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Estimating Tax Revenue Elasticity of Municipal Tobacco Taxes by Region with Average Adjustment Lags

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Abstract

In Japan, the uniform and simultaneous regulation of tobacco prices using the tobacco retail price system is regarded as a social issue. Previous studies have estimated the price elasticity or tax revenue elasticity of uniform national prices from the perspective of smoke-free promotion policies and basic municipal finances; however, uniform national estimates cannot provide sufficient data to help solve social issues. This study aimed to estimate the tax revenue elasticity of the basic municipal tobacco tax by region by considering the demand adjustment mechanism (average adjustment lag) with reference to previous studies on energy to address social and academic issues further. The results showed that the short- and long-term tax revenue elasticities differed by region—especially in the long-term—with the highest and lowest values being 4.029 (Tokai Bureau of Finance) and 1.973 (Shikoku Bureau of Finance), respectively. While previous studies estimated the short-term elasticity to be below one, the long-term elasticity was above one for all regions, indicating that the earlier results may have been underestimated. We also found differences in the average adjusted lag between the uniform national and regional estimates. As a concrete policy measure, it is better to change the current tobacco tax from a specific tax to an ad valorem tax and allow JT and other tobacco manufacturers and distributors to set the main price by region.

Keywords

Tobacco Price, Municipal Tax Revenue, Average Adjustment Lags, Japan

1. Introduction

The smoking rate in Japan has witnessed a downward trend owing to the undeniable negative effects of smoking on smokers and those around them, such as

the presence of carcinogens and addictive nicotine. In fact, according to the Ministry of Health, Labor and Welfare's National Health and Nutrition Survey, the age-adjusted smoking rate (the percentage of people who currently smoke habitually) among people aged 20 years and above in 1989 was 55.3% for men and 9.4% for women. However, in 2019, the rate was 27.1% for men and 7.6% for women, indicating a downward trend.

While there is a belief that a decrease in the smoking rate will contribute to better health, it is also necessary to consider the effect of tobacco consumption on social contribution, such as tobacco production by leaf tobacco farmers, economic activities by retail stores, and Japan Tobacco Inc. (JT), industrial investment by JT through dividend payments (Fiscal Investment and Loan Program Special Account Investment Account), and, tobacco taxes imposed by basic local governments, including the national and prefectural governments.

Table 1 shows the percentages of local taxes paid by basic municipalities during the analysis period (2014-2017), discussed later in the paper. On average, tobacco tax revenue accounts for 5% to 6% of the local taxes paid by basic

Table 1. Basic municipal tobacco tax as a percentage of local taxes.

FY	Ratio of tobacco tax revenue to local taxes	Standard deviation	Max	Min	Name of the municipality with the maximum value	Name of the municipality with the minimum value
2014	6.07%	2.47%	23.60%	0.16%	Chiyoda ward, Tokyo	Iitate Village, Fukushima Prefecture
2015	6.01%	2.43%	22.70%	0.24%	Chiyoda ward, Tokyo	Minami-Sogi Village, Nagano Prefecture
2016	5.74%	2.29%	20.12%	0.11%	Chiyoda ward, Tokyo	Okuma Town, Fukushima Prefecture
2017	5.32%	2.13%	18.30%	0.03%	Chiyoda ward, Tokyo	Kiyokawa Village, Kanagawa Prefecture

Note: Prepared by the authors based on the Municipal Accounts Settlement Survey. Note: For the 23 wards of Tokyo, there is no municipal inhabitant tax (for corporations), fixed asset tax, special land holding tax, or city planning tax; therefore, the share of the basic municipal tobacco tax in local taxes is larger. Note: For Kiyokawa Village, Aiko County, and Kanagawa Prefecture, tobacco tax revenue decreased by 92.58% from 2016 to 2017, following the withdrawal of a major convenience store, the only store in the village, in October 2016. Subsequently, it increased by 683.48% in 2018, owing to the attraction of a drugstore in March 2018, using the government's subsidy to establish local development centers, which is highly variable and was excluded as an outlier in the analysis in Section 3.

municipalities, indicating that it is one of the important sources of revenue for basic municipal finances. In other words, a decrease in the smoking rate may result in a decrease in economic activity and basic municipal tobacco tax revenue.

