

Price and Revenue Change by VAT reform in Japan -in consideration of exemption and zero tax rate-

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1. Introduction

Twenty years have passed since the Value Added Tax, (VAT or “Consumption Tax” in Japanese) introduced in Japan in April 1989, when the tax rate was no more than 3% at the time of introduction. The first VAT reform was implemented in April 1997 where the tax rate was raised to 5%, and the duty-free sales amount and the simplified taxation system was been revised. Now Japanese VAT is regarded as one of the key taxes as well as Personal Income tax and Corporate Income tax by Japanese tax payers as is shown later.

Fiscal deficit in Japan has been expanding during the recent three decades generally because of revenue shortage by economic stagnation and the increase of the fiscal expenditure on the other hand. Discussions for the raise of the VAT rate have been made among LDP members (ruling party before 2009) several times but they have not reached to the conclusion on the revision of VAT so far as described later. September 2009, there was a power change from LDP to DPJ in Japan thanks to DPJ’s large-governmental Manifesto including new “Child allowance” and Mr. Yukio Hatoyama was elected as the Prime Minister. Mr. Hatoyama has repeatedly declared “The VAT rate won’t be raised at least for four years” during the campaign. The revenue shortage, however, is becoming clear. As a result, now there is an opinion that VAT rate should be raised in a meantime even among Hatoyama cabinet members¹ and major newspapers started to carry articles on VAT rate change².

The authors think that as long as the government needs stable tax revenue adapting the stable economy, VAT rate will be raised soon or later no matter which political party takes charge of policy making. Indeed VAT revenue is stable, however policy makers need to take so-called “reverse progressiveness” of VAT in to consideration. Therefore, it would be a possible option to apply a reduced tax rate to such life necessities as foods or water supply.

It is not very well-known that there are two kinds of tax-free system: exemption and zero tax rate of VAT. Then, the purpose of this research is to give a theoretical calculation on the price and tax revenue effect by industry in the framework of input-output analysis taking two kinds of tax-free system into account. .

1 Mr. Naoto Kan, Vice-prime Minister and Finance Minister, spoke in the Diet on February 2010, “Discussion on fundamental reform of VAT will be started”.

2 For instance, Nihon Keizai Shimbun reports on February 25 in 2010 “Talks on fundamental tax reform including VAT reform was started in a technical committee of Government Tax Research Council.”

First of all, Section 2 shows the current state of VAT in Japan and discusses two methods of the tax credit (invoice method and account method). Section 3 shows the model used in this research. Section 4 shows some simulation results assuming some plausible cases such as uniform VAT rate raise or introduction of multiple tax rate system, etc. And Section 5 is a concluding remarks on policy implication of our research and remaining challenges.

2. Current situation of VAT in Japan

2-1 VAT reform and disputes for tax rate raise

VAT (“Consumption Tax” in Japanese) was introduced into Japanese tax system for the first time on April 1, 1989. According to Ishi(2008), Japan government has experienced three time failures to introduce VAT so far: (1) “Values Added Tax” proposed in the recommendation of Dr. Carl Shoup dispatched by the US government in 1950, (2) “General Consumption Tax” proposed under Ohira Cabinet in 1979, (3) “Sales tax” by Nakasone Cabinet in 1987. Consumption Tax in 1989 was the forth trial.

In April 1997 the VAT rate was raised to 4% and the Local VAT was created with 1% tax rate. Therefore, VAT rate total became 5%. At the same time it became enumerated to keep invoice or bills though the tax credit is “account method”.³ In April 2004, taxation coverage of VAT was enlarged by reducing the taxable minimum of sales amount from 30 million yen to 10 million yen.

Table1 shows historical change of the revenue of major taxes for Japanese central government after 1997 when the VAT rate was raised to 5%. Now VAT is the third important tax for the central government. The revenue of VAT in 2008 FY was 9,969 billion yen while the revenue of Personal Income tax is 14,985 billion yen and that of Corporate Income tax is 10,011 billion yen. On the other hand as to the share in the revenue, the share of both Personal Income tax and Corporate Income tax is on the decreasing trend (35.6% and 25.0% in 1997 to 33.9% and 22.6% in 2008) while the share of VAT has increased from 17.2% in 1997 to 22.5% in 2008. Generally speaking, the VAT is expected to be the stable tax resource which is relatively unaffected by business cycles unlike Personal Income tax or Corporate Income tax addressing the needs of a low birthrate and an aging population. As a matter of fact, it is described in the budget general text of every year since 1999 that VAT is to be allocated to such social security expenditures as Basic Pension, Elderly

3 As for VAT reform, see Ishi(2009), Morinobu(2007), Shinkawa(2009), etc.

Medical-care and Elderly Nursing-care.

It is Government Tax Research Commission (hereafter, Tax Commission) that have played the central role in Japanese tax reform. The VAT rate has been unchanged to be 5% since April, 1997. But, Tax Commission recently began to make a comment on “VAT rate increase”, “Multiple VAT rates, or standard rate and reduced ones”, “introduction of the invoice method”, and etc. For example in “Report on the tax reform in 2004” Tax Commission suggested that the future VAT should be based on the Invoice method by writing that it is necessary to start concrete discussions on such issues as introduction of new tax credit system, adoption of reduced VAT rates in case standard AVT rate should be increased to two digits like European countries. And in the report issued in the following year, Tax Commission took one step ahead by writing that it is necessary to raise VAT rate provided that the government should make efforts to obtain understanding of tax payers on future tax system while Tax Commission refers to “Consideration to low income people” and “Examination of the Invoice method”. And moreover, in “Basic Idea on Tax Reform” issued in November 2007, Tax Commission took another step further by writing that VAT should be earmarked to Social Security expenditure, that the government should examine European VAT system which adopts double tax rate of standard and reduced rate, and that introduction invoice method is indispensable to have multiple rate VAT system⁴.

4 As for the policy reports of Tax Council, see the web site of the Tax Council:
<http://www.cao.go.jp/zeicho/index.html>

Table 1 Transition of revenue in the central government general account and local VAT

Fiscal year	Personal Income tax (A)	Corporate Income tax (B)	VAT (C)	Others (D)	Total(E) A+B+C+D	Share					Reference	
						A/E	B/E	C/E	(A+B+C)/E	D/E	Local VAT	Central & Local VAT
1997	19,183	13,475	9,305	11,979	53,941	35.6%	25.0%	17.2%	77.8%	22.2%	807	10,112
1998	16,996	11,423	10,074	10,938	49,432	34.4%	23.1%	20.4%	77.9%	22.1%	2,550	12,625
1999	15,447	10,795	10,447	10,545	47,234	32.7%	22.9%	22.1%	77.7%	22.3%	2,479	12,926
2000	18,789	11,747	9,822	10,354	50,712	37.0%	23.2%	19.4%	79.6%	20.4%	2,528	12,350
2001	17,807	10,258	9,767	10,117	47,948	37.1%	21.4%	20.4%	78.9%	21.1%	2,475	12,242
2002	14,812	9,523	9,812	9,686	43,833	33.8%	21.7%	22.4%	77.9%	22.1%	2,425	12,236
2003	13,915	10,115	9,713	9,540	43,282	32.1%	23.4%	22.4%	78.0%	22.0%	2,394	12,106
2004	14,670	11,444	9,974	9,501	45,589	32.2%	25.1%	21.9%	79.2%	20.8%	2,614	12,588
2005	15,586	13,274	10,583	9,623	49,065	31.8%	27.1%	21.6%	80.4%	19.6%	2,551	13,135
2006	14,054	14,918	10,463	9,634	49,069	28.6%	30.4%	21.3%	80.4%	19.6%	2,629	13,092
2007	16,080	14,744	10,272	9,922	51,018	31.5%	28.9%	20.1%	80.6%	19.4%	2,569	12,841
2008	14,985	10,011	9,969	9,303	44,267	33.9%	22.6%	22.5%	79.0%	21.0%	-	-

Data source:

As to central government budget, Ministry of Finance, "Statement of taxes and stamp revenue" each fiscal year (in Japanese)

<<http://www.mof.go.jp/jouhou/syuzei/siryu/008.htm>>

As to local VAT, Ministry of Finance, "Monthly statistic of finance" each month (in Japanese)

<<http://www.mof.go.jp/kankou/zaikingedl.htm>>

Table2 International comparison of VAT system

	Japan	United Kingdom	Germany	France
Exemption	Trade & lease of land, Lease of house, Finance, Insurance, Medical care, Education, welfare.	Trade & lease of RE, Finance, Insurance, Medical care, Education, Postal service, welfare	Trade & Lease of RE, Finance, Insurance, Medical care, Education, Postal service	Trade & Lease of RE, Finance, Insurance, Medical care, Education, Postal service
Standard tax rate	5% (include local VAT)	17.5%	19%	19.6%
Zero tax rate	NA	Food, Water, Newspaper, Magazine, Book, Passenger Transport, Medicine, Residential Construction, Equipment for the handicapped	NA	NA
Reduced tax rate	NA	Fuel & electricity for household: 5%	Food, Water, Book, Newspaper, Magazine, Passenger transport: 7%	Food, Water, Book, Passenger Transport, Fertilizer: 5.5% Newspaper, Magazine, Medicine: 2.1%

Source: Shinkawa(2009), the authors revised the original table.

2-2 VAT rate of selected countries

Japanese VAT is designed based on the VAT in European countries. Therefore it is reasonable to refer VAT in European countries as to multiple VAT rate system. Table2 is a comparison of VAT systems among Japan, Britain, Germany, and France. As is shown in the Table, the VAT rates in European countries are generally high (17.5% in UK, 19% in Germany, and 19.6% in France) comparing 5% in Japan. Actually VAT rate in other European countries including non-EU members are all as high as around 20%⁵. The background of this is economic unification of Europe, where a common competition arena is one of the basic conditions. In 1993 when EC developed to EU, member countries were required to set the standard VAT rate 15% or more. Incidentally, VAT rates in Asian countries are also higher than Japan's; 17% in China, 12% in the Philippines, and 10% in Korea and Indonesia⁶.

