Purchasing Regulation and Household Tobacco Consumption in Japan: A Quasi-experimental Approach

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First draft: April 2009

Abstract

Tobacco-related industrial associations in Japan adopted an age verification system for purchasing tobacco through vending machines, called Taspo, in 2008. Using regional variations in the month of the adoption as a quasi-experiment, we evaluate the effect of this purchasing regulation on the household tobacco consumption. Our difference-in-differences approach by the repeated cross-section of monthly household surveys reveals that the TASPO operation does increase the tobacco consumption by 16-20 percent. We discuss possible mechanisms accounting for this counterintuitive statistical evidence.

JEL Classification: I18; C21.

Keywords: Smoking regulation; Tobacco consumption; Difference-in-differences.

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1 Introduction

In 2008, tobacco-related industrial associations in Japan have adopted an age verification system for purchasing tobacco through vending machines. The purpose of this purchasing licensing system, called Taspo, is the prevention of underage smoking, required by the Framework Convention on Tobacco Control (FCTC) (World Health Organization, 2005). However, the adoption of the Taspo system arguably bear additional costs for the adult smokers, changing their consumption behaviors on tobacco.

The aim of this paper is to evaluate the effect of adopting the Taspo system on Japanese household tobacco consumption using monthly repeated cross-sectional data from the Survey of Household Economy (conducted by the Statistics Bureau) for the 51 cities from August 2006 to December 2009. Using regional variations in the month of the adoption as a quasi-experiment, we run a difference-in-differences regression and reached a striking, counterintuitive statistical evidence; the Taspo operation does increase the tobacco consumption by 16-20 percent.

Increasing recognition of health and economic risks of tobacco smoking has generated numerous political debates and various types of regulations have been enacted by workplaces, cities, and countries. Numerous authors have performed empirical works quantifying the effect of regulations on the adults' and teenagers' smoking behavior. They include; Evans et al. (1999), Saffer and Chaloupka (2000), DeCicca et al. (2002), Wan (2006), Tauras (2006), DeCicca and McLeod (2008), Carpenter (2009), Adda and Cornaglia (2010), among others. However, they do not examine the efficacy of purchasing licensing on smoking which is investigated in this paper.

The rest of the paper is organized as follows. Section 2 shows institutional background on the adoption of the Taspo system in Japan. Section 3 describes the data used in this study. Section 4 reviews the difference-in-differences regression model. Section 5 shows the empirical result and checks its robustness. Section 6 discuss the mechanism generating our empirical results and concludes the paper.

2 Institutional Background

For the prevention of potential health and socio-economic losses by tobacco use, Framework Convention on Tobacco Control (FCTC) was adopted by the WHO member countries in May 2003 and effectuated in February 2005. The FCTC requires the party countries, including Japan, to prohibit the sales of tobacco to underage persons by the Article 16 (World Health Organization, 2005). The article 16 has possessed a great influence on the business strategies of the Japanese tobacco industries since minors in that country were able to purchase tobacco through vending machines without any regulations and the large fraction of tobacco sales owes these of vending machines.

In November 2001, as a voluntary regulation by the tobacco-related industries, three major industrial associations, Tobacco Institute of Japan (TIOJ), National Federation of Tobacco Retail Cooperative Associations, and Japan Vending Machine Manufacturers Association, planed to adopt an age verification system for purchasing tobacco through vending machines. After some trial operations in remote island Tanegashima in May 2004, the actual operation has begun in two prefectures, Miyazaki and Kagoshima, since March 2008. The adoption and replacement of old vending machines were completed throughout the country by July 2008 (Fiscal System Council, Ministry of Finance, 2009). Table 1 shows the dates of starting the age-verification for 47 prefectures.

The age verification is done through an IC card, called Taspo (abbreviation of "tobacco passport"), which is issed by the TIOJ for individuals over age 20 upon application with free of charge. For obtaining the Taspo card, the applicants are required to submit a filled application form, a picture of her/his face and a copy of document identifying the individual (e.g., a driver's license or welfare certificates). After the screening of the TIOJ, the card is derived to the applicant within two weeks.[1] Putting the Taspo card on the appropriate part of a vending machine,

[1]The English site on Taspo is available at: `http://www.taspo.jp/english/index.html`

one can buy tobacco through it.

In July 2008, the Ministry of Finance revised a part of the Tobacco Business Act, which regulates the production and sales of tobacco, so that the adoption of vending machines with age-verification systems is mandatory for the sales. Here the method of verification includes that by driver's license, by biometric (facial) certification, and by the above mentioned Taspo IC card though the first two are less popular than the last. Retailers refuting the requirements can be ordered to suspend business or, at worst, the revocation of the license (Fiscal System Council, Ministry of Finance, 2009).