The retail price of tobacco is to be set uniformly and simultaneously throughout the country per Articles 33(1), 33(2), and 36 of the Tobacco Business Act. According to the 1995 annual report of the Japan Fair Trade Commission (1995), "From the viewpoint of competition policy, the retail price-fixing system should be abolished, and the retail price of tobaccos should be liberalized." Although the need for regulatory reform has been questioned, the fixed retail price system remains in place.

According to the general law of demand, the quantity demanded will decrease as tobacco price increases. If the price elasticity of demand for tobacco (hereafter referred to as price elasticity) ranges between zero and one, the sales will increase as the price increases; however, if the price elasticity is greater than one, the sales will decrease (see **Table 2**). Given that the tobacco tax is a pay-as-you-go tax imposed per unit of tobacco, this relationship also holds between the price of tobacco and tobacco tax (hereafter referred to as the revenue elasticity). In other words, the retail fixed-price system, which sets the retail fixed price of tobacco uniformly and simultaneously throughout the country, is a system that cannot reflect differences in prices or tax revenue elasticity among regions; therefore, it is not necessarily desirable from the perspective of maximizing sales or tax revenue.

From the viewpoint of social demand for evidence-based policymaking, it is necessary to address these social issues from an academic perspective by presenting an empirical analysis of the data. However, although there is ample research on price and tax revenue elasticity, it has not been able to capture the differences among regions because it is estimated uniformly across the country. For example, from the perspective of policies to promote smoking cessation, Goto, Nishimura, and Ida (2007), the Science Council of Japan (2008), Itoh and Nakamura (2013), and Uemura (2014) generally estimated price elasticity to be lower than one. Additionally, Yoshida and Atoda (2011) estimated tax revenue elasticity from the perspective of its effect on basic government finances, which was also generally estimated to be lower than one. Overseas, Baltagi and Levin (1992), Karki, Pant, and Pande (2003), Gallet and List (2002), Hidayat and Thabrany (2010), Mushtaq, Mushtaq, and Beebe (2011), Kelejian and Piras (2014), Goodchild, Prucic, and Nargis (2016), Ciccarelli and Elhorst (2017), and Ho,

Table 2. The relation between the price elasticity and the sales.

The price elasticity (e)	$0 \le e < 1$		$e = 1$	$e > 1$	
The price	↑	↓	↑ or ↓	↑	↓
The sales	↑	↓	→	↑	↓

Schafferer, Lee, Yeh, and Hsieh (2018) also estimated price elasticities to be below one. Although there are differences in perspective, all these studies provide uniform estimation results across the country. If price revisions are made based on these estimates, some regions may benefit from increased sales or tax revenue due to the revisions, whereas others may not. If the price or tax revisions could be made according to the elasticity of each region, it would be possible to increase sales and tax revenues more, rather than if revisions were made uniformly and simultaneously throughout the country.

Additionally, one academic issue is the assumption of an immediate demand adjustment. Given the extent of nicotine dependence, and the fact that rush demand and subsequent rebound decline cannot be ruled out, it can be problematic to assume that the demand would immediately adjust to the optimal level in response to price changes. Dunlop, Perez, and Cotter (2011) gave two possible explanations for nicotine dependence: First, there is a short-term change in the demand for tobacco in response to price changes but a long-term return to a near-optimal demand for tobacco. Second, there is a possibility of gradual changes in the demand for tobacco in response to price changes; this was also pointed out by Dwyer-Lindgren et al. (2014) and Sharbaugh et al. (2018). Although it may be argued that these points are based on the stated preference method and time series analysis and are not analyzed in the framework of elasticity, they all indicate the possibility of a time lag in demand adjustment (hereinafter referred to as the average adjustment lag). Estimating elasticity without considering this point may result in two possibilities: the overestimation or underestimation of long-run elasticity.

Furthermore, considering the possibility of the so-called rush demand and reactionary decline, underestimation or overestimation may occur depending on when the data is used. Previous studies in Japan and abroad have not explicitly considered the average adjustment lag. Consequently, this possibility remains and should be addressed academically.

If the average adjustment lag differs by region, the long-term elasticity calculated based on the average adjustment lag also differs by region. Moreover, from the perspective of maximizing sales or tax revenue, it is better to revise prices or taxes based on the latter. Additionally, as a policy tool to promote smoking cessation, it is better to conduct price or tax revisions by region rather than nationwide; for instance, by conducting price or tax revisions beforehand in areas with a large average adjustment lag because of the timing at which the effects of the policy can be fully realized differs.

