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Brand switching or reduced consumption? A study of how cigarette taxes affect tobacco consumption

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Abstract We examined the influence of cigarette taxes on tobacco consumption, with an emphasis on smokers' choice between reducing cigarette consumption and switching brands. We constructed three scenario-based models to study the following two subjects: (1) the relationship between deciding whether to reduce one's cigarette consumption and to practice brand switching (simultaneous or sequential); (2) the key determinants that affect smokers' decisions in terms of their consumption and brand switching when facing higher taxes. We applied data collected from a survey in Taiwan, and the results indicated that both independent and two-stage decision-making models generated very similar conclusions. We also found that gender difference contributed to reduce cigarette consumption. In addition, this study indicated that high-income smokers were less likely to switch brands, whereas well-educated smokers were more likely to switch brands. Most importantly, we questioned the effectiveness of cigarette tax policy, as our results suggested that higher price did not necessarily reduce consumption. Indeed, data indicated that <24 % of smokers actually reduced their cigarette consumption after the tax on cigarettes increased.

Keywords Cigarette smoking · Brand switching · Cigarette tax

JEL Classifications I10 · I12 · I18

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Introduction

Smoking is one of the leading preventable causes of death, and it contributes to approximately 443,000—or nearly one of every five—deaths each year in the United States [10]. Accordingly, researchers and public health authorities have proposed and implemented various programs, the aim of which is to reduce the number of smokers and total cigarette consumption. Of these programs, the cigarette tax is one of the most effective intervention policies, which is why government authorities often choose it to reduce tobacco consumption [13]. Economic theory suggests that increasing taxes will result in higher direct costs for smokers and thus lessen the demand for cigarettes [8, 25, 26, 31, 38]. In addition, empirical evidence has demonstrated that smokers' cigarette demand could be very sensitive to changes in price [9, 11, 19, 37].

However, researchers have recently begun to question the effectiveness of a price-control strategy, such as cigarette taxes, in reducing tobacco consumption. For instance, some smokers may react to the increase in cigarette taxes by altering other behaviors to ensure that such price

increases will not affect their ability to purchase cigarettes. Some studies found that when the price of tobacco increased, smokers did not change their total cigarette consumption [27, 36] instead, these smokers simply switched cigarette brands: they chose to consume lower-priced, unregulated, or illegally manufactured cigarettes as their compensating strategy to maintain their smoking habits [40]. By doing so, this group of smokers may actually worsen their health (relatively speaking) than had they continued using their preferred brands.

Some scholars believe that smoking is a result of external, uncontrollable factors (nicotine addiction), environmental factors (parents, peer pressure, tobacco advertising), and psychological factors (dependency). These factors also explain the motivation behind smokers' brand-switching behavior, as the income lost by paying taxes is most likely to be smaller than the discomfort of reducing one's smoking habits [15]. Some argue tobacco addiction to be the result of miscalculation: smoking gives instant gratification, but the long-run damage to one's health is heavily discounted and often hard to predict. Therefore, smokers often underestimate the marginal costs of smoking and continue to smoke as a result of time-inconsistent preference [24]. In contrast, one economic theory suggests that smoking is a deliberate and rational decision. According to the rational addiction theory, smokers choose to smoke because the marginal benefits from consuming tobacco are greater than the costs [6]. Given the fact that continuing smoking maximizes their utility, smokers are very likely to switch to cheaper or illegal brands in order to maintain that level of utility when cigarette taxes are applied. Otherwise, smokers may continue to smoke but choose to consume a smaller quantity of their preferred brand of cigarettes, supplementing their nicotine needs with other, cheaper products. Indeed, some evidences suggested that smokers' total tobacco consumption was virtually unchanged when faced with higher prices, because most smokers chose to switch brands rather than to reduce their overall use of tobacco products [1, 3, 4, 7, 12, 14, 16, 17, 20–23, 28–30, 33, 35, 39, 41]. Occasionally, consuming lower-priced or illegal cigarettes can create unexpected, and in some cases, severe adverse health effects. Therefore, accurately identifying smokers' reactions to any form of tax policy designed to discourage tobacco consumption is essential for policy makers so that these officials can develop and effectively evaluate such actions.

