.492	44.975	45.748	45.846
	Obs	28	28	28	28	28

Z statistics in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%

average difference in the EMTR for machinery. In the equation for K/L, the estimate of the coefficient on Ave_D_EMTR_M is negative but not statistically significant, indicating that the average difference in EMTR for machinery over the past three years does not affect current capital per worker. Column (3) is the estimates for the model using the average difference in the EATR for machinery. In the equation for K/L, the estimate of the coefficient on Ave_D_EATR_M, as we expected, is negative and statistically significant at the 10% level, indicating that a rise of 1% in the average difference in EATR for machinery over the past three years decreases current capital per worker by 49,000 yen. Column (4) is the estimates for the model using the average difference in the EMTR for industrial buildings. In the equation for K/L, the estimate of the coefficient on Ave_D_EMTR_B, as we expected, is negative and statistically significant, indicating that a rise of 1% in the average difference in EMTR for industrial buildings over the past three years decreases current capital per worker by 42,000 yen. Column (5) is the estimates for the model using the average difference in the EATR for industrial buildings. In the equation for K/L, the estimate of the coefficient on Ave_D_EATR_B, as we expected, is negative and statistically significant, indicating that a rise of 1% in the average difference in EATR for industrial buildings over the past three years decreases current capital per worker by 43,000 yen.

The mentioned above results are summarized as follows. First, a rise in the average difference in the corporate tax rate (except the EMTR for machinery) over the past three years decreases current capital per worker. This suggests that an increase in the difference in the corporate tax rate causes capital to move abroad, which reduces capital per worker in the domestic country. Second, an increase in lagged capital per worker increases current wages per worker. This suggests that an increase in capital per worker causes labor productivity to rise, which increases the wage rate in the domestic country. In addition, these findings indicate the presence of the following process of the indirect incidence: increase in the difference in the corporate tax rate ⇒ decline in capital per worker (decline in labor productivity) ⇒ decline in the wage rate. Third, in controlling the effect of capital per worker, the average difference in the corporate tax rate over the past three years does not affect current wages per worker. This suggests that we cannot observe the direct incidence, which has an effect on wages through directly reducing the quasi-rent paid out in wages over which the worker and the company can bargain, using time-series data.

IV-2. Dynamic Multiplier

As Table 4 shows, the estimates of the coefficients on Ave_D_TaxRate and L_GDPC are not statistically significant in the equation for Wages. Then, in estimating VAR models, we constrain the coefficients on Ave_D_TaxRate and L_GDPC in the equation for Wages to be zero. Table 5 reports the estimation results for VAR models with constraints on the coefficients. Each coefficient estimate in the equation for Wages is identical among all columns because we omit Ave_D_TaxRate which is the only variable characterizing each equation. However, the coefficient estimates in the equation for Wages are not very different between Table 5 and