Based on the above, this study also considered the average adjustment lag for the increase in tobacco prices, estimated the short-term elasticity (as estimated by previous studies) and long-term elasticity (considering the average adjustment lag) for each region, and aimed to derive the necessity of price or tax revisions based on the long-term elasticity for each region.

This paper proceeds as follows. Section 2 investigates previous studies that

consider regional elasticities and average adjusted lags for goods and services other than tobacco and survey studies on energy demand as representative studies. Section 3 describes the methodology and data. Section 4 further presents the estimation results. Section 5 then concludes the study with policy implications and future issues.

2. Literature Review

If we investigate studies that estimate elasticities by region for goods and services other than tobacco, we can find studies on energy demand, including electricity and electric lights. For example, Bernstein and Griffin (2005), Akiyama and Hosoe (2008), Tanishita (2009), and Otsuka, Taguchi, Motonari, and Takayuki (2013) estimated the regional price elasticity of the demand for electricity; Obata and Shimazaki (2014) further estimated the regional price elasticity of the demand for kerosene. These studies generally use the following model for estimation[1]:

$$\ln\left(E_{i,t}\right) = a + b\ln\left(P_{i,t}\right) + c\ln\left(Y_{i,t}\right) + d\ln\left(E_{i,t-1}\right) + \varepsilon_{i,t} \quad (1)$$

where $E_{i,t}$ denotes the quantity demanded in region i in period t, $P_{i,t}$ denotes the price in region i in period t, $Y_{i,t}$ denotes the income level in region i in period t, $E_{i,t-1}$ denotes the quantity demanded in region i in period $t-1$, i.e., the one-period lagged term as a Koyck distributed lag, and ε_{it} denotes the disturbance term.

The most distinctive feature of this estimation model is the one-period lagged term, which represents the dynamic adjustment mechanism of demand; here, consumers do not immediately modify their behavior to the optimal demand level derived from the constrained utility maximization problem but evaluate its impact by assuming that a certain adjustment lag occurs. This model is therefore used to calculate the average adjustment lag. The elasticities identified in the above model are b for short-term price elasticity, $b/(1-d)$ for long-term price elasticity, and $d/(1-d)$ for average adjustment lag.

The analytical framework for estimating the regional price elasticity of energy can be applied to this study, particularly the framework for estimating the short- and long-term elasticities, which is useful owing to nicotine dependency and the adjustment process of demand owing to the so-called rush demand and subsequent reactionary decline. Overseas, Ciccarelli and De Fraja (2014) have conducted studies that consider the adjustment process of tobacco demand. However, this study was based on nationwide uniform estimates and did not consider the adjustment process of tobacco demand for each region in Japan. Therefore, it

[1]In this study, we estimated the tobacco tax revenue function rather than the tobacco demand function. However, the basic municipal tobacco tax is a pay-as-you-go tax imposed per the quantity of tobacco. If we assume that there is no change in the brand of tobacco consumed by smokers, the parameters of the basic municipal tobacco tax revenue function are equal to those estimated in the tobacco demand function. Therefore, the estimation results of this study can be interpreted in the same way as those of sales as well as the tax revenue of basic municipal finances.

is crucial to conduct a price elasticity of demand estimation that considers the adjustment process of tobacco demand by region in Japan.

However, data on the quantity of tobacco, which corresponds to the quantity demanded of tobacco, has not been disclosed by region in Japan, as this data is considered an important trade secret. Therefore, this study estimated the tobacco tax revenue function (tax revenue elasticity) rather than the tobacco demand function (price elasticity).

3. Methodology and Data

3.1. Period of Analysis

Upon examining the timeline of tobacco tax revisions, we found no revisions on tobacco taxes between October 1, 2010, and October 1, 2018. Moreover, all the revisions during this period were for the actual price of tobacco. Therefore, there was no need to decompose the effect of tobacco price revision on demand into the effects of tax and price revision within this period.

We further excluded the period from 2010 to 2012 to simplify the analysis because the Great East Japan Earthquake occurred during this period, leading to a supply shock, as indicated by Yuda (2012).

Additionally, we calculated basic municipal tobacco tax revenue on a fiscal year basis. However, the data for 2018 (revised on October 1, 2018), when price revisions were made within the fiscal year, was not included.