Tsai et al. [36] pointed out two types of compensation when smokers practiced brand-switching behaviors: biological compensation and economic compensation. Biological compensation behaviors occur when smokers switch brands to high-tar and/or high-nicotine tobacco brands to compensate for reducing the total quantity of cigarette purchases. This type of behavior is intended to offset the effects of negative utility from reduced smoking resulting from higher cigarette prices [2, 15, 32, 34]. Because the new brands of cigarettes contain more nicotine per cigarette, the reduced demand in terms of quantity does not necessarily mean that smokers have reduced their total tobacco and nicotine intakes Consequently, such biological compensation behavior could significantly reduce the efficacy of taxed-induced pricing strategies designed to reduce total tobacco consumption. Furthermore, Hasenfratz et al. [22] and Woodman et al. [41] suggested that tar and nicotine intake might be independent of brand-switching behaviors. They suggested that smokers would substitute their preferred brands with lower-price brands in order to maintain the total number of cigarettes consumed when facing higher cigarette taxes. In fact, financial motivation is the key factor behind economic compensation. In adopting such behavior, smokers are able to maintain similar levels of tobacco and nicotine intake by purchasing cheaper but poorer-quality cigarettes [5]. For instance, in a survey of Taiwanese smokers, Lee et al. [26] found that smokers in low-income and/or low educational attainment categories were more attracted to cheaper, illegal cigarettes when the government increased cigarette taxes.

For this study, we constructed three scenario-based decision-making models to examine how smokers would react to an increase in tobacco taxes, emphasizing the choice between reducing their total cigarette consumption and switching brands. In 2002, the Taiwanese government imposed a tobacco and welfare tax of NT $16.8 (i.e., approximately US $0.5) for each pack of cigarettes purchased. Later, the taxes were increased to NT $21.8 (about US $0.74) per pack in 2006 and NT $31.8 (about US $1.07) in 2009. Although the purpose of these tax increases was assumed to discourage tobacco consumption in Taiwan, the impact on smokers' behavioral changes and quantity of tobacco consumption have not been formally studied. We examined the influence of Taiwan's cigarette tax policy with the following three focuses: (1) the relationship between smokers' decisions to reduce consumption and to switch brands; (2) whether smokers make consumption and brand-switching decisions simultaneously or sequentially—assuming that the decisions in the relationship are related; (3) the key determinants in consumption and brand-switching decision-making processes. Most importantly, we examined whether higher prices encourage smokers to reduce consumption. Despite the importance of these issues to the general public's health and welfare, we found no formal discussion or any solid empirical evidence in the literature to support one conclusion or another. Therefore, we conducted an insightful investigation into the relationship between changes in cigarette consumption and brand switching under three different scenarios.

Moreover, we investigated how smokers' socioeconomic and demographic backgrounds affect their decisions to reduce the number of cigarettes consumed and to switch brands.

Methodology and empirical model

Based on the objectives of the study, we assigned two dummy dependent variables to indicate whether smokers reportedly reduced cigarette consumption (*REDUCE*) or switched to other brands (*BRAND*). We constructed our empirical models to examine the relationship between the two using the following three scenarios: (1) smokers' decisions to reduce cigarette consumption and brand switching were mutually independent; (2) smokers underwent a two-stage decision-making process: first, they would decide to reduce consumption, and then they would make a decision to switch brands accordingly; (3) smokers would simultaneously reduce consumption and switch brands. To reflect the nature of these three scenarios, we constructed three separate regression models to test the validity of each hypothesis (i.e., probit, probit with sample-selection models, and multinomial logit). Estimations resulting from these three scenarios should provide a better picture of smokers' reactions toward cigarette taxes and higher market prices.