To be sure VAT rates of European countries are generally high, however they also adopt discount VAT rate for necessities of life including food etc. since VAT has so-called "Reverse-progressiveness" regarding income level⁷. A series of the policy reports issued by Tax Council also keep this in mind. Japanese VAT system is of non-accumulation type which is basically same as those in European countries in a respect that the tax base of each business establishment is value-added; the difference of sales and purchases. The crucial difference is in tax credit method for VAT included in the purchases; concretely, Invoice method in European countries and Account method in Japan. It is important to understand the difference of these methods since the effects of exemption or multiple VAT rate including zero-rate are different depending on the tax credit system. In the next section, we summarize the difference of Invoice method and Account method.

2-3 Tax credit method and exemption / zero tax rate

Literature on VAT system includes Morodomi (2009), Shinkawa(2009) and Hayashi(2008) for over-all explanation, Takada(2008) for discounted VAT rate, and

5 For example VAT rate is 25% in Denmark, Sweden, and Norway, 24.5% in Iceland, and 22% in Finland and Poland.

6 As to VAT rate in the world, see the web site of Ministry of Finance
<<http://www.mof.go.jp/jouhou/syuzei/siryousyoutoku.htm>>
or the web site of Japan indirect tax union
<http://www.kanzeikai.jp/index.asp?patten_cd=12&page_no=154>

7 In 1993, it is also specified that member country can set up to two kinds of discounted VAT rate as long as they are 5% or more. The countries in foot note 5 have a discounted rate for foods except Denmark: 14% in Norway, 7% in Iceland, 12% in Sweden, 17% in Finland, and 7% in Poland. See Shinkawa(2009) in detail.

Morinobu (2007) for VAT reform in terms of tax reform. Based on those literature, let us summarize the difference between “Invoice method” and “Account method” taking the difference of “Exemption” and “Zero VAT rate” into consideration.

In the Invoice method of EU type, it is taxable business establishment that can issue the invoice that describes the price before VAT, an applied VAT rate, and the amount of VAT, etc. This invoice will be sent from the manufacturing stage through each distribution stage to the final retail stage and the taxable business establishment pays the VAT that is calculated by “sales tax” minus the “purchase tax” (or tax credit) where the “sales tax” means the VAT rate applied to the business establishment times sales value and the “purchase tax” means the VAT amount recorded in the invoice imposed already. That is why, no matter how many stages a commodity may pass through, VAT never be accumulated on the commodity price by multiple counts. On the other hand, in the Account method calculating the amount of payment of taxes by multiplying the tax rate on the amount of value added. Since the tax base for both methods is the value added, the calculation formula is the same as long as the VAT rate is unique. However, in case a commodity should pass through exempt business establishments, the treatment should be changed. If the purchase is from an exempt business establishment in the EU type Invoice method, this purchaser has no tax credit, therefore the VAT contained before the exempt business establishment is not deductible. On the other hand, in the Account method “tax credit” in the purchase is always applicable for all purchases whether the purchase counterpart is exempt or not. . That is to say, exempt business establishment also partly in the VAT system in the Account system.

Next, let us explain the difference between “exempt” and “zero tax rates” in invoice method. “Exempt” means that VAT is not imposed on a specific goods or service. A business establishment that treat goods or service, it do not have to pay VAT but it cannot get tax refund of VAT credit included the purchases. Moreover, a taxable business establishment cannot deduct the VAT credit included the purchases. In short, exempt goods and service is not the target of either tax payment or tax credit. In this context, “Exempt” is not in the system of VAT. On the other hand, “Zero tax rate” means that a tax rate of zero is imposed on sales of a specific goods and service. Zero-tax business establishment does not have to pay VAT since the tax rate is zero but can get refund the VAT credit included in purchases. In short, “Zero tax rate” is a system of VAT and the applicable tax rate is zero. In this manner, “Exemption” is a great deal different from “Zero tax rate” in VAT.

Before close this section, let us explain two more special treatments in VAT

such as “Export VAT Refund” and “Investment Tax Credit”. “Export VAT Refund” means that zero-tax rate is applied to export goods. VAT system adopts internationally “destination principle” where goods and services are not taxable in exporting but taxable in importing. Japanese VAT system also follows this international rule. Since the exports are not taxable, the tax base is only domestic sales for taxable business establishments. “Investment Tax Credit” means that investment goods can be treated as if they were general purchase. Since investments are accumulation of assets, they shouldn’t be treated in the same manner theoretically. However, VAT system including Japan’s treats investment goods as general purchase. In VAT system, VAT included in investment goods is also deductible. This research considers “Export VAT Refund” and “Investment Tax Credit”, however, does not consider “taxable minimum” system where a business establishment whose sales is less than 10 million yen is not taxable and “Simplified taxation” system where a business establishment whose sales is less than 50 million yen can calculate based on the simplified formula without the record of sales and purchases.

2-4 preceding studies

Empirical research on the price effect of VAT is implemented applied the price model of Input-Output framework. We have rather long history for this type of research. Kaneko(1981) and Nakai(1978) estimated the price effects of “Consumption Tax” proposed by Ohira cabinet, and Hayashi and Hashimoto (1987).treated the price effects of “Sales tax” proposed by Nakasone cabinet. And Fujikawa(1999) made an comparison of the price effects of Invoice method and Account method with the difference of exemption and zero tax rate taken into account. This research also basically follows the model of Fujikawa(1999) to estimate the price effects of VAT with Japanese I-O table in 2005.

Another research issue on VAT is so-called “Tax Profit” that is generated by simplified tax system and minimum level of taxable sales in the Account method. Hashimoto(2002) attempts to estimate the amount of “Tax Profit” using 1995. It is possible for our model to estimate “Tax Profit” as well as price effects. Additionally, Mochizuki(2003) and Takada(2004) do a institutional analysis on multiple tax rate, and Murasawa(2005) analyze the effects of discounted tax rate in the necessities of life using household income and expenditure survey.

3. Model

We will examine price effects of VAT rate change in Japan using (non-competitive type) I-O table in2005. The analysis follows the model of Fujikawa (1999). This section shows the calculation procedure.

3-1 Price determination model

Let us confirm general price determination model in the input output analysis. Taking look at each column on the input output table, one may have accounting relation such as equation (1).

$$p_j^d x_j^d = \sum_i p_j^d x_{ij}^d + \sum_i p_i^m x_{ij}^m + va_j \quad (1)$$

where, $p_j^d (j = 1, \dots, n)$ stands for the price of domestic product for j -th industry, $p_j^m (j = 1, \dots, n)$ stands for the price of imported products for j -th industry, $x_j^d (j = 1, \dots, n)$ stands for the output for j -th industry, $x_{ij}^d (i, j = 1, \dots, n)$ stands for the input of domestic intermediate products from i -th industry to j -th industry, $x_{ij}^m (i, j = 1, \dots, n)$ stands for the input of imported intermediate products from i -th industry to j -th industry, $va_j (j = 1, \dots, n)$ stands for the value added for j -th industry.

Here, we assume that domestic input coefficient ($a_{ij}^d = x_{ij}^d / x_j^d$), imported input coefficient ($a_{ij}^m = x_{ij}^m / x_j^d$) and value added ratio ($v_j = va_j / x_j^d$) are all fixed, then the price equation for j -th industry before imposing VAT is as follows:

$$p_j^d = \sum_i p_i^d a_{ij} + \sum_i p_i^m a_{ij}^m + v_j \quad (2)$$

Solving the equation (2) with the price for all industries gives the basic price equation.

$$\mathbf{p}^d = (\mathbf{p}^m \mathbf{A}^m + \mathbf{v})(\mathbf{I} - \mathbf{A}^d)^{-1} \quad (3)$$

where, \mathbf{p}^d stands for the domestic price vector, \mathbf{p}^m stands for the import price vector, \mathbf{A}^d stands for the physical domestic input coefficient matrix, \mathbf{A}^m stands for the physical import input coefficient matrix.

3-2 Invoice Method Model (Base, Exemption, Zero VAT rate)

In this section, we will show the calculation method concerning how price and tax revenue change according with VAT rate change. As we describe before, VAT regime has two types; invoice method and account method. First of all, we will explain the model of invoice method.

3-2-1 Base Model

Case of without Export VAT Refund and Investment Tax Credit

First, let us explain the model in the case that there is neither export VAT refund nor investment tax credit. We should deal with domestic products and imported products separately because taxation formula is different. Here we will take a look at domestic industry. VAT payment by j -th domestic industry is expressed as follows.

$$vat_j^d = \tau_j p_j^d x_j^d - \sum_i \tau_i p_i^d x_{ij}^d - \sum_i \tau_i p_i^m x_{ij}^m \quad (4)$$

where, τ_j is gross VAT rate for j -th industry. Dividing both sides of equation (4) by output gives the amount of VAT payment per unit.

$$\begin{aligned} \frac{vat_j^d}{x_j^d} &= \tau_j p_j^d - \sum_i \tau_i p_i^d a_{ij}^d - \sum_i \tau_i p_i^m a_{ij}^m \\ &= \mathbf{p}^d \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \end{aligned} \quad (5)$$

where, $\hat{\boldsymbol{\tau}}$ is a diagonal matrix with VAT rate. Supply price after imposing VAT is given by sum of the production cost (equation (2)) and the VAT (equation (5)).

$$\begin{aligned} p_j^d &= \sum_i p_i^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \\ &= \mathbf{p}^d \begin{bmatrix} a_{1j}^d \\ a_{2j}^d \\ \vdots \\ a_{jj}^d \\ \vdots \\ a_{nj}^d \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \end{aligned} \quad (6)$$

The prices for all industries after VAT imposition are expressed as follows:

$$\mathbf{p}^d = \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}} (\mathbf{I} - \mathbf{A}^d) - \mathbf{p}^m \hat{\boldsymbol{\tau}} \mathbf{A}^m \quad (7)$$

Solving equation (7) with \mathbf{p}^d gives equilibrium price vector.

$$\begin{aligned} \mathbf{p}^d &= \left[\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}) \mathbf{A}^m \right] \left[(\mathbf{I} - \hat{\boldsymbol{\tau}}) (\mathbf{I} - \mathbf{A}^d) \right]^{-1} \\ &= \left[\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}) \mathbf{A}^m \right] (\mathbf{I} - \mathbf{A}^d)^{-1} (\mathbf{I} + \hat{\boldsymbol{\tau}}) \end{aligned} \quad (8)$$

where $\hat{\boldsymbol{\tau}}$ is diagonal matrix with net VAT rate.