Furthermore, considering the possibility of dependence owing to nicotine, which is unique to tobacco, and the possibility of the so-called rush demand and subsequent reactionary decline, we presumed that it would take time to adjust to the price revision. Therefore, we used 2013 only to introduce a one-period lagged term. Based on the above, for parameter estimation, the period to be analyzed ranged from FY2014 to FY2017.

3.2. Estimation Model and Data

Based on previous energy-related studies, this study used the following estimation model:

$$\log\left(E_{i,t}\right) = \alpha_0 + \alpha_1 \log\left(I_{i,t}\right) + \alpha_2 \log\left(P_t\right) + \alpha_3 \log\left(E_{i,t-1}\right) + \varepsilon_{i,t} \quad (2)$$

where $E_{i,t}$ is the basic municipal tobacco tax revenue per resident aged 20 and above in basic municipality *i* in period *t*, $I_{i,t}$ is the real income in basic municipality *i* in period *t*, realized at the consumer price level (data from the same prefectural capital as the basic municipality), P_t is the tobacco price in period[2]

[2]Manufactured tobaccos sold and taxed in Japan include tobaccos, pipe tobacco, chopped tobacco, chewing and smoking tobacco, and heating tobacco, each with its own brand. As it is not possible to estimate basic municipal tax revenue for each brand owing to data unavailability, this study used Mevius, which is regarded as a typical tobacco by the Ministry of Finance, as a representative tobacco for convenience. The price of Mevius was 430 yen per pack in 2014 and 2015, and 440 yen per pack from 2016 to 2017. Moreover, because tobacco tax has not been revised during this period, all price changes are attributed to the revision of the unit price.

t $E_{i,t-1}$ is the basic municipal tobacco tax revenue per resident aged 20 and above in basic municipality i in period $t-1$, i.e., the one-period lagged term, and ε_{it} is the disturbance term. The short- and long-term tax revenue elasticities and average adjusted lag were calculated using the following equations, respectively[3].

$$\begin{aligned} &\text{Short-term elasticity of tax revenue: } \alpha_2 \\ &\text{Long-term elasticity of tax revenue: } \frac{\alpha_2}{1-\alpha_3} \\ &\text{Average adjusted lag: } \frac{\alpha_3}{1-\alpha_3} \end{aligned} \tag{3}$$

The sign condition for each explanatory variable is as follows: α_1 is the rate of change in tax revenue in response to a 1% increase in real income, which can be either positive (+) or negative (−)[4]. α_2 is the elasticity of tax revenue, which is negative (−) because the quantity demanded is expected to decrease due to the price revision, hence reducing the revenue from tobacco tax, which is a pay-as-you-go tax. The sign condition for α_3 is a value between 0 and 1, based on the definition of the average adjustment lag. The regional classification, the descriptive statistics, and the source of the data in the analysis are shown in Tables 3-5, respectively.

4. Results and Discussion

The results of the estimation based on the specified estimation model are shown in Table 6. The lnprice, which indicates short-term tax revenue elasticity, is at the 5% significance level for the Shikoku Finance Bureau; however, it meets the 1% significance level for the rest of the regions. By region, the national uniform model is −1.742 (tax revenue elasticity is 1.742), which is estimated to be a 1.742% decrease in tax revenue for a 1% increase in tobacco prices in the short term. −2.527 (with a tax revenue elasticity of 2.527) is particularly large for the Kanto Local Finance Bureau, indicating a large decrease in tax revenue relative to the price. Assuming that smokers do not change brands, it is estimated that price hikes have reduced both tax revenues and sales in these regions.

In contrast, the Shikoku Regional Finance Bureau and the Fukuoka Regional Finance Bureau have −0.740 (tax revenue elasticity is 0.740) and −0.874 (tax revenue elasticity is 0.874), respectively, which means that for a 1% increase in price, tax revenue decreases by less than that. Assuming that smokers do not change brands, the price increase in Shikoku and Fukuoka will increase sales,

[3]Hiromatsu, Ikeda, Fujiwara, and Wakabayashi (1988) pointed out the following problems with the Koyck distributed lag: 1) multicollinearity with explanatory variables; 2) when the parameter of the lagged term exceeds one, the lagged term alone explains the problem. Regarding the first point, the problem of multicollinearity is small because this study used panel data (Baltagi, 2005; Hsiao, 2003), and the correlation between the two variables was 0.283 at the maximum value and −0.012 at the minimum value.