Table 5 Estimation results for VAR models with constraints

		(1)	(2)	(3)	(4)	(5)
		TaxRate=STR	TaxRate=EMTR_M	TaxRate=EATR_M	TaxRate=EMTR_B	TaxRate=EATR_B
Eq. K/L	L_K/L	0.914 ***	0.896 ***	0.903 ***	0.907 ***	0.907 ***
		(42.84)	(30.42)	(35.88)	(40.20)	(40.31)
	L_Wages	-0.629 *	-0.437	-0.532	-0.574 *	-0.591 *
		(-1.74)	(-1.25)	(-1.49)	(-1.64)	(-1.68)
	Ave_D_TaxRate	-0.036 **	-0.039	-0.045 *	-0.039 **	-0.040 **
		(-1.98)	(-1.54)	(-1.74)	(-2.06)	(-2.07)
	L_GDPC	1.431 ***	1.208 ***	1.336 ***	1.299 ***	1.346 ***
		(4.12)	(3.84)	(3.95)	(4.21)	(4.23)
	Dummy09	0.982 ***	0.974 ***	0.971 ***	1.012 ***	1.000 ***
		(5.10)	(4.83)	(4.90)	(5.31)	(5.25)
	Constant	-0.043	0.227	0.098	0.456	0.334
		(-0.05)	(0.22)	(0.10)	(0.46)	(0.34)
Eq. Wages	L_K/L	0.039 ***	0.039 ***	0.039 ***	0.039 ***	0.039 ***
		(4.31)	(4.31)	(4.31)	(4.31)	(4.31)
	L_Wages	0.557 ***	0.557 ***	0.557 ***	0.557 ***	0.557 ***
		(5.22)	(5.22)	(5.22)	(5.22)	(5.22)
	Ave_D_TaxRate	0	0	0.000	0	0.000
		(omitted)	(omitted)	(-0.33)	(omitted)	(1.10)
	L_GDPC	0	0	0	0	0.000
		(omitted)	(omitted)	(omitted)	(omitted)	(-1.18)
	Dummy09	-0.438 ***	-0.438 ***	-0.438 ***	-0.438 ***	-0.438 ***
		(-5.12)	(-5.12)	(-5.12)	(-5.12)	(-5.12)
	Constant	1.630 ***	1.630 ***	1.630 ***	1.630 ***	1.630 ***
		(4.11)	(4.11)	(4.11)	(4.11)	(4.11)
	Log likelihood	44.741	43.955	44.310	44.909	44.907
	Obs	28	28	28	28	28

Z statistics in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%

Note: We constrain the coefficients on Ave_D_TaxRate and L_GDPC in the equation for Wages to be zero.

Table 4. This indicates that constraints on the coefficients do not affect the estimation results so much. In the following, we estimate how the effects of a rise of 1% in the average difference in the corporate tax rate on capital per worker and on wages per worker change over a long period (DM functions, dynamic multiplier functions) using the estimation results for VAR models with constraints.

Figure 5 shows the dynamic multiplier function (Ave_D_TaxRate⇒K/L). This is a figure which shows how the effects of a rise of 1% in the average difference in the corporate tax rates over the past three years on capital per worker change over a 16 - year period. In the cases of the statutory tax rate (Ave_D_STR⇒K/L), the effective marginal tax rate for industrial buildings (Ave_D_EMTR_B⇒K/L), and the effective average tax rate for industrial buildings (Ave_D_EATR_B⇒K/L), the dynamic multiplier estimates over the period 0 - 11 are statistically significant, indicating that an increase in the difference in the corporate tax rates decreases capital per worker for a long time.

In the cases of the effective average tax rate for machinery (Ave_D_EATR_M⇒K/L) and the effective marginal tax rate for machinery (Ave_D_EMTR_M⇒K/L), the period over which the dynamic multiplier estimates are statistically significant is from term 4 to 11 and from term 6 to 11, respectively, being shorter than in the cases of the other corporate tax rates.

The dynamic multiplier estimate (absolute value) is the largest in term zero, declining as

Figure 5 Dynamic multiplier function (Ave_D_TaxRate⇒K/L)