As far as imported products are concerned, VAT is imposed on the amount of import at the border, generally without tax credit. Thus VAT revenue from imported products is obtained by multiplying the amount of import by VAT rate.

$$vat_j^m = \tau_j m_j \quad (4')$$

where m_j is the amount of import for j -th industry, and vat_j^m is the amount of VAT payment for j -th import industry. Prices of imported products would increase at the same rate as VAT rate, and which is hold true for all cases we describe in the following. Thus, we will show the model about domestic industry hereafter.

Case of with Export VAT Refund and Investment Tax Credit

If we consider export VAT refund and investment tax credit, VAT payment by j -th domestic industry is expressed as follows.

$$vat_j^d = \tau_j p_j^d (x_j^d - E_j) - \sum_i \tau_i p_i^d (x_{ij}^d + K_{ij}) - \sum_i \tau_i p_i^m x_{ij}^m \quad (9)$$

where E_j stands for the amount of export of j -th industry, and K_{ij} is the amount of capital goods j -th industry purchase from i -th industry. The amount of VAT payment per unit is

$$\frac{vat_j^d}{x_j^d} = \tau_j p_j^d (1 - e_j) - \sum_i \tau_i p_{ij}^d (a_{ij}^d + c_{ij}) - \sum_i \tau_i p_i^m a_{ij}^m \quad (10)$$

where, $c_{ij} = K_{ij}/x_j$. Supply price after imposing VAT is given as

$$\begin{aligned}
 p_j^d &= \sum_i p_i^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \tau_j p_j^d (1 - e_j) - \sum_i \tau_i p_{ij}^d (a_{ij}^d + c_{ij}) - \sum_i \tau_i p_i^m a_{ij}^m \\
 &= \mathbf{p}^d \begin{bmatrix} a_{1j}^d \\ a_{2j}^d \\ \vdots \\ a_{jj}^d \\ \vdots \\ a_{nj}^d \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^d - c_{1j} \\ -a_{2j}^d - c_{2j} \\ \vdots \\ 1 - a_{jj}^d - e_j - c_{jj} \\ \vdots \\ -a_{nj}^d - c_{nj} \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \quad (11)
 \end{aligned}$$

The prices for all industries after VAT imposition are expressed as follows.

$$\mathbf{p}^d = \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}} (\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C}) - \mathbf{p}^m \hat{\boldsymbol{\tau}} \mathbf{A}^m \quad (12)$$

Solving equation (12) with \mathbf{p}^d gives equilibrium price vector.

$$\mathbf{p}^d = [\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}) \mathbf{A}^m] [\mathbf{I} - \mathbf{A}^d - \hat{\boldsymbol{\tau}} (\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C})]^{-1} \quad (13)$$

3-2-2 Exemption in invoice method

Next, exemption in invoice method is modeled with the frame of the input-output analysis. Here, let's think about the case where only k -th industry is exempted.

Case of without Export VAT Refund and Investment Tax Credit

Under exemption system in invoice method, though exemption industry, k -th industry, has no obligation of tax payment, it does not deduct VAT included in purchasing costs. The amount of VAT payment is as follows.

$$vat_k^d = 0 \quad (14a)$$

$$vat_j^d = \tau_j p_j^d x_j^d - \sum_i \tau_i p_i^d x_{ij}^d - \sum_i \tau_i p_i^m x_{ij}^m \quad (\tau_k=0) \quad (14b)$$

Dividing both sides of equation (14b) by x_j^d yields:

$$\frac{vat_j^d}{x_j^d} = \mathbf{p}^d \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \quad (15)$$

Where, $\hat{\boldsymbol{\tau}}^{(k)}$ is the same diagonal matrix as $\hat{\boldsymbol{\tau}}$ except that k -th element is zero.

Supply price for j -th industry (taxation industry) after imposing VAT is as follows.

$$\begin{aligned}
 p_j^d &= \sum_i p_i^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1-a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \\
 &= \mathbf{p}^d \begin{bmatrix} a_{1j}^d \\ a_{2j}^d \\ \vdots \\ a_{jj}^d \\ \vdots \\ a_{nj}^d \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1-a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix}
 \end{aligned} \tag{16}$$

Expressing the prices of taxation (j -th) industries and exemption (k -th) industry together, one may have:

$$\begin{aligned}
 & \text{(} k \text{-th column)} \\
 \mathbf{p}^d &= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} \begin{bmatrix} 1-a_{11}^d & -a_{12}^d & \cdots & 0 & \cdots & -a_{1n}^d \\ -a_{21}^d & 1-a_{22}^d & \cdots & 0 & \cdots & -a_{2n}^d \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ -a_{n1}^d & -a_{n2}^d & \cdots & 0 & \cdots & 1-a_{nn}^d \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \mathbf{A}^m
 \end{aligned} \tag{17}$$

$$= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} (\mathbf{I} - \mathbf{A})_k - \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \mathbf{A}^m$$

Where, $(\mathbf{I} - \mathbf{A})_k$ is a matrix in which all k -th column elements of $(\mathbf{I} - \mathbf{A})$ are replaced by zero. If more than two exemption industry exists, the relationship such as equation (17) holds true. That is to say, you can get the similar price equation by putting VAT rate of exemption industry zero and replacing exemption industries' columns in $(\mathbf{I} - \mathbf{A})$ to zero.

Solving equation (17) with \mathbf{p}^d gives equilibrium price vector.

$$\mathbf{p}^d = \left(\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) \mathbf{A}^m \right) \left[(\mathbf{I} - \mathbf{A}^d) - \hat{\boldsymbol{\tau}}_{(k)} (\mathbf{I} - \mathbf{A}^d)_k \right]^{-1} \tag{18}$$

The prices of exemption industries would rise slightly when consumption tax is introduced or raised, because exemption industries have no obligation for tax payment but cannot exempt VAT included in purchasing costs.

Case of with Export VAT Refund and Investment Tax Credit

If we consider export VAT refund and investment tax credit, The amount of VAT payment is as follows.

$$vat_k^d = 0 \quad (19a)$$

$$vat_j^d = \tau_j p_d^j (x_d^j - E_j) - \sum_i \tau_i p_i^d (x_{ij}^d + K_{ij}) - \sum_i \tau_i p_i^m x_{ij}^m \quad (\tau_k = 0) \quad (19b)$$

Dividing both sides of equation (19b) by x_j^d yields

$$\frac{vat_j^d}{x_j^d} = \mathbf{p}^d \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^d + c_{1j} \\ -a_{2j}^d + c_{2j} \\ \vdots \\ 1 - a_{jj}^d + c_{jj} - e_j \\ \vdots \\ -a_{nj}^d + c_{nj} \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \quad (20)$$

Supply price for j-th industry (taxation industry) after imposing VAT is as follows.

$$p_j^d = \sum_i p_i^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^d + c_{1j} \\ -a_{2j}^d + c_{2j} \\ \vdots \\ 1 - a_{jj}^d + c_{jj} - e_j \\ \vdots \\ -a_{nj}^d + c_{nj} \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \quad (21)$$

$$= \mathbf{p}^d \begin{bmatrix} a_{1j}^d \\ a_{2j}^d \\ \vdots \\ a_{jj}^d \\ \vdots \\ a_{nj}^d \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^d + c_{1j} \\ -a_{2j}^d + c_{2j} \\ \vdots \\ 1 - a_{jj}^d + c_{jj} - e_j \\ \vdots \\ -a_{nj}^d + c_{nj} \end{bmatrix} - \mathbf{p}^m \hat{\boldsymbol{\tau}}^{(k)} \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix}$$

Expressing the prices of taxation (j-th) industries and exemption (k-th) industry together, one may have:

$$\begin{aligned}
\mathbf{p}^d &= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m \\
&\quad (k\text{-th column}) \\
&+ \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} \begin{bmatrix} 1 - a_{11}^d - c_{11} - e_1 & -a_{12}^d - c_{12} & \cdots & 0 & \cdots & -a_{1n}^d - c_{1n} \\ -a_{21}^d - c_{21} & 1 - a_{22}^d + c_{22} - e_2 & \cdots & 0 & \cdots & -a_{2n}^d - c_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ -a_{n1}^d - c_{n1} & -a_{n2}^d - c_{n2} & \cdots & 0 & \cdots & 1 - a_{nn}^d - c_{nn} - e_n \end{bmatrix} \quad (22) \\
&- \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \mathbf{A}^m \\
&= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} (\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C})_k - \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \mathbf{A}^m
\end{aligned}$$

Where, $(\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C})_k$ is a matrix in which all k-th elements of $(\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C})$ are replaced by zero. If more than two exemption industries exist, the relationship such as equation (22) holds true. Solving equation (22) with \mathbf{p}^d gives equilibrium price vector.

$$\mathbf{p}^d = (\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) \mathbf{A}^m) [(\mathbf{I} - \mathbf{A}^d) - \hat{\boldsymbol{\tau}}_{(k)} (\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C})_k]^{-1} \quad (23)$$

3-2-3 Zero VAT rate in invoice method

Under zero VAT rate system, not only zero VAT rate industry has no obligation for tax payment, but deduct VAT included in purchasing costs, which is not allowed in exemption system.