The propagation of the Taspo system and subsequent revision of the Act brought visible changes to the sales of tobacco-related industries. Table 2 shows the total tobacco sales, the sales by vending machines, and the number of vending machines through 2006-2008. The table suggests that the Taspo regulation severely damaged the Japanese tobacco industries. A notable reduction is found in the 2008 sales by vending machines, dropping to the half of the previous year's figure. The number of vending machines itself declined in that period which implies the retailers' quitting behavior.

The primal goal of adopting the age-verification system to the vending machines is to prohibit minors from purchasing tobacco. However, some evidences, partly anecdotal and partly based on news paper reports, cast doubt on the efficacy of this new regulation. An unpublished 2008 fall survey on adolescent tobacco and alcohol use by the Ministry of Health, Labour, and Welfare reveals that 42% of junior-high and high school students who are current smokers have accessed the vending machines by Taspo cards. (****) Another concern is the shift of underage smokers from vending machines to other sites selling tobacco, e.g., convenience stores, supermarkets, and restaurants. In October 2008, Community Safety Bureau, National Police Agency issued a notification arguing these industries to verify the age of customers strictly when they selling tobacco.

3 Data Description

The data set we use in this study comes from the Survey of Household Economy (SHE) conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications, Japan. The SHE is a monthly survey consisting of approximately 8,000 households par month where the household has at least two family members and the household's head is an employed worker. Unfortunately, the micro data sets are not of public use. The Statistics Bureau, however, releases the monthly averages for the selected 51 cities and the number of surveyed households for each city.[2] So our empirical analysis utilize this monthly time series of city level cross-sectional data. Finally, based on table 1, we construct a dummy variable identifying the Taspo operation status of a city in a given month; a key policy variable in our study.

There are some limitations worth noting in our data. First, due to aggregation over city, we cannot distinguish zero and positive tobacco consumptions of individual households. It may be more desirable to evaluate the Taspo effect on the extensive margin (probability of reporting non-zero tobacco consumption) and on the intensive margin (mean tobacco consumption conditional on its non-zero value). But we cannot perform such analyses in the current setting. Next, since the variables are recorded not on individual but on household basis, it is impossible to separate the adult tobacco consumption from that of the minor. We nevertheless use the SHE data since there are no alternative monthly cross-sections which contains tobacco consumption, regional information and other socio-economic variables.

As an outcome, our analysis examines two variables, a real household tobacco consumption and its share to the total consumption. The set of control variables includes; the age of household head, real disposable income, family size, the number of families under age 18, that of over 64, and home owner dummy. In addition to these variables, our regression model presented in the next section includes city dummies, city-specific time trends, and time dummies (or common

[2]They include the 47 prefecture capitals and four large cities. The data on two cities, Hamamatsu and Sakai, are available since January 2007.

time trend). The number of individuals of each cell is used as a weight.

We use the observations from August 2006 to December 2009 of the released data, consisting of 2057 city×month group means of individual households. This observation window was chosen since the tobacco price in that country is stable (virtually unchanged) during these periods.[3] Table 3 shows the summary statistics of the variables for the total sample and the samples conditional on the Taspo status. The Taspo era covers about a half of the total city-month cells. We cannot find visible differences between these sub-samples except slice increase in the tobacco expenditures in the Taspo group.

Figure 1 depicts the monthly variations of the household tobacco expenditures, the tobacco shares to the consumptions, and the tobacco sales, the last of which is drown from ***. The first and the last vertical lines in each of three panels denote March 2008 and June 2008, i.e., the months when the first and the last group of regions adopted the Taspo system. A striking fact found in comparing these three panels of figure 1 is that the two household tobacco variables behave quite differently from the sales data. The sales of tobacco exhibit a secular decline during these periods. On the other hand, the two household-side variables seem to shift the levels upward upon the beginning of the Taspo operation, confirming a tentative view of table 3.

4 Design of Empirical Analysis

We employ a difference-in-differences (DD) regression approach for evaluating the Taspo effect on the household tobacco consumption. For household i lived in city $c \in \{1, 2, \ldots, C\}$ in month $t \in \{1, 2, \ldots, T\}$, we assume that tobacco consumption y_{ist} is determined by the following process:

$$y_{ict} = \delta D_{ct} + \boldsymbol{x}_{ict}'\boldsymbol{\beta} + \gamma_c + \eta_t + \xi_c t + u_{ict}, \tag{1}$$

[3]More specifically, we do not use observations before August 2006 since a tax increase on tobacco was performed in June 2006 and the price was strongly fluctuated around that month. It also should be noted that the variation of tobacco price is driven by the (infrequent) tax changes of the Japanese national government and so each cities face identical prices in a given month. For this reason, we do not use the price as a regressor.

where D_{ct} is a dummy variable taking on unity if the Taspo system is operated in city c in month t and zero otherwise and $\boldsymbol{x}_{ict}$ is the vector of household i's characteristics including a constant. γ_c and η_t denote city and time effects, respectively. Also, ξ_c captures a city-specific time trend. Hereafter we treat them as unknown parameters and normalized so that $\gamma_1 = \eta_1 = \xi_1 = 0$.