Scenarios

Scenario 1: smokers make decisions to reduce consumption and practice brand switching independently The first scenario hypothesizes that smokers make two independent decisions: one to reduce consumption and one to switch brands. This scenario assumes that the individual decision to reduce smoking for individual smoker, i, is a linear function of price (per pack) (P) and a vector of exogenous variables including age, gender, income, and education (X). Given u is an error term, Eq. 1 demonstrates the decision function to reduce consumption:

$$REDUCE_i = \alpha_1 P + \alpha_2' X_i + u_i \tag{1}$$

Due to the binary nature and independence between reduced consumption and brand switching, we employed a probit model to estimate reduced consumption and brand-switching decisions. Scenario 1 is a standard model applied by most current studies on the subject, which requires a single equation probit or logit model to analyze reduced smoking and brand switching, respectively (e.g., [36]. The empirical specification of Eq. 1 for a probit model is:

$$\begin{aligned} REDUCE_i^* &= \gamma_{11} P + \gamma_{12}' X_i + u_{11i} \\ E(u_{11}) &= 0 \\ Var(u_{12}) &= 1 \end{aligned} \tag{2}$$

where $REDUCE^*$ is an unobservable latent variable.

Similarly, the decision to switch brands is:

$$\begin{aligned} BRAND_i^* &= \gamma_{21} P + \gamma_{22}' X_i + u_{21i} \\ E(u_{21}) &= 0 \\ Var(u_{22}) &= 1 \end{aligned} \tag{3}$$

where $BRAND_i^*$ is an unobservable latent variable.

We estimated the values of γ_{21} and γ_{22} in Eqs. 2 and 3 separately based on the assumption of independent decision making.

Scenario 2: smokers engage in a two-stage decision-making process This scenario assumes that smokers engage in a sequential decision-making process. In the first stage, smokers decide whether to maintain their current cigarette consumption after market prices increase. If the decision in the first stage is not to reduce the current level of consumption, smokers would then decide whether and how to practice brand switching in the second stage. Eqs. 4 and 5 are empirical specification of this scenario. The first stage of the decision-making model is:

$$NON\_REDUCE_i = \beta_{31} + \beta_{32} P + \beta_{33}' X + \mu_{31i} \tag{4}$$

We assigned a binary dependent variable (NON_REDUCE_i) to indicate whether smokers decide to maintain their current cigarette consumption. If any smoker decided to keep the status quo (the latent variable $NON\_REDUCE_i^* > 0$), we assigned value of 1 for the dependent variable NON_REDUCE_i. Otherwise, we assigned a value of 0 if the smoker, i, decided to reduce consumption (i.e., the latent variable $NON\_REDUCE_i^* \leq 0$).

Smokers with certain characteristics might be more likely to keep the same behavioral pattern and consumption level when facing tax hikes. Hence, the observations applied at the second stage of scenario 3 were not random. We included only smokers who decided not to reduce consumption in order to estimate their brand-switching behaviors. We used these observations with a high value of μ_{31} to a conditional brand-switching model, as shown in Eq. (5):

$$\begin{aligned} BAND_i^* &= \beta_{33}' X_i + \mu_{32i} \quad \text{if} \quad NON\_REDUCE = 1 \\ E(\mu_{31}) &= E(\mu_{32}) = 0 \\ Var(\mu_{32}) &= Var(\mu_{32}) = 1 \\ Cov(\mu_{31}, \mu_{32}) &= \rho \end{aligned} \tag{5}$$

We examined the fitness of scenario 3 (i.e., probit with sample-selection bias) by testing the statistical significance of ρ.