Case of without Export VAT Refund and Investment Tax Credit

The amount of VAT payment, in actual the term, ‘refund’, is correct for exemption industry, takes the same form as equation (4) except that τ_k is zero.

$$vat_k^d = \tau_k p_k^d x_k^d - \sum_i \tau_i p_i^d x_{ik}^d - \sum_i \tau_i p_i^m x_{ij}^m = - \sum_i \tau_i p_i^d x_{ik}^d - \sum_i \tau_i p_i^m x_{ij}^m \quad (24a)$$

$$vat_j = \tau_j p_j^d x_j - \sum_i \tau_i p_i^d x_{ij}^d - \sum_i \tau_i p_i^m x_{ij}^m \quad (\text{ただし } \tau_k = 0) \quad (24b)$$

While tax payment by zero-VAT-rate industry is zero, VAT tax included in purchasing costs could be refunded. This is why net tax payment by zero-VAT-rate industry, equation (24a), is minus.

The price equation after tax imposition for all industries takes the same form as equation (7) except that $\hat{\boldsymbol{\tau}}$ is replaced by $\hat{\boldsymbol{\tau}}_{(k)}$.

$$\mathbf{p}^d = \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} (\mathbf{I} - \mathbf{A}^d) - \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \mathbf{A}^m \quad (25)$$

Solving equation (25) with \mathbf{p}^d gives equilibrium price vector.

$$\begin{aligned}
 \mathbf{p}^d &= \left[\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) \mathbf{A}^m \left[(\mathbf{I} - \mathbf{A}^d) - \hat{\boldsymbol{\tau}}_{(k)} (\mathbf{I} - \mathbf{A}^d) \right]^{-1} \right. \\
 &= \left[\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) \mathbf{A}^m \left[(\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) (\mathbf{I} - \mathbf{A}^d) \right]^{-1} \right. \\
 &= \left[\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) \mathbf{A}^m \left[(\mathbf{I} - \mathbf{A}^d) \right]^{-1} (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)})^{-1} \right. \\
 &= \left[\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) \mathbf{A}^m \left[(\mathbf{I} - \mathbf{A}^d) \right]^{-1} (\mathbf{I} + \hat{\boldsymbol{\tau}}_{(k)}) \right.
 \end{aligned} \tag{26}$$

Equation (26) implies that the prices of taxation industry after imposing VAT become as constant times as before imposing VAT. On the other hand, the price of zero-VAT-rate industry after imposing VAT keeps at the same level as before imposing VAT. When more than two zero-VAT-rate industries exist, equation (26) is applicable by VAT rates of corresponding industries make zero.

Case of with Export VAT Refund and Investment Tax Credit

The amount of VAT payment by k-th industry (zero-VAT-rate industry) and taxation industry is given by equation (27a) and (27b), respectively.

$$\begin{aligned}
 vat_k^d &= \tau_k p_k^d (x_k^d - E_k) - \sum_i \tau_i p_i^d (x_{ik}^d + K_{ik}) - \sum_i \tau_i p_i^m x_{ik}^m \\
 &= - \sum_i \tau_i p_i (x_{ik} + K_{ik}) - \sum_i \tau_i p_i^m x_{ik}^m
 \end{aligned} \tag{27a}$$

$$vat_j^d = \tau_j p_j^d (x_j^d - E_j) - \sum_i \tau_i p_i^d (x_{ij}^d + K_{ij}) - \sum_i \tau_i p_i^m x_{ij}^m \quad (\tau_k=0) \tag{27b}$$

The price equation for all industries after imposing VAT is as follows.

$$\mathbf{p}^d = \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d \hat{\boldsymbol{\tau}}_{(k)} \left[(\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C}) \right] - \mathbf{p}^m \hat{\boldsymbol{\tau}}_{(k)} \mathbf{A}^m \tag{28}$$

Solving equation (28) with \mathbf{p}^d gives equilibrium price vector.

$$\mathbf{p}^d = \left[\mathbf{v} + \mathbf{p}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)}) \mathbf{A}^m \left[(\mathbf{I} - \mathbf{A}^d) - \hat{\boldsymbol{\tau}}_{(k)} (\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C}) \right]^{-1} \right. \tag{29}$$

3-3 Account Method Model (Base, Exemption, Zero VAT rate)

3-3-1 Base Model

Case of without Export VAT Refund and Investment Tax Credit

VAT payment by j-th domestic industry is expressed as follows.

$$vat_j^d = \tau_j \left(p_j^d x_j^d - \sum_i p_i^d x_{ij}^d - \sum_i p_i^m x_{ij}^m \right) \tag{30}$$

Dividing both sides of equation (30) by output gives the amount of VAT payment per unit.

$$\begin{aligned} \frac{vat_j^d}{x_j^d} &= \tau_j \left(p_j^d - \sum_i p_i^d a_{ij}^d - \sum_i p_i^m a_{ij}^m \right) \\ &= \mathbf{p}^d \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \end{aligned} \quad (31)$$

Supply price after imposing VAT is

$$\begin{aligned} p_j^d &= \sum_i p_i^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \mathbf{p}^d \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \\ &= \mathbf{p}^d \begin{bmatrix} a_{1j}^d \\ a_{2j}^d \\ \vdots \\ a_{jj}^d \\ \vdots \\ a_{nj}^d \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \end{aligned} \quad (32)$$

The prices for all industries after VAT imposition are expressed as follows.

$$\mathbf{p}^d = \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d (\mathbf{I} - \mathbf{A}^d) \hat{\boldsymbol{\tau}} - \mathbf{p}^m \mathbf{A}^m \hat{\boldsymbol{\tau}} \quad (33)$$

Solving equation (32) with \mathbf{p}^d gives equilibrium price vector.

$$\begin{aligned} \mathbf{p}^d &= [\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}})] (\mathbf{I} - \mathbf{A}^d) (\mathbf{I} - \hat{\boldsymbol{\tau}})^{-1} \\ &= [\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}})] (\mathbf{I} - \hat{\boldsymbol{\tau}})^{-1} (\mathbf{I} - \mathbf{A}^d)^{-1} \\ &= [\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}})] (\mathbf{I} + \hat{\boldsymbol{\tau}}) (\mathbf{I} - \mathbf{A}^d)^{-1} \end{aligned} \quad (34)$$

In the case of account method, as shown by equation (34), VAT rate matrix $(\mathbf{I} + \hat{\boldsymbol{\tau}})$, is between the value added term and Leontief Inverse. On the other hand, in the case of invoice method, VAT rate matrix is at the most end as shown by equation (8). This means if VAT rate of each industry is same, both methods have same effects. But if not, in the case of account method, the price of an industry is depend

on VAT rate applied to not only own industry but also other industries. The two taxation methods are absolutely different in this sense.

Case of with Export VAT Refund and Investment Tax Credit

Considering export VAT refund and investment tax credit, VAT payment by j-th domestic industry is expressed as follows.

$$vat_j^d = \tau_j \left[p_j^d (x_j^d - E_j) - \sum_i p_i^d (x_{ij}^d + K_{ij}) - \sum_i p_i^m x_{ij}^m \right] \quad (35)$$

The amount of VAT payment per unit:

$$\frac{vat_j^d}{x_j} = \tau_j \left[p_j^d (1 - e_j) - \sum_i p_i^d (a_{ij}^d + c_{ij}) - \sum_i p_i^m a_{ij}^m \right] \quad (36)$$

Supply price after imposing VAT:

$$p_j^d = \sum_i p_j^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \tau_j \left[p_j^d (1 - e_j) - \sum_i p_i^d (a_{ij}^d + c_{ij}) - \sum_i p_i^m a_{ij}^m \right]$$

$$= \mathbf{p}^d \begin{bmatrix} a_{1j}^d \\ a_{2j}^d \\ \vdots \\ a_{jj}^d \\ \vdots \\ a_{nj}^d \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \begin{bmatrix} -a_{1j}^d - c_{1j} \\ -a_{2j}^d - c_{2j} \\ \vdots \\ 1 - a_{jj}^d - e_j - c_{jj} \\ \vdots \\ -a_{nj}^d - c_{nj} \end{bmatrix} \tau_j \quad (37)$$

The prices for all industries after VAT imposition are expressed as follows.

$$\mathbf{p}^d = \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d (\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C}) \hat{\boldsymbol{\tau}} - \mathbf{p}^m \mathbf{A}^m \quad (38)$$

Solving equation (38) with \mathbf{p}^d gives equilibrium price vector.

$$\mathbf{p}^d = \left[\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}) \right] \left[(\mathbf{I} - \mathbf{A}^d) - (\mathbf{I} - \mathbf{A}^d - \hat{\mathbf{e}} - \mathbf{C}) \hat{\boldsymbol{\tau}} \right]^{-1} \quad (39)$$

3-3-2 Exemption in account method

Under account method, when taxable business establishment purchases from exempt one, two kind of “exemption” would be theoretically considerable: first case is taxable business establishment could deduct the amount of VAT included in purchase from exempt business establishment, and second case is taxable business establishment could not. In either case, VAT payment by exempt business

establishment is zero, and exempt business establishment does not receive any refund. When the first case is adopted, we do not have to consider whether selling business establishment is taxable or exempt and VAT is not accumulated on the commodity price. Though current system is not necessarily clear, purchasing business establishments do not have duty to book that whether selling business establishments are taxable or exempt. As far as actual operation is concerned, it would be regarded as the first case since the amount of VAT regarding purchase is not determined. In the following, we will construct model about the account method assuming the first case.