Averaging the both sides of equation (1) over c and t, we have

$$\bar{y}_{ct} = \delta D_{ct} + \bar{\boldsymbol{x}}_{ct}'\boldsymbol{\beta} + \gamma_c + \eta_t + \xi_c t + \bar{u}_{ct}. \tag{2}$$

The interpretation of variables and coefficients remain unchanged but the variance of error term, $\bar{u}_{ct}$, is now given by that of u_{ct} times $1/N_{ct}$, where N_{ct} denotes the number of households in a city $\times$ time cell. We estimate δ, $\boldsymbol{\beta}$, γ_s, η_t, and ξ_s in equation (2) by OLS with weight N_{ct}. In obtaining standard errors, we allow arbitrary heteroskedasticity and within-city correlations of error terms, as suggested by Bertrand et al. (2004). The presence of correlations over the time period is considered here for the following reasons. First, due to the sampling design of the SHE, a household sampled in a given month is surveyed during the next five months. So a large fraction of identical households of city c in the current period remains in the subsequent periods. Second, it is well known that the consumption of addicted goods is highly persistent (***).

The number of time periods, T, is relatively large in our monthly repeated cross-section data. (We use at most 41 time periods.) Therefore estimating the model with unrestricted variations of time effects η_t gives rise to a large reduction of the degree of freedom. For this reason, we impose a constant growth restriction on the time effects that

$$\mathrm{H}_0: \quad \eta_{t+1} - \eta_t = \eta_t - \eta_{t-1}, \quad t = 2, 3, \ldots, T-1, \tag{3}$$

which is, coupled with normalization $\eta_1 = 0$, equivalent to

$$\eta_t = \eta \cdot t, \tag{4}$$

with unknown parameter η. The hypothesis is statistically tested in the empirical analysis.[4]

What does parameter δ, the coefficient of Taspo dummy D_{ct} in equation (1) or equation (2), capture? For answering this question, we first assume a mean-independence of error terms,

$$\mathrm{E}(\varepsilon_{ict}|\boldsymbol{x}_{ict}, \gamma_c, \eta_t) = \mathrm{E}(\varepsilon_{ict}|\boldsymbol{x}_{1ct}, \boldsymbol{x}_{2ct}, \ldots, \boldsymbol{x}_{N_{ct},ct}, \gamma_c, \eta_t) = 0, \tag{5}$$

for individual household equation (1). As shown in the appendix, this assumption implies that

$$\mathrm{E}(\bar{\varepsilon}_{ict}|\bar{\boldsymbol{x}}_{ct}, \gamma_c, \eta_t) = 0 \tag{6}$$

in grouped-data regression (2).

Consider two cities c and q where the Taspo system was operated as of period t_c and as of period t_q, respectively, and $t_q > t_c$. Then, since $\mathrm{E}(d_{ct}|\bar{\boldsymbol{x}}_{ct}, \gamma_c, \eta_t) = \mathrm{E}(d_{ct}|\gamma_c, \eta_t) = d_{ct}$, the conditional means of the tobacco expenditures are given by

$$\mathrm{E}(\bar{y}_{ct}|\bar{\boldsymbol{x}}_{ct}, \gamma_c, \eta_t) = \begin{cases} \delta + \bar{\boldsymbol{x}}_{ct}'\boldsymbol{\beta} + \gamma_c + \eta_t + \xi_c t, & t_c \leq t, \\ \bar{\boldsymbol{x}}_{ct}'\boldsymbol{\beta} + \gamma_c + \eta_t + \xi_c t, & t_c > t, \end{cases} \tag{7}$$

and

$$\mathrm{E}(\bar{y}_{qt}|\bar{\boldsymbol{x}}_{qt}, \gamma_q, \eta_t) = \bar{\boldsymbol{x}}_{qt}'\boldsymbol{\beta} + \gamma_q + \eta_t + \xi_q t, \quad t < t_c \leq t_q. \tag{8}$$

[4]We reached this estimation strategy since, as shown in section 5, unrestricted time effects have a very weak explanatory power for tobacco expenditures conditional on other regressors. On the other hand, we cannot impose such restrictions on γ_c and ξ_c since there are no natural orders in cities in the current situation.