Scenario 3: mixed model that allows us to estimate four possible behavioral changes In contrast to the previous two scenarios, scenario 3 applies a multinomial logit specification that allows us to estimate the probability of four different combinations of behavioral changes: (1) reduce total consumption but not switch brands; (2) reduce total consumption and practice brand switching; (3) do not reduce consumption but switch to different brands; (4) do not reduce consumption and do not practice brand switching.[1]

Let J denote a smoker's choice from the four possible choices of behavioral changes (i.e., $J = \{1, 2, 3, 4\}$), and let $U_{ij} = z'_{ij}\beta + \varepsilon_{ij}$ be the utility of the alternative j ε J for smoker i, where z_{ij} is a vector of explanatory variables and where β is the associated parameters. We assume that each smoker, i, will chooses the best alternative, j, that maximizes her/his utility. In other words, the alternative j is chosen only if

$$Pr(U_{ij} > U_{ik}) = \text{for any other alternative} \quad k \neq j. \tag{6}$$

We further assume the J errors are independently and identically distributed (IID) with Gumbel distribution (i.e., $F(\varepsilon_{ij}) = \exp(-e^{-\varepsilon_{ij}})$). Equation (7) is a multinomial logit model estimating the probability of an alternative j to be chosen by smokers:

$$Pr(Y_i = j) = \frac{\exp(z'_{ij}\beta)}{\sum_{j=1}^{4}\exp(z'_{ij}\beta)}, \quad j = 1, 2, 3, 4. \tag{7}$$

Data descriptive statistics

In 2009, Taiwan's Department of Health Executive Yuan conducted a survey to examine the effects of cigarette tax on tobacco consumption after the additional NT $10 tax imposed in 2009 (i.e., increased from NT $21.8 in 2006 to NT $31.8 in 2009). The survey questionnaire contained a series of questions regarding smoking behavior after imposing the additional taxes. In 2010, the Executive Yuan conducted a similar survey to update the information. We utilized the information from this 2010 survey and applied a random sampling procedure to select representative samples. After deleting unfeasible and incomplete answers, we collected 1,022 usable observations of current smokers (i.e., smoked in past 1 month and their life-time cumulative consumptions exceed 100 cigarettes) and who were aged ≥18. All samples were randomly collected in Taiwan's 22 counties and cities. Among all smokers, 188 reduced consumption without practicing brand switching, and 135 practiced brand switching but did not reduce total cigarette consumption. Only 51 smokers reportedly reduced cigarette consumption and practiced brand switching at the same time. Accordingly, Table 1 shows that our sample has 239 smokers (i.e., 188 + 51) who reduced consumption and 186 (i.e., 135 + 51) who practiced brand switching.

Table 1 Descriptive statistics (n = 1,022)

	Definition	Mean	SD
Variables			
Price	Cigarette price per pack (unit, NT$)	65.22	11.7
Education	Schooling years	12.54	3.74
Income	Monthly income, divided by 10,000 (unit, NT$)	3.15	2.40
Binary variables			
REDUCE (n)	1 = yes	239	23.39 %
BRAND (n)	1 = yes	186	18.20 %
Male (n)	1 = male, 0 = female	953	93.25 %
In northern Taiwan (n)	1 = yes	500	48.92 %
In central Taiwan (n)	1 = yes	192	18.79 %
In southern Taiwan (n)	1 = yes	330	32.29 %

SD standard deviation

Table 1 reports the definitions and descriptive statistics of all variables used in our empirical analysis from the 1,022 total sample observations. The average cigarette price (*Price*) per pack was NT $65.22 (∼US $2.00). The average years of school completed (*Education*) was 12.54, which indicated a high school graduation degree. The average monthly income (*Income*) was NT $30,000 (∼US $1,000). However, the standard deviation (SD) of *Income* was NT $24,000, suggesting a relatively uneven income distribution among our sample smokers. The vast majority (93.25 %) of sample respondents were male (*Male*), which closely reflected the gender distribution of smokers in Taiwan. Moreover, about 48.92 % of the observations were from northern Taiwan and 32.29 % from the south, which reflected the geographic density of population in Taiwan.