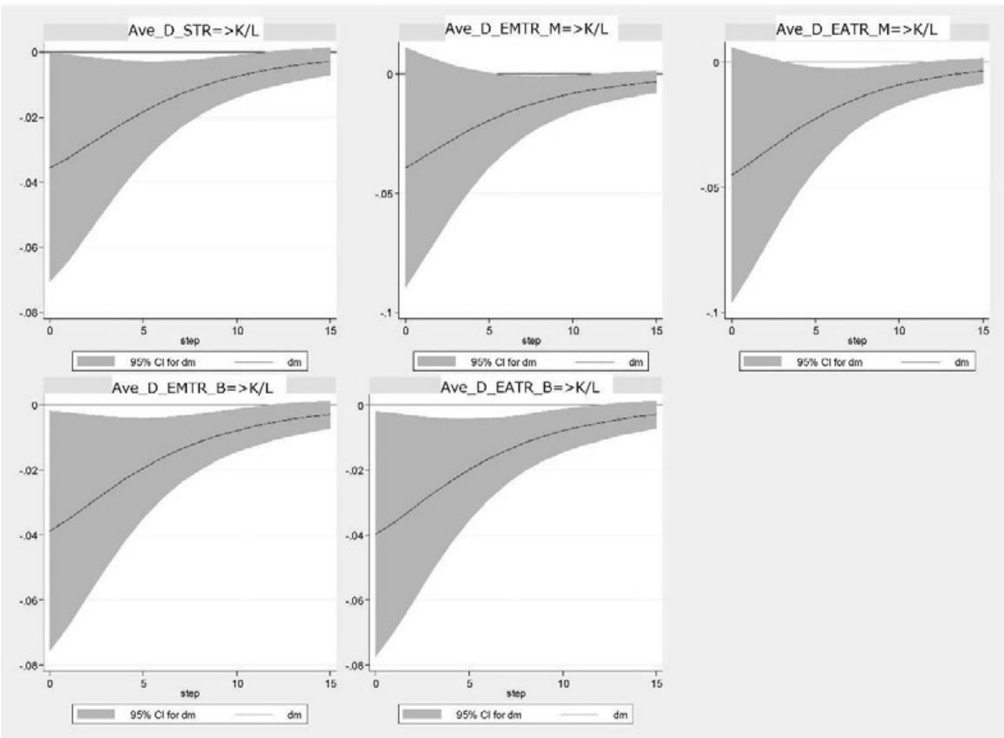
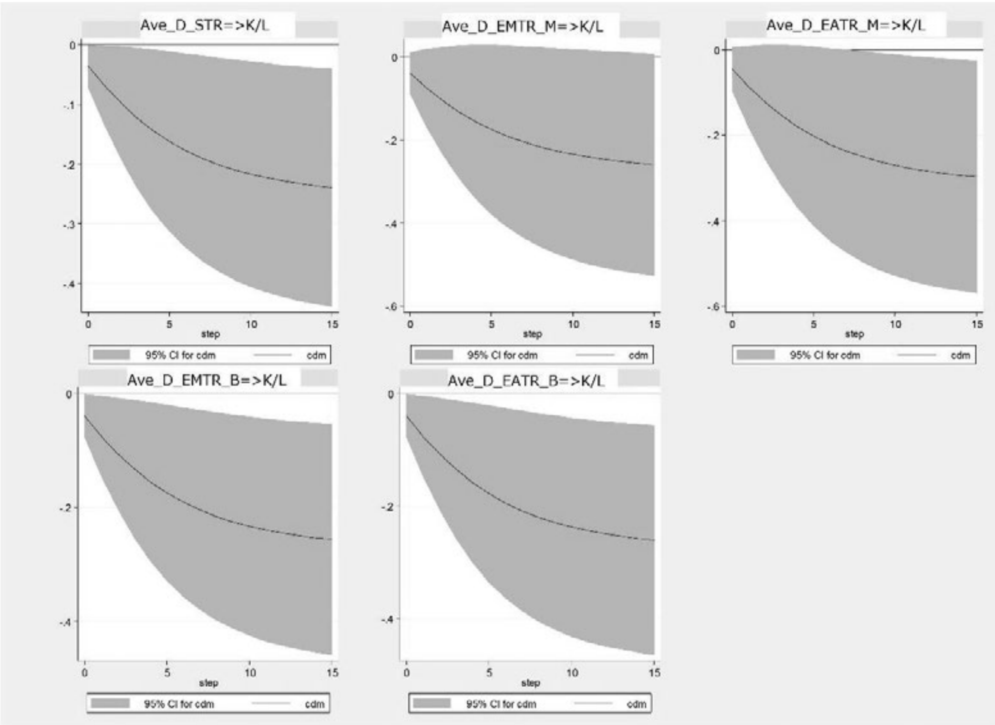