Suppressing regional and time effects in the conditioning sets, we have

$$\begin{aligned}&\left[\mathrm{E}(\bar{y}_{st_{\text{post}}}|\bar{\boldsymbol{x}}_{st_{\text{post}}}) - \mathrm{E}(\bar{y}_{st_{\text{pre}}}|\bar{\boldsymbol{x}}_{st_{\text{pre}}})\right] - \left[\mathrm{E}(\bar{y}_{qt_{\text{post}}}|\bar{\boldsymbol{x}}_{qt_{\text{post}}}) - \mathrm{E}(\bar{y}_{qt_{\text{pre}}}|\bar{\boldsymbol{x}}_{qt_{\text{pre}}})\right] \\ &= \delta + \left[\left(\bar{\boldsymbol{x}}_{st_{\text{post}}} - \bar{\boldsymbol{x}}_{st_{\text{pre}}}\right)' - \left(\bar{\boldsymbol{x}}_{qt_{\text{post}}} - \bar{\boldsymbol{x}}_{qt_{\text{pre}}}\right)'\right]\boldsymbol{\beta} + (\xi_s - \xi_q)(t_{\text{post}} - t_{\text{pre}}) \qquad (9)\end{aligned}$$

for periods t_{pre} and t_{post} satisfying

$$t_{\text{pre}} < t_s, \quad t_s \leq t_{\text{post}} < t_q. \qquad (10)$$

Thus parameter δ measures the difference of pre- and post-Taspo outcomes in different cities controlling for the regressors'changes and heterogeneous growth rates.

5 Estimation Results

5.1 Main results

Table 4 and table 5 summarize the estimation results of equation (2) where outcome variables are the tobacco consumption and tobacco share to the consumption. We divide the estimated coefficients by the average of outcomes so that we interpret them as percent-change effects due to regressors. City fixed effects and city-specific time trends are controlled as a default and t statistics are constructed based on cluster-robust standard errors (see Bertrand et al., 2004). Model I imposes constant growth restriction (3) on time effects whereas Model II allows unrestricted variations of time effects. In addition to the estimation results based on the whole sample, we also present the sub-sample results excluding four Japanese mega-cities (i.e., the 23 wards of Tokyo, Yokohama, Nagoya, and Osaka) since the households' dependence on tobacco vending machines in these cities is different from that in the cities of moderate size.

Tables 4 and 5 reveal that the operation of Taspo system does *increase* the household's ex-

penditure for tobacco. This finding is more obvious when we focusing on the results excluding mega-cities. The Taspo induces approximately 13-20 percent increase in the tobacco expenditure and 16-22 percent increase in the tobacco share to consumption upon specifications and inclusion/exclusion of mega-cities.

Our secondary finding is that quite a few regressors have statistically significant influences on the expenditures conditional on the city effects and city-specific time trends. Among them, home owner status has a large negative effect on the tobacco expenditure. The robust chi-square statistics for testing restriction (3) are also in the tables. Based on these statistics, we conclude that freely varying time effects are redundant for our regression models.

5.2 Robustness check

The identification strategy in the DD regression utilizes both the cross-sectional and time series differences of treatment status among individuals. However, in our analysis so far, the variation of the Taspo operation is driven predominately by the time series difference since we use data from August 2006 to December 2009 but the operation has completed between March 2008 and July 2008. (See table 1 and figure 1.) Another concern is the increasing probability of encountering other tobacco policies by the national and local governments when we using the data of extended time periods.

For these reasons, we re-estimate the model using only the sample from January 2008 to December 2008 so that relatively more cross-sectional contrasts of Taspo and non-Taspo groups are made and other policies' confounding effects are minimized. The results are presented in table 6 and table 7. We obtain similar but slightly larger effects of the Taspo. The precision of estimated Taspo effects seems improved by this sub-sample regression.

As a next robustness check, we consider the dynamic response of tobacco expenditures to the

adoption of Taspo system. Specifically, we estimate the following regression model:

$$\bar{y}_{ct} = \sum_{b=1}^{B} \delta^{(-b)} D_{ct}^{(-b)} + \delta D_{ct} + \sum_{a=1}^{A} \delta^{(+a)} D_{ct}^{(+a)} + \bar{\boldsymbol{x}}_{ct}' \boldsymbol{\beta} + \gamma_c + \eta_t + \xi_c t + \bar{u}_{ct}. \tag{11}$$

Here dummy $D_{ct}^{(-b)}$ takes on unity if period t is b months before the adoption of the Taspo onward for city c and zero otherwise. Likewise, $D_{ct}^{(+a)}$ takes on unity if period t is a months after the adoption of the Taspo onward for city c and zero otherwise. Thus coefficient $\delta^{(-b)}$ captures anticipatory effects of the Taspo while $\delta^{(+a)}$ examines its lasting effects. Similar specifications have been employed by Autor (2003) in the context of the DD regression.

Table 8 and table 9 shows the result of the extended regression where $b = \{3, 6\}$ and $a = \{3, 6, 9, 12\}$ are selected as the order of leads and as lags. The results for the both of outcomes shows that the anticipation of running the Taspo (which was actually announced well before the operation by the TIOJ) does not cause prior behavioral changes of the household. It is also found that the influence of the Taspo has been virtually constant since its beginning. Therefore the adoption of the Taspo system seems cause a long-lasting effect on the household tobacco consumption.