We assigned values to the two dependent variables (*REDUCE* and *BRAND*) by the answers given by respondents to the following two questions: The government imposed the additional Health and Welfare (cigarette) tax on cigarettes in 2009. How do you respond to the increasing cigarette prices? (1) Have you reduced the number of cigarettes smoked per day? (2) Have you switched to other cigarette brands? For each dependent variable, we assigned the value 1 if the respondent answered yes; otherwise, we assigned the value 0. Table 1 indicates 23.39 % (n = 239) of smokers chose to reduce cigarette consumption (*REDUCE*) after the tax increases in 2009. If the purpose of imposing a cigarette tax was to reduce smokers' total consumption, the value of *REDUCE* suggests a relatively disappointing policy outcome, as 24 % of

[1] We appreciate referees' suggestions to include this scenario.

smokers reportedly reduced their consumption. Moreover, Table 1 shows that about 18.20 % ($n = 186$) of smokers chose to switch cigarette brands (*BRAND*). Data indicate that 135/186 smokers who practiced brand switching did not reduce their total consumption. These numbers indicate that the majority of smokers would either continue the same smoking habits or practice brand switching to maintain the same cigarette consumption.

Results and discussion

Tables 2 and 3 summarize estimations of *REDUCE* and *BRAND* from the first two scenarios (i.e., probit and probit with sample selection models). Table 4 reports the estimates of scenario 3, which allows different combinations of behavioral changes by applying a multinomial logit model.

Table 2 shows that gender was the only variable that contributed to the decision to reduce consumption (*REDUCE*) for scenario 1. The coefficient *Male* (0.6545) suggests that male smokers are more likely to reduce smoking when facing higher taxes. We can also interpret this coefficient as evidence that the 2009 tax increase was an ineffective attempt to reduce female smokers' tobacco consumption. The remaining variables in Eq. 2 are statistically insignificant in their influence on *REDUCE*.

Column 2 in Table 2 (*BRAND*) shows the estimated brand-switching behavior. Although it is not significant in the decision to reduce consumption, the coefficient *Price* (−0.0376) is negative and statistically significant at 1 %, suggesting that smokers who bought higher-priced cigarettes were less likely to practice brand switching. We believe this result can be explained in one of two ways: (1) these smokers were not sensitive to the change in cigarette prices, or (2) the NT$10 per pack tax was not high enough to generate brand-switching behaviors. This result is consistent with the coefficient *Income* (−0.0752), which suggests that higher-income smokers are less likely to practice brand switching. Moreover, although we are inclined to believe that higher education would create better health awareness that would, in turn, enhance the effectiveness of the tax policy in reducing cigarette consumption, we found that the opposite is true. In fact, Table 2 demonstrates that the coefficient *Education* (0.1068) is significant and positive, suggesting that higher education contributed to more brand-switching practices rather than an overall reduced consumption.

Table 3 shows that scenario 2 generated an LR test value of 5.51, with *P* value 0.0189, indicating that the two-stage probit model (controlling for sample selection bias) is statistically a better decision-making model for Taiwan's smokers than is scenario 1. However, comparison between the estimations of Tables 2 and 3 suggests that scenarios 1 and 2 actually generated a very similar conclusion despite their very different assumptions about smokers' decision-

Table 2 Estimations of reduced consumption and brand switching from probit model (reduced consumption and brand switching are mutually independent)

Variable	REDUCE		BRAND	
	Coefficient	*t* statistics	Coefficient	*t* statistics
Price	−0.0039	−1	–0.0376	–8.2***
	[−0.0012]		[–0.089]	
Education	0.0058	0.44	0.1068	6.71***
	[0.0017]		[0.2513]	
Income	−0.0238	−1.12	–0.0752	–3.02***
	[−0.072]		[–0.0177]	
Male	0.6545	2.98***	–0.093	–0.48
	[0.1458]		[–0.0228]	
Northern Taiwan	−0.1098	−0.98	0.0691	0.54
	[−0.0333]		[0.0163]	
Southern Taiwan	0.0066	0.05	0.0606	0.44
	[0.002]		[0.0144]	
Constant	−1.0399	−2.94***	0.3603	0.98
Log likelihood	−548.0058		−430.4182	
Pseudo-R^2	0.014		0.1123	