Case of without Export VAT Refund and Investment Tax Credit

Under exemption system in account method, though exemption industry, k-th industry, has no obligation of tax payment, it does not deduct VAT included in purchasing costs. The amount of VAT payment is as follows.

$$vat_k^d = 0 \tag{40a}$$

$$vat_j^d = \tau_j \left[p_j^d x_j^d - \sum_i p_i^d x_{ij}^d - \sum_i p_i^m x_{ij}^m \right] \tag{40b}$$

Dividing both sides of equation (40b) by x_j^d yields:

$$\begin{aligned} \frac{vat_j^d}{x_j^d} &= \tau_j \left(p_j^d - \sum_i p_i^d x_{ij}^d - \sum_i p_i^m x_{ij}^m \right) \\ &= \mathbf{p}^d \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1 - a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \end{aligned} \tag{41}$$

Supply price for j-th industry (taxation industry) after imposing VAT is as follows:

$$\begin{aligned}
 p_j^d &= \sum_i p_i^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \mathbf{p}^d \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1-a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \\
 &= \mathbf{p}^d \begin{bmatrix} a_{1j}^d \\ a_{2j}^d \\ \vdots \\ a_{jj}^d \\ \vdots \\ a_{nj}^d \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \begin{bmatrix} -a_{1j}^d \\ -a_{2j}^d \\ \vdots \\ 1-a_{jj}^d \\ \vdots \\ -a_{nj}^d \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j
 \end{aligned} \tag{42}$$

Expressing the prices of taxation (j -th) industries and exemption (k -th) industry together, one may have:

$$\begin{aligned}
 \mathbf{p}^d &= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m \\
 + \mathbf{p}^d \begin{bmatrix} 1-a_{11}^d & -a_{12}^d & \cdots & -a_{1k}^d & \cdots & -a_{1n}^d \\ -a_{21}^d & 1-a_{22}^d & \cdots & -a_{2k}^d & \cdots & -a_{2n}^d \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ -a_{n1}^d & -a_{n2}^d & \cdots & -a_{nk}^d & \cdots & 1-a_{nn}^d \end{bmatrix} \hat{\boldsymbol{\tau}}_{(k)} - \mathbf{p}^m \mathbf{A}^m \hat{\boldsymbol{\tau}}_{(k)} \\
 &= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d (\mathbf{I} - \mathbf{A}^d) \hat{\boldsymbol{\tau}}_{(k)} - \mathbf{p}^m \mathbf{A}^m \hat{\boldsymbol{\tau}}_{(k)}
 \end{aligned} \tag{43}$$

Solving equation (43) with \mathbf{p}^d gives equilibrium price vector.

$$\begin{aligned}
 \mathbf{p}^d &= [\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}})] [(\mathbf{I} - \mathbf{A}^d) - (\mathbf{I} - \mathbf{A}^d) \hat{\boldsymbol{\tau}}_{(k)}]^{-1} \\
 &= [\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}})] [(\mathbf{I} - \mathbf{A}^d) (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)})]^{-1} \\
 &= [\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}})] (\mathbf{I} - \hat{\boldsymbol{\tau}}_{(k)})^{-1} (\mathbf{I} - \mathbf{A}^d)^{-1} \\
 &= [\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}})] (\mathbf{I} + \hat{\boldsymbol{\tau}}_{(k)}) (\mathbf{I} - \mathbf{A}^d)^{-1}
 \end{aligned} \tag{44}$$

Even if more than two exemption industries exist, the above model is effective by only making the VAT rate for the exemption industry zero.

Case of with Export VAT Refund and Investment Tax Credit

The amount of VAT payment is as follows:

$$vat_k^d = 0 \tag{45a}$$

$$vat_j^d = \tau_j \left[p_j^d (x_j^d - E_j) - \sum_i p_i^d (x_{ij}^d + K_{ij}) - \sum_i p_i^m x_{ij}^m \right] \quad (45b)$$

Dividing both sides of equation (45b) gives VAT payment per unit by taxation industry.

$$\begin{aligned} \frac{vat_j^d}{x_j^d} &= \tau_j \left[p_j^d - e_j - \sum_i p_i^d (a_{ij}^d + c_{ij}) - \sum_i p_i^m a_{ij}^m \right] \\ &= \mathbf{p}^d \begin{bmatrix} -a_{1j}^d + c_{1j} \\ -a_{2j}^d + c_{2j} \\ \vdots \\ 1 - a_{jj}^d + c_{jj} - e_j \\ \vdots \\ -a_{mj}^d + c_{nj} \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \end{aligned} \quad (46)$$

Supply price for j -th industry (taxation industry) after imposing VAT is as follows.

$$\begin{aligned} p_j^d &= \sum_i p_i^d a_{ij}^d + v_j + \sum_i p_i^m a_{ij}^m + \mathbf{p}^d \begin{bmatrix} -a_{1j}^d + c_{1j} \\ -a_{2j}^d + c_{2j} \\ \vdots \\ 1 - a_{jj}^d + c_{jj} - e_j \\ \vdots \\ -a_{mj}^d + c_{nj} \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \\ &= \mathbf{p} \begin{bmatrix} a_{1j} \\ a_{2j} \\ \vdots \\ a_{jj} \\ \vdots \\ a_{nj} \end{bmatrix} + v_j + \mathbf{p}^m \begin{bmatrix} a_{1j}^m \\ a_{2j}^m \\ \vdots \\ a_{jj}^m \\ \vdots \\ a_{nj}^m \end{bmatrix} + \mathbf{p}^d \begin{bmatrix} -a_{1j}^d + c_{1j} \\ -a_{2j}^d + c_{2j} \\ \vdots \\ 1 - a_{jj}^d + c_{jj} - e_j \\ \vdots \\ -a_{mj}^d + c_{nj} \end{bmatrix} \tau_j + \mathbf{p}^m \begin{bmatrix} -a_{1j}^m \\ -a_{2j}^m \\ \vdots \\ -a_{jj}^m \\ \vdots \\ -a_{nj}^m \end{bmatrix} \tau_j \end{aligned} \quad (47)$$

Expressing the prices of taxation (j -th) industries and exemption (k -th) industry together, we have:

$$\begin{aligned}
 \mathbf{p}^d &= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m \\
 + \mathbf{p}^d &\begin{bmatrix} 1-a_{11}^d-c_{11}-e_1 & -a_{12}^d-c_{12} & \cdots & -a_{1k}^d-c_{1k} & \cdots & -a_{1n}^d-c_{1n} \\ -a_{21}^d-c_{21} & 1-a_{22}^d+c_{22}-e_2 & \cdots & -a_{2k}^d-c_{2k} & \cdots & -a_{2n}^d-c_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ -a_{n1}^d-c_{n1} & -a_{n2}^d-c_{n2} & \cdots & -a_{nk}^d-c_{nk} & \cdots & 1-a_{nn}^d-c_{nn}^d-e_n \end{bmatrix} \hat{\boldsymbol{\tau}}_{(k)} \quad (48) \\
 &- \mathbf{p}^m \mathbf{A}^m \hat{\boldsymbol{\tau}}_{(k)} \\
 &= \mathbf{p}^d \mathbf{A}^d + \mathbf{v} + \mathbf{p}^m \mathbf{A}^m + \mathbf{p}^d (\mathbf{I} - \mathbf{A} - \hat{\mathbf{e}} - \mathbf{C}) \hat{\boldsymbol{\tau}}_{(k)} - \mathbf{p}^m \mathbf{A}^m \hat{\boldsymbol{\tau}}_{(k)}
 \end{aligned}$$

Solving equation (48) with \mathbf{p}^d gives equilibrium price vector.

$$\mathbf{p}^d = \left[\mathbf{v} + \mathbf{p}^m \mathbf{A}^m (\mathbf{I} - \hat{\boldsymbol{\tau}}) \left[(\mathbf{I} - \mathbf{A}^d) - (\mathbf{I} - \mathbf{A} - \hat{\mathbf{e}} - \mathbf{C}) \hat{\boldsymbol{\tau}}_{(k)} \right]^{-1} \right]^{-1} \quad (49)$$

3-3-3 Zero VAT rate in account method

Calculating effects of zero VAT rate in account method is difficult because VAT payment included in purchasing costs could not be determined.

4. Results of simulation

Based on the model shown in the previous section, we calculated the effect of price and VAT revenue. We used 2005 Input-Output tables for Japan with 108 sectors Non-competing import tables of Statistics Bureau of Ministry of Internal Affairs and Communications. As for the rate of capital formation for concerning investment tax credit, we prepared using fixed capital formation matrix which was the supplementary tables of Input-Output tables.

To calculate the theoretical (benchmark) value due to price and VAT revenue, it is necessary to set a various assumptions, and we show the following results of six cases(see Table 3).

Table3 Assumptions of simulation

	Case1 (current)	Case 2	Case 3	Case 4	Case 5	Case 6
	Account method	Invoice method	Invoice method	Invoice method	Invoice method	Invoice method
Tax rate	5% tax rate	5% tax rate	15% tax rate	15% tax rate	15% tax rate	15% tax rate
Exemption	-	-	-	Foods	-	-
Zero VAT rate	-	-	-	-	Foods	Foods
Discount VAT rate industry (10% tax rate)	-	-	-	-	-	Medical service, Book, Newspaper, Water Supply, and Passenger Transport etc.