6 Discussion and Conclusion

We have reached a very counter-intuitive finding: the adoption of the Taspo system, which seems to bear non-negligible costs for the consumers and retailers of tobacco, increases the tobacco expenditure and the expenditure share of the households. We finally consider possible mechanisms for accounting for this rather counterintuitive result.

The first explanation may concerns the measurement of the SHE. As other household consumption surveys, the SHE is based on the monthly account book of each household. It is hard here to monitor and record expenditures of household members through vending machines since

they are often frequent and the amount of money spent per purchasing is small. On the other hand, the adoption of the Taspo system lead smokers to purchase tobacco in convenience stores and super markets where they buy not a piece but a carton of tobacco for reducing transaction costs. So a household can record more correct amount of tobacco spending after the Tasop adoption.

The second is due to a "smuggling" of Tobacco from the adult to the underage smokers within a household. Before the Taspo, the tobacco spending of minors are not recorded in the account book because they were able to buy tobacco without the adult's help. On the other hand, if the adult household members buy tobacco for their children and minor siblings as well as for themselves after the Taspo, then the spending is correctly booked.

Does the adoption of the Taspo enhance one's health? If the correct measurement of health-related goods is necessary for considering proper disease prevention policies, our empirical results suggest that this age-verification system does contribute to it.

Proof

The regionally averaged error term is given by

$$\bar{\varepsilon}_{ict} = \frac{1}{N_{ct}} \sum_{i=1}^{N_{ct}} \varepsilon_{ict}. \tag{12}$$

So we have

$$\mathrm{E}(\bar{\varepsilon}_{ct}|\bar{\boldsymbol{x}}_{ct}, \gamma_c, \eta_t) = \frac{1}{N_{ct}} \sum_{i=1}^{N_{ct}} \mathrm{E}(\varepsilon_{ict}|\bar{\boldsymbol{x}}_{ct}, \gamma_c, \eta_t). \tag{13}$$

Since we have assumed that the mean-independence assumption in (5), it follows that

$$\begin{aligned} \mathrm{E}(\varepsilon_{ict}|\bar{\boldsymbol{x}}_{ct}, \gamma_c, \eta_t) &= \mathrm{E}_{\boldsymbol{x}_{ict}} \left[\mathrm{E}(\varepsilon_{ict}|\boldsymbol{x}_{ict}, \bar{\boldsymbol{x}}_{ct}, \gamma_c, \eta_t)\right] \\ &= \mathrm{E}_{\boldsymbol{x}_{ict}} \left[\mathrm{E}(\varepsilon_{ict}|\boldsymbol{x}_{ict}, \gamma_c, \eta_t)\right] \\ &= 0, \end{aligned} \tag{14}$$

where expectation $\mathrm{E}_{\boldsymbol{x}_{ict}}(\cdot)$ is defined on the joint density of $\boldsymbol{x}_{ict}$. Thus equation (6) holds.

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	Date	Prefectures			
1	March 2008	Miyazaki	Kagoshima		
2	May 2008	Hokkaido	Aomori	Iwate	Miyagi
		Akita	Yamagata	Fukushima	Tottori
		Shimane	Okayama	Hiroshima	Yamaguchi
		Tokushima	Kagawa	Ehime	Kochi
		Fukuoka	Saga	Nagasaki	Kumammoto
		Oita			
3	June 2008	Nigata	Toyama	Ishikawa	Fukui
		Yamanashi	Nagano	Gifu	Shizuoka
		Aichi	Mie	Shiga	Kyoto
		Osaka	Hyogo	Nara	Wakayama
4	July 2008	Ibaraki	Tochigi	Gunma	Saitama
		Chiba	Tokyo	Kanagawa	Okinawa

Source: Fiscal System Council, Ministry of Finance (2009).

Table 1: The date of Operating the Taspo System by prefectures

	Total tobacco sales	Sales by v. m.	Sales % by v. m.	# of v. m.
2006	39820	18421	46.26	565200
2007	39131	16989	43.42	519600
2008	37270	8540	22.91	424200

Source: TIOJ and Japan Vending Machine Manufacturers Association.

Table 2: Vendor machine (v. m.) tobacco sales in Japan

	Total		Taspo=0		Taspo=1	
	Mean	S.d.	Mean	S.d.	Mean	S.d.
Tobacco (yen)	922.824	451.561	909.900	462.686	937.170	438.672
Tobacco share	0.291	0.151	0.285	0.153	0.298	0.149
Taspo	0.474	0.499	0.000	0.000	1.000	0.000
Age of head	46.739	1.868	46.571	1.822	46.926	1.901
Income	4.429	1.576	4.401	1.596	4.460	1.553
Family size	3.409	0.188	3.407	0.187	3.412	0.189
Children	0.990	0.169	0.986	0.165	0.995	0.172
Old	0.193	0.084	0.191	0.084	0.195	0.085
Home owner	0.658	0.126	0.643	0.128	0.674	0.122
Sample size	2057		1070		987	

