Understanding Forward-Looking Behavior using Dynamic Discrete Choice and Rational Addiction Model: Application to California Cigarette Tax Increase

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Abstract

Consumer's forward-looking behavior can create change in current purchase and consumption in response to the change in expectation on future price. Using cigarette tax increase in California as exogenous variation, I found gradual decrease in purchase after the announcement but before the actual increase. Additional pattern I found was a spike of purchase right before the tax increase, and plunge after the tax increase. Using dynamic discrete choice model with rational addiction and stockpiling, further counterfactual simulations are possible.

Keywords: dynamic discrete choice model; rational addiction; consumer inventory behavior; cigarettes;

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1 Introduction

Consumers make their purchase and consumption choice based on their preferences. One of key factors that affect consumer preference is price. In general, by the Law of Demand, an increase in price decreases the quantity demanded for the product. An interesting aspect of the price is that not only the current price but also the expected future price can affect consumer choice. If people expect that the future price would increase, then they increase the quantity demanded before the actual price increase. If the good is storable, then consumer might even purchase more to increase inventory in order to offset the shock of price increase.

If the good is addictive, the purchasing behavior in response to price increase expectation and subsequent stockpiling might be different compared to non-addictive goods. Key insights about rational addiction are reinforcement, an increase in current consumption leads to the increase in future consumption, and tolerance, an increase in current consumption leads to less future utility given the amount of consumption (Becker and Murphy 1988). Thus, if a good is addictive, the degree of stockpiling might be different. On the one hand, because of considering reinforcement, consumer might reduce the consumption in order to reduce addiction level and stockpile less. On the other hand, because of considering tolerance, consumer might stockpile more not to reduce the consumption.

Using the consumer panel data from Nielsen IQ, I studied how consumer's purchase and consumption behavior changes with respect to expected future price increase. Specifically, by using California Proposition 56, which announced cigarette tax increase from $ 0.87 per pack to $2.87 per pack in November 7th, 2016 and went into effect in April 1st, 2017, as treatment, I studied how smokers changed their purchase and consumption behavior in response to tax increase announcement and actual tax increase.

In order to investigate how consumer's purchased quantity changes as the future price changes, I used synthetic control method and found three distinctive patterns. The first pattern is that, after the tax increase announcement but before the actual tax increase ahead of time, quantity purchased decreased. The second pattern is that right before the actual tax increase, quantity purchased increased abruptly. The third pattern is that after the actual tax increase, the purchased jumped down and kept in low level until the end of observation period.

Since consumers could adjust their purchase and consumption behavior at a different rate of speed in response to the time gap between tax increase announcement and actual tax increase, the amount of purchase and consumption could approach to the new steady state at different speed. This could imply that although the time gap between the announcement date and effective date is less than a year, consumers' consumption might be at higher level than equilibrium level for several years, in extreme. In order to find the purchase and consumption adjustment speed and do counterfactual simulations about estimating the relevant tax revenue change, I applied dynamic discrete choice model.

Previous literature dealing relevant idea are discussed in section 2. Background information about cigarette tax increase in California is explained in section 3. Data that I used for the analysis is explained in section 4. The reduced form analysis for estimating the announcement effect is explained in section 5. The structural form analysis for estimating the effect of announcement-effect time gap and counterfactual analysis are suggested in section 6. Further discussions and conclusion are discussed in section 7.

2 Literature Review

2.1 Synthetic Control

Synthetic control method (Abadie and Gardeazabal 2003, Abadie, Diamond, and Hainmueller 2010) is one of the most widely applied methods in empirical research in economics and other disciplines. In order to find the treatment effect in response to an exogenous variation, a researcher should find the counterfactual data where the treated group are not treated at the same time period. However, this hypothetical data cannot exist in real world, since an observation cannot be treated and untreated at the same time. Thus, the key challenge is to estimate the counterfactual data.

Synthetic control is one of the methods that estimate the counterfactual data, by synthesizing control groups (donor pool) to resembles the pattern of the treated group in the pre-treatment period. Thus, the comparison between the treated group and synthesized group after the treatment can be interpreted as the treatment effect.

I used synthetic control method in order to find the effect of tax increase announcement and actual tax increase on cigarette sales in California.