The Foods in the table stands for “crop cultivation”, “livestock”, “agricultural services”, “forestry”, “fisheries”, “foods”, “beverage”, “feeds and organic fertilizer (nec.)”, and “tobacco”. “The necessities of life industry” that applied to the discounted tax rate were defined with “publishing and printing”, “medicaments”, “water supply”, “railway transport”, “road transport (except transport by private cars)”, “water transport”, and “air transport”..

4-1 Price change

First of all, let's see the change of the price. Table 4 shows the level of domestic industry prices in the six cases mentioned above.

In the results, the price in the case of without VAT is assumed to be one. Moreover, we shaded exemption sectors in the table 4 and 5 , for example, house rent , Public administration, such as exemption in the current tax system were calculated assuming that exemption.

First of all, let's see case 1 and case 2. In the model of invoice method and account method, if there is no export VAT refund, investment tax credit and exemption items, both models the change of prices would certainly be equal. In the table 4, because of tax refund for export, investment tax credit and exemption articles, the difference of rising domestic prices calculated by the invoice method model is about 0.4 points larger than the account method model. However, we can say the difference between the two is very small. Concerning by industry, the industry of depends on external demand, for example, “passenger motor cars” tends to decline the rise in prices.

Case 3 is VAT rate raised by 15%. The average domestic prices is about 1.0848, that is to say, the assuming the rate of 15% VAT raises domestic prices by about 8.5%.

Case 4 is applied exemption on “Food” in addition case3. The raise of prices by industry defined “Food” are calculated about from 3 to 4 points, and the average of domestic price rises about 8.4 point.

Case 5 is applied zero VAT rate on “Food”, but the exemption doesn't apply in those. Because of the subject of industries for zero VAT rate can deduct VAT from the buying price, so the rise of prices calculated negative for many “Food” industries.

In case 6, the tax rate of industries related to goods and services for necessities of life is reduced to 10% with “Food” assumed to be zero VAT rate. It is so-called

multiple rates case. The overall average price calculated about 1.076 and the price decrease didn't observe too much, but it was declined that the price rise of industries which applied to the discounted tax rate such as "railway transport".

4-2 Revenue change

Table 5 shows the VAT revenue which is the same case in table 4. In the cases of VAT rate is flatly 5%, namely, case 1 and case 2, the VAT revenue are calculated 14,000 billion yen and 15,000 billion yen, respectively.

In recent years, such as in fiscal year 2007, the VAT revenue was about 13,000 billion yen, so there were 1,000-2,000 billion yen the difference between our calculated revenue and theoretical (benchmark) revenue. In fact, we can observe "Tax Profit" by the duty-free system and the simplified taxation system, etc. So we think that it is the cause of difference. Moreover, it might be a cause that the effect of the restrain consumption by the prices rise is not caught in our Input-Output model.

In case 3, we assume that the VAT rate is raised to 15%, tax revenue reaches even 44,600 billion yen. In addition, in case 3 assumptions, the case 4 assume exemption on "Food", tax revenue calculates about 42,300 billion yen when tax revenue decreases about 2,000 billion yen. The decrease of tax revenue because of exemption on "Food", etc. will be able to be called a limited.

In case 5, instead of exemption on "Food", we applied zero VAT rate to these industries that tax revenue decreases about 2,000 billion yen furthermore. In all industries by which zero VAT rate were applied, the tax revenue calculated negative.

In addition, In case 6, we assumed that the value added tax rate was reduced 10% for goods and services related to necessities of life, the tax revenue was calculated about 39,400 billion yen that it is decrease of about 1,000 billion yen.

Table4 Effect of consumption tax of domestic industry prices improving

(Current tax system)						
Sectors	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
	Account Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method
	Tax rate 5%	Tax rate 5%	Tax rate 15%	Tax rate 15%	Tax rate 15%	Tax rate 15%
	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit
				Exemption for foods	Zero VAT rate for foods	Zero VAT rate for foods
						10% tax rate for Medical servic,book,newspaper, water supply and passenger transport
001 Crop cultivation	1.0301	1.0360	1.1058	1.0328	0.9906	0.9908
002 Livestock	1.0335	1.0376	1.1105	1.0339	0.9913	0.9917
003 Agricultural services	1.0321	1.0405	1.1198	1.0310	0.9915	0.9916
004 Forestry	1.0377	1.0448	1.1333	1.0209	0.9954	0.9954
005 Fisheries	1.0341	1.0377	1.1112	1.0325	0.9880	0.9881
006 Metallic ores	1.0181	1.0262	1.0749	1.0751	1.0750	1.0752
007 Non-metallic ores	1.0315	1.0394	1.1165	1.1166	1.1165	1.1166
008 Coal mining, Crude petroleum and natural gas	1.0271	1.0361	1.1057	1.1058	1.1057	1.1058
009 Foods	1.0362	1.0403	1.1193	1.0419	0.9889	0.9891
010 Beverage	1.0381	1.0414	1.1227	1.0384	0.9876	0.9878
011 Feeds and organic fertilizer, n.e.c.	1.0406	1.0441	1.1313	1.0336	0.9917	0.9919
012 Tobacco	1.0407	1.0450	1.1341	1.0133	0.9971	0.9971
013 Textile products	1.0154	1.0205	1.0576	1.0577	1.0577	1.0579
014 Wearing apparel and other textile products	1.0302	1.0362	1.1065	1.1066	1.1065	1.1067
015 Timber and wooden products	1.0382	1.0436	1.1296	1.1336	1.1307	1.1310
016 Furniture and fixtures	1.0357	1.0399	1.1178	1.1183	1.1180	1.1182
017 Pulp, paper, paperboard, building paper	1.0315	1.0366	1.1073	1.1078	1.1074	1.1078
018 Paper products	1.0356	1.0402	1.1190	1.1191	1.1190	1.1193
019 Printing, plate making and book binding	1.0364	1.0400	1.1183	1.1184	1.1184	1.0703
020 Chemical fertilizer	1.0344	1.0376	1.1105	1.1106	1.1105	1.1109
021 Industrial inorganic chemical products	1.0247	1.0286	1.0822	1.0822	1.0822	1.0826
022 Petrochemical basic products	1.0354	1.0369	1.1081	1.1082	1.1081	1.1084
023 industrial organic chemicals(Expect petrochemical basic products)	1.0156	1.0186	1.0517	1.0521	1.0518	1.0521
024 Synthetic resins	1.0136	1.0168	1.0464	1.0465	1.0464	1.0467
025 Synthetic fibers	1.0114	1.0159	1.0434	1.0435	1.0435	1.0438
026 Medicaments	1.0318	1.0362	1.1061	1.1066	1.1062	1.0608
027 Final chemical products, n.e.c.	1.0227	1.0268	1.0767	1.0770	1.0768	1.0770
028 Petroleum refinery products	1.0445	1.0451	1.1342	1.1342	1.1342	1.1345
029 Coal products	1.0400	1.0422	1.1251	1.1251	1.1251	1.1261
030 Plastic products	1.0242	1.0276	1.0794	1.0794	1.0794	1.0797
031 Rubber products	1.0210	1.0248	1.0706	1.0707	1.0706	1.0708
032 Leather, fur skins and miscellaneous leather products	1.0320	1.0393	1.1159	1.1168	1.1161	1.1162
033 Glass and glass products	1.0240	1.0290	1.0837	1.0838	1.0838	1.0839
034 Cement and cement products	1.0353	1.0418	1.1240	1.1241	1.1240	1.1245
035 Pottery, china and earthenware	1.0285	1.0342	1.0997	1.0998	1.0997	1.1000
036 Other ceramic, stone and clay products	1.0290	1.0340	1.0991	1.0993	1.0991	1.0995
037 Pig iron and crude steel	1.0390	1.0425	1.1263	1.1263	1.1263	1.1270
038 Steel products	1.0237	1.0276	1.0792	1.0792	1.0792	1.0797
039 Cast and forged steel products	1.0350	1.0404	1.1195	1.1195	1.1195	1.1200
040 Other iron or steel products	1.0285	1.0339	1.0991	1.0991	1.0991	1.0996
041 Non-ferrous metals	1.0294	1.0329	1.0958	1.0958	1.0958	1.0968
042 Non-ferrous metal products	1.0285	1.0319	1.0925	1.0926	1.0926	1.0930
043 Metal products for construction and architecture	1.0343	1.0385	1.1137	1.1137	1.1137	1.1140
044 Other metal products	1.0324	1.0362	1.1061	1.1061	1.1061	1.1064
045 General industrial machinery	1.0163	1.0215	1.0608	1.0608	1.0608	1.0610
046 Special industrial machinery	1.0107	1.0153	1.0423	1.0424	1.0423	1.0425
047 Other general machines and components	1.0214	1.0257	1.0736	1.0736	1.0736	1.0739
048 Machinery for office and service industry	1.0271	1.0318	1.0927	1.0928	1.0927	1.0929
049 Industrial heavy electrical equipment	1.0140	1.0179	1.0499	1.0500	1.0499	1.0502
050 Applied electronic equipment, electric measuring instruments	1.0029	1.0063	1.0158	1.0158	1.0158	1.0159
051 Other electrical equipment	1.0115	1.0155	1.0427	1.0427	1.0427	1.0428
052 Household electric appliances	1.0241	1.0285	1.0821	1.0822	1.0822	1.0824
053 Communication equipment and equipments	1.0160	1.0196	1.0551	1.0551	1.0551	1.0553
054 Electronic computing equipment and accessory equipment	0.9976	1.0012	1.0009	1.0010	1.0009	1.0011

Table4 Effect of consumption tax of domestic industry prices improving (cont.)