Table 3: Summary statistics

	Whole cities		Large cities excluded	
	Model I	Model II	Model I	Model II
Taspo	0.134*	0.163*	0.157**	0.196**
	(1.920)	(1.712)	(2.198)	(2.002)
Age of head	0.005	0.006	0.010	0.010
	(0.314)	(0.373)	(0.586)	(0.588)
Income	0.009*	0.011	0.006	0.010
	(1.895)	(0.646)	(1.222)	(0.573)
Family size	0.169	0.169	0.124	0.134
	(0.873)	(0.841)	(0.613)	(0.652)
Children	-0.357	-0.364	-0.263	-0.278
	(-1.490)	(-1.512)	(-1.151)	(-1.193)
Old	-0.035	-0.068	-0.035	-0.024
	(-0.140)	(-0.255)	(-0.127)	(-0.084)
Home owner	-0.669**	-0.693**	-0.803**	-0.835**
	(-2.405)	(-2.399)	(-3.034)	(-3.036)
Time trend	-0.030**		-0.031**	
	(-10.842)		(-10.837)	
Time dummies	No	Yes	No	Yes
Adj. R^2	0.349	0.344	0.371	0.365
Sample size	2057	2057	1893	1893

Note: Estimated regression coefficients are converted to the percent changes of outcome due to regressors' variation. City fixed effects and city specific time trends are controlled. Cluster and heteroskedasticity robust t statistics are reported in the brackets.

Table 4: Estimation results (tobacco consumption)

	Whole cities		Large cities excluded	
	Model I	Model II	Model I	Model II
Taspo	0.185**	0.158	0.219**	0.223**
	(2.629)	(1.465)	(3.123)	(1.993)
Age of head	0.000	0.000	0.003	0.003
	(-0.069)	(-0.011)	(0.164)	(0.159)
Income	-0.017**	-0.021	-0.021**	-0.027
	(-3.946)	(-1.228)	(-4.721)	(-1.543)
Family size	0.158	0.158	0.127	0.147
	(0.791)	(0.767)	(0.632)	(0.716)
Children	-0.412*	-0.408*	-0.336	-0.349
	(-1.691)	(-1.656)	(-1.458)	(-1.478)
Old	-0.024	-0.045	-0.048	-0.027
	(-0.089)	(-0.164)	(-0.164)	(-0.097)
Home owner	-0.765**	-0.758**	-0.931**	-0.921**
	(-2.567)	(-2.427)	(-3.275)	(-3.084)
Time trend	-0.034**		-0.034**	
	(-12.090)		(-12.388)	
Time dummies	No	Yes	No	Yes
Adj. R^2	0.378	0.374	0.4	0.396
Sample size	2057	2057	1893	1893

Note: Estimated regression coefficients are converted to the percent changes of outcome due to regressors' variation. City fixed effects and city specific time trends are controlled. Cluster and heteroskedasticity robust t statistics are reported in the brackets.

Table 5: Estimation results (tobacco share to consumption)

	Whole cities		Large cities excluded	
	Model I	Model II	Model I	Model II
Taspo	0.180**	0.193**	0.171**	0.184*
	(2.667)	(2.020)	(2.504)	(1.778)
Age of head	-0.022	-0.017	-0.013	-0.011
	(-0.661)	(-0.496)	(-0.458)	(-0.339)
Income	0.001	0.009	-0.003	0.017
	(0.139)	(0.315)	(-0.332)	(0.513)
Family size	0.213	0.245	0.017	0.022
	(0.633)	(0.706)	(0.050)	(0.060)
Children	-0.422	-0.447	-0.088	-0.091
	(-1.130)	(-1.151)	(-0.263)	(-0.245)
Old	-0.118	-0.164	-0.198	-0.177
	(-0.177)	(-0.238)	(-0.293)	(-0.252)
Home owner	-0.532	-0.578	-0.481	-0.515
	(-0.953)	(-1.031)	(-0.892)	(-0.944)
Time trend	-0.088**		-0.085**	
	(-5.795)		(-5.869)	
Time dummies	No	Yes	No	Yes
Adj. R^2	0.614	0.612	0.646	0.642
Sample size	612	612	564	564

Note: Estimated regression coefficients are converted to the percent changes of outcome due to regressors' variation. City fixed effects and city specific time trends are controlled. Cluster and heteroskedasticity robust t statistics are reported in the brackets.