Figure 6 Cumulative dynamic multiplier function (Ave_D_TaxRate⇒K/L)

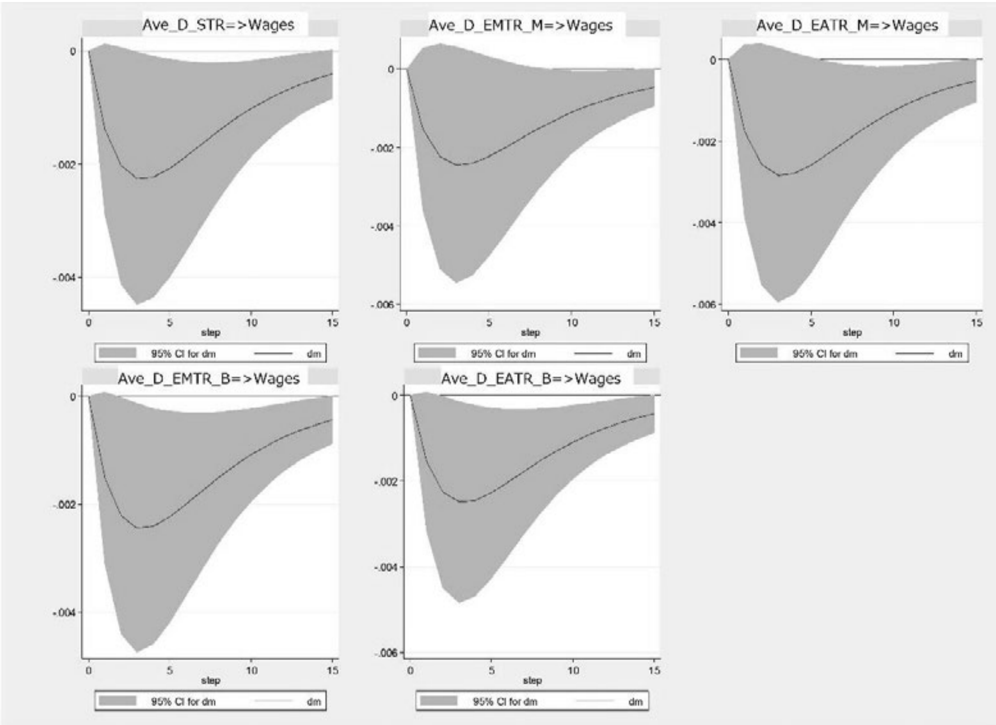


time passes. In the cases of the STR, the EMTR_B, and the EATR_B, the dynamic multiplier estimates (absolute values) in term zero are about 36,000, 39,000, and 40,000 yen, respectively.

In addition, Figure 6 shows the cumulative dynamic multiplier function (Ave_D_ TaxRate⇒K/L). In the cases of the STR, the EMTR_B, and the EATR_B, the cumulative dynamic multiplier estimates over the period 0 - 15 are statistically significant. In the case of the EATR_M, the cumulative dynamic multiplier estimates over the period 8 - 15 are statistically significant. The cumulative dynamic multiplier estimates (absolute values) in the 15th term are about 240,000 (in the case of the STR), 260,000 (in the cases of the EMTR_B and the EATR_B), and 300,000 (in the case of the EATR_M) yen. These findings indicate that although an increase of 1% in the average difference in the corporate tax rate decreases capital per worker, the total amount of decrease in capital per worker over a 16 - year period is only 240,000 to 300,000 yen.