Marginal effects are in square brackets

Significant at * 1 %, ** 5 %, *** 10 %

Table 3 Estimations of reduced consumption and brand switching from probit with sample-selection model (two-stage decision process)

Variable	No reduction		Brand switching	
	Coefficient	*t* statistics	Coefficient	*t* statistics
Price	0.0105	2.66***	–	–
	[0.0032]			
Education	−0.0086	−0.67	0.0638	4.15***
	[−0.0027]		[0.0176]	
Income	0.0167	0.8	−0.0847	−3.41***
	[0.0052]		[−0.0237]	
Male	−0.6169	−2.8***	−0.0965	−0.51
	[−0.1493]		[−0.0041]	
Northern Taiwan	0.1379	1.38	0.0663	0.57
	[0.0374]		[0.0120]	
Southern Taiwan	0.0353	0.28	0.0526	0.36
	[−0.01165]		[0.0285]	
Constant	0.6044	1.67*	−1.6379	−5.93***
ρ	0.0888			
Log likelihood	−892.1722			
$P = 0$: LR test (P value)	5.51** (0.0189)			

Marginal effects are in square brackets

Significant at * 1 %, ** 5 %, *** 10 %

Table 4 Estimates of cigarette smoking for scenario 4 (multinomial logit model)

Variable	(1)		(2)		(3)	
	Coefficient	*t* statistics	Coefficient	*t* statistics	Coefficient	*t* statistics
Price	−0.0064	−0.83	−0.0670	−4.74***	−0.0708	−7.33***
Education	0.0065	0.27	0.1799	3.59***	0.1907	5.72***
Income	−0.0476	−1.19	−0.1308	−1.7*	−0.1516	−2.93***
Male	1.3444	2.54**	0.6527	0.87	−0.2077	−0.58
Northern Taiwan	−0.3844	−1.84*	0.6231	1.32	−0.1358	−0.54
Southern Taiwan	−0.1827	−0.82	0.8082	1.64	−0.1717	−0.61
Constant	−1.7973	−2.4**	−1.4393	−1.15	1.1783	1.6
Log likelihood	−974.02567					

(1) Reduced but did not switch brands ($n1 = 188$), (2) reduce and switched brands ($n2 = 51$), (3) did not reduce but switched brand ($n3 = 135$), (4) did not reduce or switch brands ($n4 = 648$)

making processes. The similar conclusions of scenarios 1 and 2 is an important finding for Taiwan's government because our results suggest that the various factors that determine smokers' reactions toward the new tax policy are consistent, regardless of the potential differences in how smokers make their decisions to reduce consumption or practice brand switching.

Table 4 summarizes the estimates of scenario 3. The advantage of applying the multinomial logit model is that the model assumes that the probability ratio between any two pairs of alternatives is independent of all other alternatives (i.e., Independent of irrelevant alternatives, IIA). By setting the choice of "no changes in behavior" as the baseline (i.e., no reduction in consumption and no brand switching), we are able to estimate how the same factors affect smokers' decision-making processes in choosing among the three other choices of behavioral changes.

We first examined the validity of IIA assumption by conducting the Hausman test. The results at the bottom of Table 4 show that the test statistic is statistically insignificant, indicating that the multinomial logit model is a proper model [18]. Compared with the default choice (i.e., no consumption reduction and no brand switching), the three columns in Table 4 report the estimates of the following three types of behavior changes: (1) column 1, reduce consumption but do not switch brands; (2) column 2, reduce consumption and switch brands; (3) column 3, do not reduce consumption but switch brands.