[4]Assuming that smokers do not change brands owing to price revisions, the results are positive (+) if tobaccos are a higher-order good and negative (−) if they are a lower-order good.

Table 3. Regional classification.

Financial bureau	Prefecture	Financial bureau	Prefecture
Hokkaido	Hokkaido	Kinki	Hyogo
Tohoku	Aomori		Kyoto
	Iwate		Shiga
	Akita		Nara
	Miyagi		Osaka
	Yamagata		Wakayama
	Fukushima	Chugoku	Tottori
Kanto	Gunma		Okayama
	Nagano		Simane
	Niigata		Hiroshima
	Saitama		Yamaguchi
	Tochigi	Shikoku	Tokushima
	Chiba		Kagawa
	Ibaraki		Ehime
	Tokyo		Kochi
	Yamanashi	Kyushu/Okinawa	Kumamoto
	Kanagawa		Oita
Tokai	Shizuoka		Okinawa
	Mie		Miyazaki
	Aichi		Kagoshima
	Gifu	Fukuoka	Fukuoka
Hokuriku	Toyama		Saga
	Ishikawa		Nagasaki
	Fukui		

although it will reduce tax revenue. However, if the price revision is based on the taxation of tobacco rather than its price, the tax revenue will increase, and the sales will decrease for the producers.

The results of the F-test, which tests whether there is a statistically significant difference between the lnprice estimate, indicating the short-term elasticity of tax revenue and the nationally uniform estimate, show that there is no significant difference in Tohoku, Tokai, Hokuriku, and Kinki. The null hypothesis that the lnprice is equal to the nationally uniform estimate is rejected at the 1% significance level in Hokkaido, Kanto, Chugoku, Shikoku, and Fukuoka, and at the 5% significance level in Kyushu and Okinawa.

Table 4. Descriptive statistics.

	Variable		Obs.	Mean	S.D.	Min	Max	Sign condition
Nationwide	Tobacco tax revenue per capita	$log(E_{i,t})$	792	8.812	0.493	6.391	11.134	
	Real income	$log(I_{i,t})$	792	14.214	0.255	13.431	15.189	+ or −
	Typical tobacco price	$log(P_{i,t})$	792	6.075	0.012	6.064	6.087	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	428	14.086	0.210	13.539	14.566	0 - 1
Hokaido	Tobacco tax revenue per capita	$log(E_{i,t})$	376	13.978	0.244	13.376	14.525	
	Real income	$log(I_{i,t})$	376	6.075	0.012	6.064	6.087	+ or −
	Typical tobacco price	$log(P_{i,t})$	376	8.868	0.366	7.538	9.559	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	688	6.075	0.012	6.064	6.087	0 - 1
Tohoku	Tobacco tax revenue per capita	$log(E_{i,t})$	400	6.075	0.012	6.064	6.087	
	Real income	$log(I_{i,t})$	400	9.075	0.280	7.658	9.874	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1
Kanto	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1
Tokai	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1
Hokuriku	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1
Kinki	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1
Chugoku	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1

Continued

Shikoku	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1
Kyushu/Okinawa	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1
Fukuoka	Tobacco tax revenue per capita	$log(E_{i,t})$	0	0.000	0.000	0.000	0.000	
	Real income	$log(I_{i,t})$	0	0.000	0.000	0.000	0.000	+ or −
	Typical tobacco price	$log(P_{i,t})$	0	0.000	0.000	0.000	0.000	-
	1st lag of the dependent variable	$log(E_{i,t-1})$	0	0.000	0.000	0.000	0.000	0 - 1

Table 5. Source of data.

Variable	Source
Tobacco tax revenue	Account settlement by municipality (Shichosonbetsu Kessan Joukyoutou Sirabe) for each city according to fiscal year Ministry of Internal Affairs and Communications, Japan
Real income	Account settlement by municipality (Shichosonbetsu Kessan Joukyoutou Sirabe) for each city according to fiscal year Ministry of Internal Affairs and Communications, Japan
Population	The basic resident registration for each city according to fiscal year Ministry of Internal Affairs and Communications, Japan
Typical tobacco price	Tobacco and Salt Industries Office, Planning and Administration Division, Financial Bureau, Ministry of Finance, Japan

Table 6. Estimation results.