Figure 7 shows the dynamic multiplier function (Ave_D_TaxRate⇒Wages). This is a figure which shows how the effects of a rise of 1% in the average difference in the corporate tax rates over the past three years on wages change over a 16 - year period. As wages per worker are indirectly affected by an increase in the difference in the corporate tax rate through a change in capital per worker, the dynamic multiplier occurs since term 1. As Figure 7 shows, in all cases, the dynamic multiplier estimates in term 1 are not statistically significant. In the cases of the statutory tax rate (Ave_D_STR⇒Wages), the effective marginal tax rate

Figure 7 Dynamic multiplier function (Ave_D_TaxRate⇒Wages)



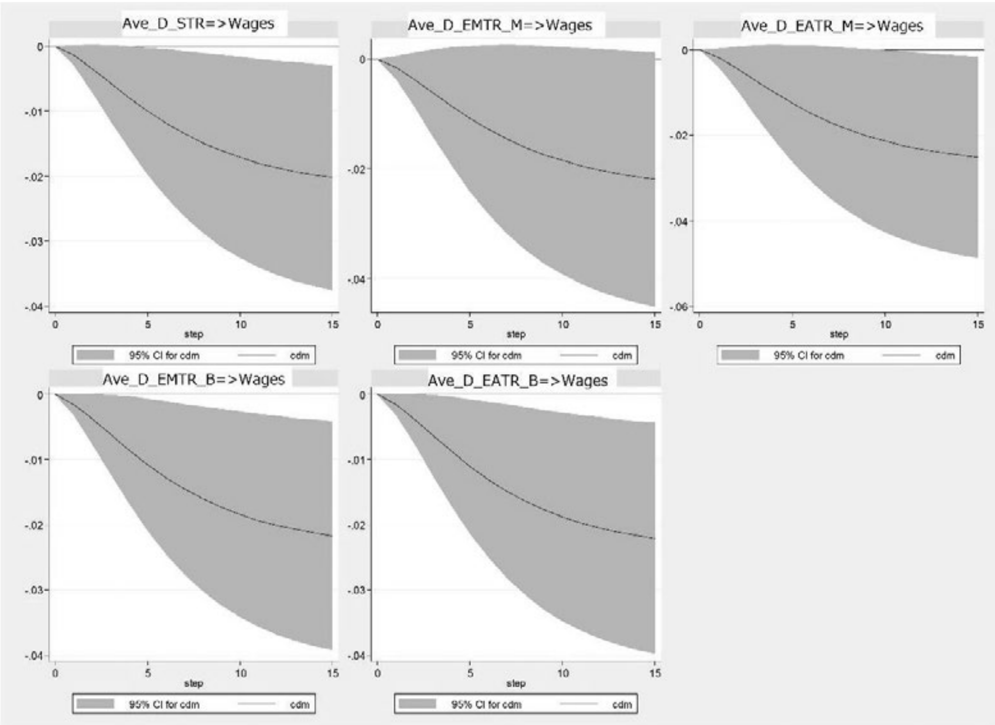
for industrial buildings (Ave_D_EMTR_B⇒Wages), and the effective average tax rate for industrial buildings (Ave_D_EATR_B⇒Wages), the dynamic multiplier estimates over the period 2(3) - 14 are statistically significant, indicating that an increase in the difference in the corporate tax rates decreases wages per worker for a long time.

In the cases of the effective average tax rate for machinery (Ave_D_EATR_M⇒Wages) and the effective marginal tax rate for machinery (Ave_D_EMTR_M⇒Wages), the period over which the dynamic multiplier estimates are statistically significant is from term 6 to 14 and from term 9 to 14, respectively, being shorter than in the cases of the other corporate tax rates.

The dynamic multiplier estimate (absolute value) increases from term 1 to 3, decreasing since term 4. In the cases of the STR, the EMTR_B, and the EATR_B, the dynamic multiplier estimates (absolute values) in term 3 are about 2,300, 2,400, and 2,500 yen, respectively.