The coefficient for *Male* is positive and statistically significant at the 5 % level in column 1 (i.e., 1.34), suggesting that male respondents are more likely to reduce their cigarette consumption than are female respondents. In contrast, columns 2 and 3 indicate that *Male* is not a significant factor for brand switching. Moreover, the coefficient *Education* in column 1 suggests that higher education does not affect smokers' decision to reduce consumption alone (i.e., 0.0065, statistically insignificant). However, the coefficients *Education* in columns 2 and 3 (0.18 and 0.19, respectively) indicate that higher education will create a significant and positive influence for smokers to practice brand switching. When combined with brand switching, higher education may also reduce tobacco consumption. Regarding the effects of higher prices, the coefficient *Price* in Table 4 suggests that higher price does not encourage reduced consumption (−0.0064 in column 1, statistically insignificant). Compared with smokers who continue to smoke despite facing higher taxes, the coefficient *Price* in columns 2 and 3 suggest that higher prices do, in fact, reduce the predicted probability that smokers will switch brands. Likewise, the coefficient *Income* suggests that it does not affect smokers' decisions to reduce consumption but, instead, has an impact on discouraging brand-switching behaviors.

Based on our findings, we recommend that Taiwan's health authorities review the efficacy of the current cigarette tax policy in terms of its actual impact on reducing cigarette consumption. Table 1 suggests that only a relatively small percentage of smokers (23.29 %) reduced their consumption 2 years after the additional tax was imposed. In fact, a majority of smokers did not reduce consumption at all; instead, they continued the same smoking behavior or switched brands to continue consuming the same amount of cigarettes. We propose that an NT $10 tax increase might be too trivial to create a disincentive to reduce smoking. Moreover, results of the three scenarios shown in Tables 2–4 also suggest that, overall, higher prices did not contribute to reduced consumption. In some case, higher prices will reduce the probability of smokers switching brands. Male smokers had a higher probability of reducing consumption when facing higher prices. In fact, estimates from scenarios 1 and 2 suggest that low-income smokers were more likely to practice brand switching to

maintain their previous tobacco consumption level. Interestingly, these two models also predicted that higher education did not reduce consumption but contributed to brand-switching behaviors.

Conclusion

We examined how Taiwan's smokers reacted to the increased tobacco taxes in 2009, emphasizing their choice between reducing overall cigarette consumption and switching to a different brand. We studied the influence of Taiwan's cigarette tax policy with the following three focuses: (1) the relationship between decisions regarding consumption and brand switching; (2) if the two decisions are related, whether smokers make these decisions simultaneously or sequentially; (3) key determinants in consumption and brand-switching decision-making processes. We conducted our empirical analysis by examining the following three scenarios: (1) smokers' decisions to reduce cigarette consumption and switch brands were mutually independent; (2) smokers decided whether to reduce consumption first and then made decisions of whether to switch brands accordingly; (3) smokers decided to reduce cigarette consumption and switch brands simultaneously. We used data collected from a 2011 survey to examine three empirical models designed under the assumptions of these three scenarios.

Study results indicate that although scenario 2 (the two-stage decision-making model) is statistically a better model than scenario 1 (simple probit model), both scenarios generated almost identical predictions in terms of decision-making, indicating that both models provide solid and consistent conclusions, regardless of the different model assumptions. A comparison between the three scenarios also suggests a consistent conclusion. Data indicate that gender difference contributed to the greatest reduction in cigarette consumption. As data indicate, male smokers are more likely to cut consumption when facing higher cigarette price (or taxes). Also, income and education level also affect the decision-making process. Our data suggest that as income increases, smokers are less likely to practice brand switching. We also found educational attainment has a positive impact on the decision to switch brands. Most importantly, we found that, overall, higher cigarette prices alone does not reduce smokers' cigarette consumption.

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Conflict of interest All authors declare that they have no conflicts of interest.

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