	Nationwide		Hokkaido		Tohoku		Kanto		Tokai		Hokuriku	
lnrealincome	0.002		0.202	**	0.165		−0.003		0.069		−0.041	
	(0.049)		(0.079)		(0.204)		(0.077)		(0.114)		(0.162)	
lnprice	−1.742	***	−1.184	***	−1.351	***	−2.527	***	−1.630	***	−1.924	***
	(0.063)		(0.137)		(0.274)		(0.090)		(0.129)		(0.188)	
lag	0.389	***	0.570	***	0.598	***	0.198	***	0.595	***	0.396	***
	(0.011)		(0.040)		(0.035)		(0.014)		(0.038)		(0.060)	
const.	16.005	***	8.276	***	9.485	***	22.548	***	12.513	***	17.665	***
	(0.633)		(1.207)		(2.105)		(1.077)		(1.759)		(2.325)	
Within R-sq.	0.386		0.520		0.376		0.525		0.643		0.720	

Continued

Between R-sq.	0.992		0.906		0.974		0.991		0.982		0.991	
Overall R-sq.	0.959		0.892		0.952		0.885		0.963		0.941	
F-value	1086.520	***	192.540	***	132.470	***	492.540	***	286.910	***	128.620	***
Hausman test	1984.610	***	109.600	***	95.140	***	1098.880	***	93.350	***	66.290	***
	Fixed effect		Fixed effect		Fixed effect		Fixed effect		Fixed effect		Fixed effect	
F-test												
H_0: lnprice = −1.742			16.47	***	2.05		76.46	***	0.75		0.94	
H_0: lag = 0.389			20.35	***	35.57	***	188.83	***	28.66	***	0.01	
	Kinki		Chugoku		Shikoku		Kyushu/Okinawa		Fukuoka			
lnrealincome	−0.259		−0.372	**	−0.326	+	0.121		−0.721	***		
	(0.227)		(0.188)		(0.215)		(0.135)		(0.191)			
lnprice	−1.846	***	−1.088	***	−0.740	**	−1.270	***	−0.874	***		
	(0.298)		(0.232)		(0.297)		(0.197)		(0.207)			
lag	0.413	***	0.498	***	0.625	***	0.443	***	0.590	***		
	(0.046)		(0.048)		(0.064)		(0.039)		(0.052)			
const.	20.054	***	16.259	***	12.351	***	11.000	***	19.189	***		
	(3.030)		(2.250)		(2.633)		(1.703)		(2.473)			
Within R-sq.	0.295		0.454		0.430		0.318		0.477			
Between R-sq.	0.879		0.670		0.895		0.957		0.355			
Overall R-sq.	0.848		0.644		0.881		0.927		0.358			
F-value	82.540	***	88.270	***	70.060	***	79.880	***	68.080	***		
Hausman test	136.880	***	91.480	***	40.090	***	159.390	***	68.080			
	Fixed effect		Fixed effect		Fixed effect		Fixed effect		Fixed effect			
F-test												
H_0: lnprice = −1.742	0.12		7.96	***	11.41	***	5.77	**	17.64	***		
H_0: lag = 0.389	0.27		50.4	**	13.74	***	1.94		14.82	***		

Note: ***, **, and + indicate significance at the 1%, 5%, and 15% levels, respectively. Note: Figures in parentheses represent standard errors.

The one-period lagged term is significantly positive and between zero and one in all regions; therefore, it satisfies the sign condition as an adjustment coefficient. In contrast, the parameter of real income is not significant for many regions.

In essence, based on the estimation results of short-term tax revenue elasticity, if smokers do not change brands, the price reduction will lead to a sales increase in all regions except Shikoku and Fukuoka, and the price increase will result in sales increases only in Shikoku and Fukuoka. The same applies if the taxing entity makes the price revision, where a price reduction will lead to increased tax revenue, except for Shikoku and Fukuoka, where a price increase will result in

increased tax revenue. In light of the above, a nationwide uniform retail price system is not desirable from the perspective of tax revenue and sales and should be reviewed.

Table 7 calculates the long-term tax revenue elasticity and the average adjusted lag based on the parameter estimation results in Table 6. The long-term elasticity of tax revenue is above one for all regions, including Japan. The value is above two except for Shikoku; however, the Tokai Finance Bureau has a value above four. This means that tax revenue is extremely elastic to tobacco prices in the long run.

Additionally, assuming that smokers do not change brands, the tax revenue elasticity and price elasticity are equal. Moreover, a 1% increase in price will reduce tax revenue and sales.