In addition, Figure 8 shows the cumulative dynamic multiplier function (Ave_D_TaxRate⇒Wages). In the cases of the STR, the EMTR_B, and the EATR_B, the cumulative dynamic multiplier estimates over the period 3(4) - 15 are statistically significant. In the cases of the EATR_M, the cumulative dynamic multiplier estimates over the period 10 - 15 are statistically significant. The cumulative dynamic multiplier estimates (absolute values) in term 15 are about 20,000 (in the case of the STR), 22,000 (in the cases of the EMTR_B and the EATR_B), and 25,000 (in the case of the EATR_M) yen. These findings indicate that

Figure 8 Cumulative dynamic multiplier function (Ave_D_TaxRate⇒Wages)



although an increase of 1% in the average difference in the corporate tax rate decreases wages per worker, the total amount of decrease in wages per worker over a 16 - year period is only 20,000 to 25,000 yen.

V. Conclusion

We estimate the effect of the difference in the corporate tax rate (difference between the corporate tax rates in Japan and the average corporate tax rate in the other 18 developed counties) on capital per worker and the effect of capital per worker on wages per worker based on a VAR model using a time - series data set of the Japanese manufacturing industry. In addition, we estimate how the effects of an increase of 1% in the difference in the corporate tax rate on capital per worker and on the wage rate over a long period (the dynamic multiplier functions). The main findings in this paper are as follows.

First, a rise in the average difference in the corporate tax rate over the past three years decreases current capital per worker. This suggests that an increase in the difference in the corporate tax rate causes capital to move abroad, which reduces capital per worker in the domestic country.

Second, an increase in lagged capital per worker increases current wages per worker. This suggests that an increase in capital per worker causes labor productivity to rise, which increases the wage rate in the domestic country. In addition, these findings indicate that there is the following process of the indirect incidence: increase in the difference in the corporate tax rate ⇒ decline in capital per worker (decline in labor productivity) ⇒ decline in the wage rate.

Third, in controlling the effect of capital per worker, the average difference in the corporate tax rate over the past three years does not affect current wages per worker. This suggests that we cannot observe the direct incidence, which has an effect on wages through directly reducing the quasi-rent paid out in wages over which the worker and the company can bargain, using time-series data.

Fourth, an increase of 1% in the average difference in the corporate tax rate decreases capital per worker by only 240,000 to 300,000 yen in total over a 16-year period. In addition, an increase of 1% in the average difference in the corporate tax rate decreases wages per worker by only 20,000 to 25,000 yen in total over a 16-year period. These findings suggest that the corporate tax burden on workers (reduction in the wage rate) is small because a rise in the difference in corporate tax rate does not reduce capital per worker so much.

There are some reasons why the difference in the corporate tax rate does not decrease capital per worker so much as follows. First, as corporate income including foreign source income is taxed at a domestic tax rate based on the residence principle, an increase in the difference in the corporate tax rate may be less likely to affect whether domestic corporations invest in their own country or in a foreign country (Gravelle and Hungerford, 2012). In Japan, foreign source income such as remittance (dividends, interest, and royalties) from foreign branches and subsidiaries are taxed at the Japanese tax rate with foreign tax credit which is adjusted for double taxation based on the residence principle. Although dividend remittance from foreign subsidiaries has been substantially exempted from Japanese corporate tax since a tax reform in 2009, other foreign source income still continues to be taxed based on the residence principle.

Second, an increase in the difference in the corporate tax rate may be less likely to affect the total amount of domestic investment because it reduces domestic investment financed by equity or retained earnings and increases domestic investment financed by debt (Gravelle and Hungerford, 2012).

Third, as multinational corporations can shift their income to low-tax foreign countries using means such as transfer-pricing to avoid the burden of domestic corporate tax, an increase in the difference in the corporate tax rate may be less likely to affect whether they invest in a domestic country or in a foreign country (Clausing, 2013).

Fourth, as there is a complimentary relation between a domestic parent company's and a foreign subsidiary's production activity, an increase in the difference in the corporate tax rate may be less likely to reduce domestic investment. If there is a complimentary relation between the domestic and foreign production activity, an increase in foreign direct investment has an effect to increase domestic investment. Actually, some studies show that there is a positive correlation between domestic parent and subsidiary investment (Desai et al., 2005; Hotei and Tsukamoto, 2014).