Table 6: Estimation results for year 2008 samples (tobacco consumption)

	Whole cities		Large cities excluded	
	Model I	Model II	Model I	Model II
Taspo	0.236**	0.193*	0.244**	0.203*
	(3.266)	(1.850)	(3.296)	(1.806)
Age of head	-0.034	-0.030	-0.024	-0.024
	(-0.970)	(-0.835)	(-0.812)	(-0.765)
Income	-0.024**	-0.024	-0.031**	-0.024
	(-2.307)	(-0.822)	(-2.584)	(-0.746)
Family size	0.047	0.068	-0.093	-0.089
	(0.130)	(0.181)	(-0.241)	(-0.218)
Children	-0.328	-0.358	-0.038	-0.065
	(-0.855)	(-0.900)	(-0.106)	(-0.169)
Old	0.189	0.034	-0.027	-0.100
	(0.275)	(0.045)	(-0.040)	(-0.133)
Home owner	-0.611	-0.591	-0.598	-0.522
	(-1.037)	(-0.981)	(-3.521)	(-3.040)
Time trend	-0.057**		-0.052**	
	(-3.529)		(-3.466)	
Time dummies	No	Yes	No	Yes
Adj. R^2	0.618	0.622	0.645	0.647
Sample size	612	612	564	564

Note: Estimated regression coefficients are converted to the percent changes of outcome due to regressors' variation. City fixed effects and city specific time trends are controlled. Cluster and heteroskedasticity robust t statistics are reported in the brackets.

Table 7: Estimation results for year 2008 samples (tobacco share to consumption)

	Whole cities		Large cities excluded	
	Model I	Model II	Model I	Model II
Taspo (-6)	-0.055	-0.041	-0.055	0.009
	(-0.863)	(-0.378)	(-0.765)	(0.102)
Taspo (-3)	0.052	-0.022	0.010	-0.013
	(0.792)	(-0.277)	(0.194)	(-0.134)
Taspo	0.148**	0.163*	0.166**	0.198**
	(2.587)	(1.716)	(2.903)	(2.021)
Taspo (+3)	-0.081	-0.066	-0.039	-0.045
	(-1.328)	(-0.573)	(-0.654)	(-0.386)
Taspo (+6)	-0.009	0.033	0.011	0.055
	(-0.144)	(0.334)	(0.161)	(0.480)
Taspo (+9)	0.029	0.092	0.010	0.092
	(0.625)	(1.244)	(0.191)	(1.103)
Taspo (+12)	-0.043	-0.035	-0.035	-0.048
	(-0.693)	(-0.396)	(-0.543)	(-0.487)
Age of head	0.007	0.007	0.010	0.011
	(0.414)	(0.403)	(0.589)	(0.626)
Income	0.009**	0.012	0.006	0.009
	(1.970)	(0.676)	(1.235)	(0.531)
Family size	0.168	0.154	0.126	0.123
	(0.854)	(0.768)	(0.629)	(0.600)
Children	-0.358	-0.348	-0.269	-0.261
	(-1.508)	(-1.438)	(-1.176)	(-1.108)
Old	-0.060	-0.055	-0.025	-0.010
	(-0.222)	(-0.204)	(-0.088)	(-0.033)
Home owner	-0.691**	-0.690**	-0.810**	-0.833**
	(-2.534)	(-2.430)	(-3.094)	(-3.047)
Time trend	-0.028**		-0.029**	
	(-4.863)		(-4.952)	
Time dummies	No	Yes	No	Yes
Adj. R^2	0.349	0.343	0.370	0.364
Sample size	2057	2057	1893	1893

Note: Estimated regression coefficients are converted to the percent changes of outcome due to regressors' variation. City fixed effects and city specific time trends are controlled. Cluster and heteroskedasticity robust t statistics are reported in the brackets.

Table 8: Dynamic response to Taspo (tobacco consumption)

	Whole cities		Large cities excluded	
	Model I	Model II	Model I	Model II
Taspo (-6)	-0.045	-0.031	-0.058	0.003
	(-0.696)	(-0.266)	(-0.795)	(0.039)
Taspo (-3)	0.024	-0.055	-0.007	0.000
	(0.381)	(-0.588)	(-0.131)	(-0.013)
Taspo	0.213**	0.154	0.243**	0.226**
	(3.604)	(1.353)	(4.062)	(2.028)
Taspo (+3)	-0.072	-0.096	-0.031	-0.082
	(-1.115)	(-0.771)	(-0.485)	(-0.654)
Taspo (+6)	-0.024	0.031	-0.003	0.051
	(-0.426)	(0.328)	(-0.037)	(0.482)
Taspo (+9)	-0.003	0.065	-0.027	0.082
	(-0.103)	(0.876)	(-0.531)	(1.042)
Taspo (+12)	0.017	-0.014	0.027	0.010
	(0.314)	(-0.131)	(0.476)	(0.087)
Age of head	-0.010	-0.010	0.003	0.003
	(-0.673)	(-0.660)	(0.170)	(0.206)
Income	-0.021**	-0.034	-0.021**	-0.027
	(-3.543)	(-1.590)	(-4.717)	(-1.576)
Family size	0.172	0.165	0.137	0.134
	(0.901)	(0.856)	(0.684)	(0.649)
Children	-0.371	-0.353	-0.339	-0.332
	(-1.484)	(-1.386)	(-1.469)	(-1.392)
Old	-0.051	-0.048	-0.027	-0.014
	(-0.170)	(-0.157)	(-0.093)	(-0.048)
Home owner	-0.436*	-0.398	-0.921**	-0.918**
	(-1.683)	(-1.472)	(-3.260)	(-3.087)
Time trend	0.031**		-0.034**	
	(4.745)		(-5.715)	
Time dummies	No	Yes	No	Yes
Adj. R^2	0.247	0.24	0.399	0.394
Sample size	2057	2057	1893	1893