		(Current tax system)					
Sectors	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	
	Account Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method	
	Tax rate 5%	Tax rate 5%	Tax rate 15%	Tax rate 15%	Tax rate 15%	Tax rate 15%	
	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	
				Exemption for foods	Zero VAT rate for foods	Zero VAT rate for foods	
						10% tax rate for Medical service,book,newspaper, water supply and passenger transport	
055	Semiconductor devices and integrated circuits	0.9837	0.9874	0.9610	0.9610	0.9610	0.9613
056	Other electronic components	1.0170	1.0205	1.0580	1.0580	1.0580	1.0582
057	Passenger motor cars	0.9975	1.0010	0.9999	0.9999	0.9999	1.0002
058	Other cars	1.0046	1.0085	1.0215	1.0216	1.0215	1.0219
059	Motor vehicles parts and accessory equipment	1.0196	1.0230	1.0652	1.0653	1.0652	1.0656
060	Ships and repair of ships	0.9934	0.9985	0.9936	0.9937	0.9937	0.9939
061	Other transportation equipment and repair of transportation equipment	1.0207	1.0248	1.0708	1.0708	1.0708	1.0710
062	Precision instruments	1.0090	1.0132	1.0360	1.0360	1.0360	1.0362
063	Miscellaneous manufacturing products	1.0231	1.0292	1.0843	1.0847	1.0844	1.0846
064	Reuse and recycling	1.0201	1.0226	1.0642	1.0643	1.0642	1.0703
065	Building construction	1.0395	1.0437	1.1300	1.1303	1.1301	1.1303
066	Repair of construction	1.0391	1.0428	1.1273	1.1273	1.1273	1.1275
067	Public construction	1.0388	1.0446	1.1329	1.1332	1.1330	1.1332
068	Other civil engineering and construction	1.0334	1.0400	1.1185	1.1186	1.1185	1.1188
069	Electricity	1.0313	1.0354	1.1035	1.1035	1.1035	1.1039
070	Gas and heat supply	1.0329	1.0355	1.1038	1.1038	1.1038	1.1041
071	Water supply	1.0265	1.0309	1.0887	1.0887	1.0887	1.0415
072	Waste management service	1.0348	1.0376	1.1102	1.1102	1.1102	1.1104
073	Commerce	1.0363	1.0416	1.1231	1.1232	1.1231	1.1231
074	Financial and insurance	1.0096	1.0110	1.0324	1.0325	1.0324	1.0307
075	Real estate agencies and rental services	1.0417	1.0480	1.1436	1.1436	1.1436	1.1435
076	House rent	1.0050	1.0069	1.0204	1.0204	1.0204	1.0203
077	House rent (imputed house rent)	1.0023	1.0029	1.0088	1.0088	1.0088	1.0087
078	Railway transport	1.0191	1.0283	1.0805	1.0805	1.0805	1.0342
079	Road transport (except transport by private cars)	1.0367	1.0396	1.1170	1.1170	1.1170	1.0716
080	Self-transport by private cars	1.0316	1.0379	1.1117	1.1117	1.1117	1.1120
081	Water transport	1.0050	1.0100	1.0272	1.0272	1.0272	1.0126
082	Air transport	1.0077	1.0143	1.0380	1.0381	1.0380	1.0057
083	Freight forwarding	1.0351	1.0404	1.1192	1.1192	1.1192	1.1193
084	Storage facility service	1.0336	1.0374	1.1097	1.1097	1.1097	1.1098
085	Services relating to transport	1.0233	1.0278	1.0787	1.0788	1.0787	1.0788
086	Communication	1.0315	1.0381	1.1122	1.1122	1.1122	1.1122
087	Broadcasting	1.0327	1.0403	1.1192	1.1192	1.1192	1.1194
088	Information services	1.0408	1.0440	1.1309	1.1310	1.1309	1.1310
089	Internet services	1.0268	1.0357	1.1046	1.1046	1.1046	1.1046
090	Motion picture and video production, and distribution	1.0352	1.0404	1.1194	1.1195	1.1194	1.1197
091	Public administration	1.0085	1.0088	1.0260	1.0260	1.0260	1.0248
092	Education	1.0038	1.0056	1.0164	1.0164	1.0163	1.0152
093	Research	1.0314	1.0399	1.1181	1.1183	1.1181	1.1182
094	Medical service and health	1.0142	1.0147	1.0434	1.0428	1.0424	1.0348
095	Social security	1.0087	1.0104	1.0308	1.0283	1.0266	1.0252
096	Nursing care	1.0082	1.0093	1.0273	1.0233	1.0207	1.0196
097	Other public services	1.0120	1.0137	1.0406	1.0404	1.0402	1.0374
098	Advertising services	1.0341	1.0405	1.1197	1.1198	1.1198	1.1199
099	Goods rental and leasing services	1.0160	1.0224	1.0630	1.0631	1.0630	1.0633
100	Repair of motor vehicles and machine	1.0315	1.0353	1.1041	1.1041	1.1041	1.1043
101	Other business services	1.0421	1.0462	1.1379	1.1380	1.1380	1.1379
102	Amusement and recreational services	1.0337	1.0368	1.1080	1.1090	1.1088	1.1089
103	Eating and drinking places	1.0380	1.0417	1.1236	1.1388	1.1272	1.1274
104	Hotel and other lodging places	1.0288	1.0330	1.0959	1.1053	1.0983	1.0984
105	Cleaning, laundry and dyeing services, barber shops, beauty shops, and public baths	1.0435	1.0457	1.1365	1.1365	1.1365	1.1366
106	Other personal services	1.0432	1.0451	1.1346	1.1354	1.1348	1.1349
107	Office supplies	1.0334	1.0379	1.1117	1.1119	1.1117	1.1122
108	Activities not elsewhere classified	1.0072	1.0535	1.1616	1.1618	1.1616	1.1602
	Weighted average	1.0250	1.0289	1.0848	1.0811	1.0783	1.0758
	(Growth rate by Case 1)		0.4%	5.8%	5.5%	5.2%	5.0%
	Simple Average	1.0254	1.0301	1.0881	1.0809	1.0773	1.0748
	(Growth rate by Case 1)		0.5%	6.1%	5.4%	5.1%	4.8%

Note: The price level before it is taxed is assumed to be 1.
Current exemption items is assumed to be exemption with all cases.

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Table5 Effect of revenue for VAT

		(Current tax system)						Unit: Million Yen
Sectors		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	
		Account Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method	
		Tax rate 5%	Tax rate 5%	Tax rate 15%	Tax rate 15%	Tax rate 15%	Tax rate 15%	
		Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	
					Exemption for foods	Zero VAT rate for foods	Zero VAT rate for foods	
							10% tax rate for Medical serviv,book,newspaper, water supply and passenger transport	
001	Crop cultivation	202,911	207,289	611,862	0	-251,705	-247,519	
002	Livestock	23,504	26,729	76,716	0	-61,432	-53,475	
003	Agricultural services	23,165	23,770	70,398	0	-36,607	-34,375	
004	Forestry	52,464	53,605	160,080	0	-29,255	-28,187	
005	Fisheries	48,394	50,237	148,880	0	-68,341	-66,995	
006	Metallic ores	78,995	79,013	236,975	236,987	236,987	237,026	
007	Non-metallic ores	20,863	24,088	71,615	71,628	71,628	72,578	
008	Coal mining, Crude petroleum and natural gas	618,431	618,812	1,856,221	1,856,272	1,856,272	1,856,415	
009	Foods	479,430	490,333	1,459,172	0	-903,491	-859,918	
010	Beverage	203,169	208,309	619,864	0	-377,097	-368,116	
011	Feeds and organic fertilizer, n.e.c.	21,729	22,590	67,429	0	-42,861	-40,627	
012	Tobacco	107,967	109,024	325,391	0	-35,758	-35,099	
013	Textile products	15,272	19,835	54,867	60,180	60,175	62,550	
014	Wearing apparel and other textile products	172,107	177,450	530,994	533,025	533,026	535,743	
015	Timber and wooden products	91,375	93,867	280,772	342,696	341,894	345,771	
016	Furniture and fixtures	59,993	62,958	187,526	187,525	187,529	191,527	
017	Pulp, paper, paperboard, building paper	58,767	62,994	184,056	188,141	188,006	195,823	
018	Paper products	60,928	63,898	190,336	190,356	190,357	198,787	
019	Printing, plate making and book binding	148,680	154,289	457,439	457,434	457,437	177,738	
020	Chemical fertilizer	7,159	7,492	22,103	22,161	22,158	22,517	
021	Industrial inorganic chemical products	21,989	23,801	67,263	67,549	67,548	69,921	
022	Petrochemical basic products	-8,103	-6,419	-23,845	-23,847	-23,845	-21,561	
023	Industrial organic chemicals (Expect petrochemical basic products)	6,160	9,946	17,952	22,699	22,620	29,586	
024	Synthetic resins	-8,484	-5,938	-23,625	-23,571	-23,560	-19,782	
025	Synthetic fibers	-78	226	-561	-469	-467	296	
026	Medicaments	132,427	137,325	403,425	415,457	415,151	133,770	
027	Final chemical products, n.e.c.	49,096	56,275	155,244	161,077	160,961	173,048	
028	Petroleum refinery products	301,534	306,119	904,241	904,248	904,250	912,503	
029	Coal products	12,485	12,900	37,623	37,713	37,714	40,538	
030	Plastic products	95,353	98,024	278,326	278,445	278,451	287,659	
031	Rubber products	34,704	36,959	104,355	124,525	124,531	127,176	
032	Leather, fur skins and miscellaneous leather products	41,159	41,468	123,967	127,929	127,893	128,359	
033	Glass and glass products	23,803	25,814	73,499	73,516	73,518	75,842	
034	Cement and cement products	56,705	61,599	183,568	183,567	183,568	191,760	
035	Pottery, china and earthenware	13,238	14,510	42,171	42,243	42,242	43,246	
036	Other ceramic, stone and clay products	31,475	33,316	96,995	97,560	97,546	101,323	
037	Pig iron and crude steel	92,465	96,368	286,357	286,355	286,356	293,337	
038	Steel products	2,004	7,643	-2,760	-2,770	-2,763	5,279	
039	Cast and forged steel products	35,840	37,341	111,319	111,322	111,322	114,438	
040	Other iron or steel products	25,925	27,307	81,488	81,488	81,488	84,569	
041	Non-ferrous metals	83,626	86,408	254,695	254,693	254,694	258,651	
042	Non-ferrous metal products	44,222	47,706	133,453	133,487	133,492	138,913	
043	Metal products for construction and architecture	80,314	86,032	256,374	256,371	256,372	262,685	
044	Other metal products	159,565	165,329	486,425	486,418	486,423	495,218	
045	General industrial machinery	33,363	40,494	101,234	101,220	101,230	109,587	
046	Special industrial machinery	18,758	27,545	57,649	57,626	57,643	67,310	
047	Other general machines and components	42,729	47,424	133,628	133,623	133,626	137,990	
048	Machinery for office and service industry	33,243	35,343	102,522	102,519	102,521	107,204	
049	Industrial heavy electrical equipment	16,483	19,931	44,643	44,626	44,638	49,963	
050	Applied electronic equipment, electric measuring instruments	-9,651	-8,775	-30,311	-30,321	-30,314	-28,488	
051	Other electrical equipment	-16,410	-14,450	-52,496	-52,508	-52,499	-49,240	
052	Household electric appliances	32,459	34,117	98,132	98,129	98,131	101,285	
053	Communication equipment and equipments	24,648	28,558	69,979	69,963	69,975	79,303	
054	Electronic computing equipment and accessory equipment	55,074	56,968	167,441	167,427	167,437	170,117	