As we show, if a decrease in the difference in the corporate tax rate does not increase capital per worker so much, we cannot expect that a reduction in the corporate tax rate will increase wages so much.

One of the limitations of this study is that we were not able to collect the corporate tax rates in the foreign countries other than the 18 developed countries due to limited data availability. In order to check the robustness in the future, we need to calculate the corporate tax rate (STR, EMTR, and EATR) in the countries such as Asian developing countries which have strong economic linkages with Japan.

References

Arulampalam, W., M.P. Devereux, and G. Maffini (2012), "The Direct Incidence of Corporate Income Tax on Wages," *European Economic Review*, 56 (6), pp. 1038 - 1054.

Clausing, K.A. (2012), "In Search of Corporate Tax Incidence," *Tax Law Review*, 65 (3), pp. 433 - 472.

Clausing, K.A. (2013), "Who Pays the Corporate Tax in a Global Economy?" *National Tax Journal*, 66 (1), pp. 151 - 184.

Council on Economic and Fiscal Policy (2014), *Basic Policies for the Economic and Fiscal Management and Reform 2014: From Deflation to an Expanded Economic Virtuous Cycle*, Cabinet Office.

Desai, M.A., F. Foley, and J.R. Hines Jr. (2005), "Foreign Direct Investment and the Domestic Capital Stock," *American Economic Review*, 95 (2), Papers and Proceedings of the One Hundred Seventeenth Annual Meeting of the American Economic Association, Philadelphia, PA, January 7 - 9, pp. 33 - 38.

Devereux, M.P. and Griffith, R. (2003), "Evaluating Tax Policy for Location Decisions," *International Tax and Public Finance*, 10 (2), pp. 107 - 26.

Devereux, M.P., Griffith, R. and Klemm, A. (2002), "Corporate Income Tax: Reforms and Tax Competition," *Economic Policy*, 17, pp. 451 - 495.

Gravelle, J.G. and T.L. Hungerford (2012), "Corporate Tax Reform: Issues for Congress," *CRS report for Congress*, RL34229.

Harberger, A.C. (1962), "The Incidence of the Corporation Income Tax," *Journal of Political Economy*, 70 (3), pp. 215 - 240.

Harberger, A.C. (1995), "The ABCs of Corporation Tax Incidence: Insights into the Open-Economy Case," In *Tax Policy and Economic Growth*, American Council for Capital Formation, Washington, D.C., pp. 51 - 73.

Harberger, A.C. (2008), "Corporation Tax Incidence: Reflections on What is Known, Unknown, and Unknowable," In Diamond, J.W. and G.R. Zodrow (eds.), *Fundamental Tax Reform: Issues, Choices and Implications*, MIT Press, Cambridge, M.A., pp. 283 - 307.

Hassett, K.A. and A. Mathur (2010), "Spatial Tax Competition and Domestic Wages," *AEI Papers and Studies*.

Hotei, M. and T. Tsukamoto (2014), “The Effects of Foreign Affiliated firms’ Investment on Domestic Parent Firm’s Investment: A Case of Japanese manufacturing industries,” *PRI Discussion Paper Series*, No. 14A - 08 (in Japanese).

Klemm, A. (2005), Corporate Tax Rate Data, Institute for Fiscal studies. <http://www.ifs.org.uk/publications/3210>

RIETI (2015), Japan Industrial Productivity Database 2015. <http://www.rieti.go.jp/en/database/JIP2015/index.html>

Spengel, C., D. Endres, K. Finke, and J. Heckemeyer (2014), *Effective Tax Levels Using the Devereux/Griffith Methodology*, Centre for European Economic Research.

Suzuki, M. (2009), “The Effects of Corporate Tax Reform in major countries: Focusing on The Change in Effective Tax Rate,” *Mizuho report*, September 3rd, 2009 (in Japanese).