Note: Estimated regression coefficients are converted to the percent changes of outcome due to regressors' variation. City fixed effects and city specific time trends are controlled. Cluster and heteroskedasticity robust t statistics are reported in the brackets.

Table 9: Dynamic response to Taspo (tobacco share to consumption)

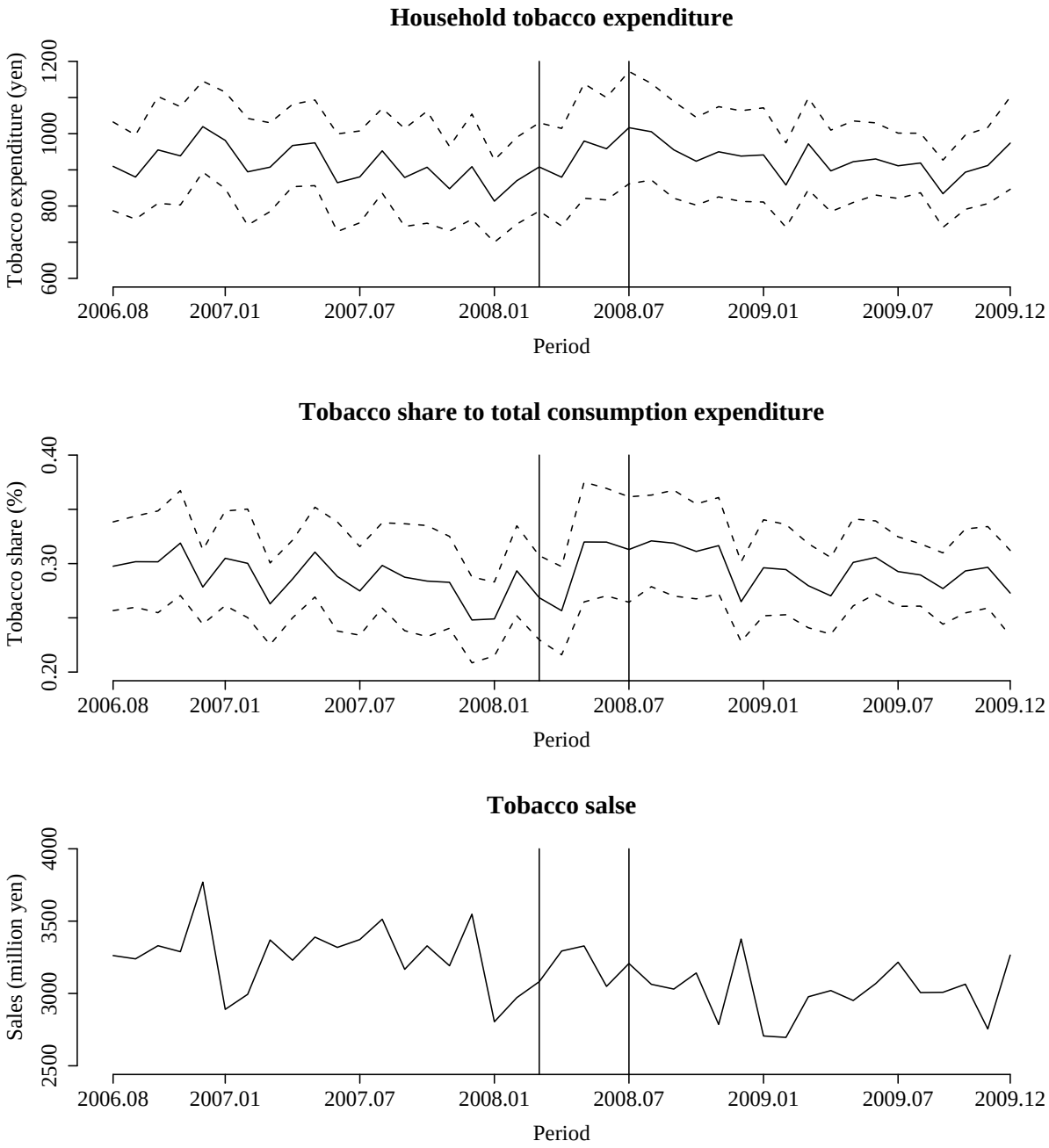

Figure 1: Time series patterns of household tobacco consumption, share to the total consumption, and sales