Additionally, from the perspective of smoking cessation promotion policies, the long-term elasticity varies significantly from region to region, ranging from 1.973 to 4.029. A uniform nationwide price revision may result in a disparity between regions where excessive policy effects are observed and those where they are not.

By region, the Kanto Local Finance Bureau has the shortest average lag, at 0.247, and adjusts demand in about three months on average. In contrast, the Shikoku Local Finance Bureau has the longest average lag, at 1.666, taking approximately 20 months on average to adjust demand. The Science Council of Japan (2008) calls for the use of price mechanisms to promote smoke-free policies. However, considering the differences in the average adjustment lag by region, it is better to revise prices at different times based on the average adjustment lag rather than simultaneously nationwide.

Table 7. Elasticity and average adjusted lag.

	Price elasticity of tax revenue		
	Short	Long	Average adjusted lag
Nationwide	1.742	2.853	0.638
Hokkaido	1.184	2.757	1.328
Tohoku	1.351	3.357	1.485
Kanto	2.527	3.151	0.247
Tokai	1.630	4.029	1.472
Hokuriku	1.924	3.187	0.656
Kinki	1.846	3.146	0.704
Chugoku	1.088	2.166	0.991
Shikoku	0.740	1.973	1.666
Kyushu/Okinawa	1.270	2.280	0.795
Fukuoka	0.874	2.135	1.442

5. Conclusions and Implications

This study estimated the short- and long-term regional tax revenue elasticity of tobacco demand, considering the demand adjustment mechanism.

While tobacco consumption has undeniable adverse effects on health, it is one of the most important financial resources for basic municipal finances and economic activities such as production and sales. Japan's fixed price tobacco retailing system regulates tobacco prices uniformly and simultaneously throughout the country, which is considered a social issue in terms of competition policy and lost opportunities for tax revenue and sales growth. Previous studies have estimated the price elasticity or tax revenue elasticity of uniform national prices from the perspective of smoke-free promotion policies and basic municipal finances. However, uniform national estimates cannot provide sufficient data for solving social issues. Additionally, nicotine dependence and rush demand followed by a reactionary decline cannot be denied. Moreover, insofar as previous studies have estimated short-term elasticity by assuming the immediacy of demand adjustment, academic issues remain. This study estimated the tax revenue elasticity of the basic municipal tobacco tax by region by considering the demand adjustment mechanism (average adjustment lag) with reference to previous studies on energy to further address social and academic issues.

We found that the short- and long-term tax revenue elasticities differed by region, especially in the long-term, with the largest and smallest values being 4.029 (Tokai Bureau of Finance) and 1.973 (Shikoku Bureau of Finance) respectively. Additionally, while previous studies estimated the short-term elasticity, which was estimated to be below one, the long-term elasticity found in this study was above one for all regions, indicating that the results of previous studies may have been underestimated. We also found that the average adjusted lag differs between the uniform national and regional estimates.

As a concrete policy measure, it is better to change the current tobacco tax from a specific tax to an ad valorem tax, as well as to allow JT and other tobacco manufacturers and distributors to set the main price by region. In addition to enabling market-oriented pricing by JT and other companies, an ad valorem tax system would make it possible to share the benefits of price revisions between the industry and the government in a certain ratio while maintaining consistency as a single nation (a uniform tax rate, rather than a uniform tax amount).

This study has several limitations. First, we used the price of Mevius, a typical brand of JT tobaccos, as a variable for the tobacco price because JT has many other brands and imposes tobacco taxes on foreign tobaccos and cigars. The accuracy of the estimation results can be improved by considering the fact that there are many other brands, as well as foreign tobaccos and cigars, that are subject to tobacco tax. This is a difficult issue from the perspective of data availability; however, it can be addressed in future studies. Second, the data period was set to 2017. Tobacco prices have been revised in stages since October 2018.

Moreover, the awareness of the need to quit smoking has continued to grow since 2017. Future studies must use the updated municipal financial status report and work on the availability of the data mentioned in the first limitation, to solve this problem. Third, it is important to consider the difference between the place of consumption and the place of demand. Moreover, it would be meaningful to incorporate the possibility of cross-border purchasing behavior into the analysis as a similar framework. Future studies should analyze urban structure (e.g., day/night population ratio, age structure, household composition, gender, etc.).

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Conflicts of Interest

The authors declare no conflicts of interest.

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