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Table5 Effect of revenue for VAT (cont.)

		(Current tax system)					Unit: Million Yen
Sectors		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
	Account Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method	Invoice Method
	Tax rate 5%	Tax rate 5%	Tax rate 15%	Tax rate 15%	Tax rate 15%	Tax rate 15%	Tax rate 15%
	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit	Export VAT refund and investment tax credit
				Exemption for foods	Zero VAT rate for foods	Zero VAT rate for foods	10% tax rate for Medical serviv,book,newspaper, water supply,and passenger transport
055	Semiconductor devices and integrated circuits	-66,646	-63,928	-189,176	-189,206	-189,184	-183,380
056	Other electronic components	29,550	35,013	83,110	83,085	83,103	95,334
057	Passenger motor cars	-275,721	-271,893	-819,112	-819,156	-819,123	-806,086
058	Other cars	-55,575	-54,334	-168,324	-168,336	-168,327	-164,753
059	Motor vehicles parts and accessory equipment	42,558	50,128	112,416	112,387	112,408	130,722
060	Ships and repair of ships	-48,377	-44,964	-135,136	-135,137	-135,130	-132,526
061	Other transportation equipment and repair of transportation equipment	57,857	60,239	174,454	174,450	174,453	176,995
062	Precision instruments	50,024	54,731	155,945	155,934	155,942	159,106
063	Miscellaneous manufacturing products	93,858	106,003	309,934	320,130	320,041	326,346
064	Reuse and recycling	4,438	4,527	11,698	11,697	11,698	30,979
065	Building construction	688,583	707,632	2,120,531	2,124,144	2,124,005	2,164,683
066	Repair of construction	197,928	202,212	605,844	605,927	605,926	618,236
067	Public construction	375,444	395,633	1,188,185	1,195,992	1,195,684	1,220,433
068	Other civil engineering and construction	142,621	149,686	445,131	447,215	447,137	458,642
069	Electricity	183,878	215,307	614,182	614,152	614,171	630,349
070	Gas and heat supply	10,478	12,550	31,627	31,618	31,624	36,839
071	Water supply	56,823	60,215	166,776	166,746	166,763	-25,129
072	Waste management service	100,265	102,886	301,490	301,473	301,483	312,504
073	Commerce	2,987,408	3,276,658	9,695,105	9,699,001	9,698,907	9,814,980
074	Financial and insurance	0	0	0	0	0	0
075	Real estate agencies and rental services	305,979	336,608	1,009,305	1,009,306	1,009,308	1,011,385
076	House rent	0	0	0	0	0	0
077	House rent (imputed house rent)	0	0	0	0	0	0
078	Railway transport	88,424	126,476	355,970	355,926	355,954	57,129
079	Road transport (except transport by private cars)	478,297	496,306	1,468,253	1,468,237	1,468,247	702,192
080	Self-transport by private cars	0	33,024	100,986	100,987	100,986	106,687
081	Water transport	-21,411	-10,939	-44,043	-44,053	-44,046	-33,257
082	Air transport	39,521	42,822	120,392	120,382	120,389	29,015
083	Freight forwarding	14,544	15,277	45,188	45,187	45,187	45,666
084	Storage facility service	40,774	42,808	125,035	125,032	125,033	126,123
085	Services relating to transport	104,703	112,765	309,299	310,860	310,836	317,114
086	Communication	393,716	413,407	1,211,480	1,211,436	1,211,463	1,232,941
087	Broadcasting	68,771	71,465	211,264	211,259	211,262	215,361
088	Information services	509,676	522,702	1,558,752	1,558,745	1,558,749	1,571,217
089	Internet services	14,615	15,504	44,381	44,378	44,380	45,649
090	Motion picture and video production, and distribution	147,770	153,121	454,144	454,139	454,143	508,227
091	Public administration	0	0	0	0	0	0
092	Education	0	0	0	0	0	0
093	Research	316,789	332,460	983,196	990,687	990,449	1,024,576
094	Medical service and health	0	0	0	0	0	0
095	Social security	0	0	0	0	0	0
096	Nursing care	0	0	0	0	0	0
097	Other public services	0	0	0	0	0	0
098	Advertising services	125,408	132,886	392,881	392,875	392,878	413,026
099	Goods rental and leasing services	96,974	148,638	401,409	401,511	401,538	409,795
100	Repair of motor vehicles and machine	215,231	223,177	666,981	666,976	666,979	676,407
101	Other business services	1,094,804	1,162,424	3,479,926	3,479,996	3,479,998	3,498,295
102	Amusement and recreational services	240,331	256,412	751,270	765,776	765,567	779,727
103	Eating and drinking places	442,389	455,964	1,352,603	2,174,591	2,143,528	2,173,578
104	Hotel and other lodging places	163,680	176,713	515,416	663,320	657,846	666,177
105	Cleaning, laundry and dyeing services, barber shops, beauty shops, and public baths	221,374	224,349	671,594	671,656	671,656	680,178
106	Other personal services	284,981	290,313	868,264	882,666	882,100	893,283
107	Office supplies	-0	0	0	0	-0	3,637
108	Activities not elsewhere classified	-2,401	171,727	523,827	525,367	525,313	530,530
	Total	14,013,750	15,168,506	44,635,519	42,254,075	40,408,139	39,382,908

5. Concluding remarks

This study research price and revenue change by VAT reform in Japan based on VAT reform over the past 20 years, disputes for tax increase and purchase tax deduction method i.e. exemption and zero VAT rate using an extension of Fujikawa (1999) studies, however we apply the latest data (that of the year 2005). The main findings are as follows:

- A) The average price of domestic industry rise about 2.5-3.0 points compared with benchmark price when VAT rate of 5% is imposed on all industries except a present exemption item. The rate of price increase does not reach 5% due to restrain the ripple effect of price because of the system of export VAT refund and investment tax credit exemption item.
- B) The amount of the VAT estimated from the model which considered export VAT refund and investment tax credit calculated about 14,000 -15,000 billion yen in the case with the VAT rate 5%. Though the actual VAT revenue is about 13,000 billion yen, this tax revenue exceeds the actual revenue by about 1,000-2000 billion yen. It is thought that corresponded to so-called “Tax Profit” of share is large.
- C) The average prices of a domestic industry rise about 8.5 points when a VAT rate of 15% is imposed on all industries, and VAT revenue calculates about 44,600 billion yen.
- D) We assume VAT rate 15% and exemption on “Food”, the raise of prices exemption industry restrain about from 3 to 4 points, and the average of domestic price rises about 8.4 point. The deceasing of tax revenue by exemption estimated about 2,000 billion yen.
- E) The price of industry which zero VAT rate are applied that decrease before introduce to the VAT, and tax revenue tends to negative. The tax revenue decrease of about 2,000 billion yen compared with in the case of exemption.

As noted previously, the Hatoyama cabinet established on September, 2009 declared that VAT rate fixed to at the current level for the next 4 years.

However, the tax reform involving VAT may not get by with avoiding because

of responding to burgeoning government social security-related expenditure and budget deficit with progress of aging society.

Though Japanese Government Tax Commission has discussed for tax reform, we guess it needs adequate amount of time to prepare for plan to increase taxes, introduce to discounted tax rate and invoice method of adoption.

Conversely, it is necessary to discuss actively that people can easily accept tax system in these four years.

Finally, we will easily show that remain to be solved of this study in the future.

As a pointed out of Fujikawa (1999), our result of analysis only analyzed first-order effect of the increased VAT rate. And this study isn't considered that the change of price system will affect a lot of economic variables such as wedge and consumption structure. Moreover, we can consider that regressive tax and household burden by expanded analysis of by income class that using the data of *Annual Report on the Family Income and Expenditure Survey*.

We would like to improve the analysis precision by addressing these remaining issues in the future.

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