2.2 Dynamic Discrete Choice Model

Dynamic discrete choice model was first used for the study of optimal bus engine replacement decision (Rust 1987). This insight of the model is that the current period state variable could affect the choice in the next period. Thus, when an agent determines the choice variable in the current period, the agent also should consider the effect of choice in the future. This interdependency of time periods leads to the dynamic model. The strategy to solve the model and estimate the underlying demand parameter is nested fixed-point algorithm (NFXP).

For cigarette smokers, the time-dependency exists. One scenario is that the cigarette consumption in current period changes the addiction level, and the changed addiction level changes the utility of cigarette consumption in the future period. Another scenario is that by consuming one more pack of cigarette in current period, the inventory of cigarettes is decreased by one pack. Thus, this consumption will leads to an increased probability to purchase more cigarettes in the future. Therefore, I used dynamic discrete choice model to analyze the smoker's behavior.

2.3 Rational Addiction

Studied by Becker and Murphy (Becker and Murphy 1988), addiction was understood as rational behavior. The rational addiction theory suggests that addiction is the result of rational choice, not the result of irrational and emotional behavior. By calculating the effect of addiction in the future, rational agent determines the consumption in the current period which might affect the addiction level in the future.

2.4 Consumer Inventory Behavior

Studied by Hendel and Nevo (Hendel and Nevo 2006), considering consumer inventory behavior is crucial when understanding the consumer choice. Without implementing the inventory in the model, whereas the consumers set inventory in the real world, the price elasticities estimates might be biased. Specifically, the own-price elasticities are overestimated, cross-price elasticities are underestimated, and substitutions to the no-purchase are overestimated.

Since cigarettes can be stocked and the change in the inventory in response to the tax increase is the key variable of interest in my model, I applied consumer inventory behavior.

3 Backgrounds

In November 8, 2016, voters passed California Proposition 56, the Tobacco Tax Increase Initiative. It contains to increase the tax on cigarette from $0.87 per pack to $2.87 per pack, starting from April 1, 2017. Revenue from the additional $2.00 tax was allocated to physician training, prevention and treatment of dental diseases, Medi-Cal, tobacco-use prevention, research into cancer, heart and lung diseases, and other tobacco-related diseases, and school programs focusing on tobacco-use prevention and reduction.

4 Data

I used consumer panel data provided by Nielsen IQ. The time period that I used was 1/1/2016 - 12/31/2017. I restricted the households to which purchased a 20-cigarette pack at least once during the sample period, and appear in both years. Among the restricted sample, the number of CA households is 448, and the number of non-CA households is 6726, composing

7174 households in total. I classified households into four groups of smokers (non-smokers, light smokers, average smokers, and heavy smokers) based on the quantity consumed during the period before the tax increase announcement. Non-smokers are households who did not purchase any cigarette during the control period, and other smoker groups are divided to have equal proportion based on weekly consumption.

The summary statistics is as follows.

5 Reduced Form Analysis

5.1 Synthetic Control

By using synthetic control, I estimated the effect of cigarette tax increase announcement and actual increase on people's purchasing behavior. In order to perform synthetic control, I aggregated individual level sales by state in order to make state level quantity of sales, and divided it into the number of households for each state and made quantity sales per household. The observation is on a weekly basis. Then, I synthesized other states in order to create synthetic California that resembles the sales pattern of California before the tax increase announcement. Then, I compared the sales pattern after the treatment.

Let Y_{jt} be the cigarette sales per capita in state j and in week t. I assigned $j = 1$ to California, and $j = 2, ..., 48$ to other states, where Alaska is not included, or "donor pool". In order to construct synthetic California that resembles the sales pattern of real California during the pre-treatment period, where $t = 0, ..., T_0$, I calculated appropriate weights on donor pool by minimizing the following equation.

$$\min_{\omega} \sum_{t=0}^{T_0} \left(Y_{1t} - \sum_{j=2}^{48} \omega_j Y_{jt} \right)^2 \text{ s.t. } \omega_j \geq 0 \text{ and } \sum_{j=2}^{48} \omega_j = 1 \quad (1)$$

By the construction of synthetic control, the difference between actual California and synthetic California can be interpreted as the effect of treatment on the variables of interest.

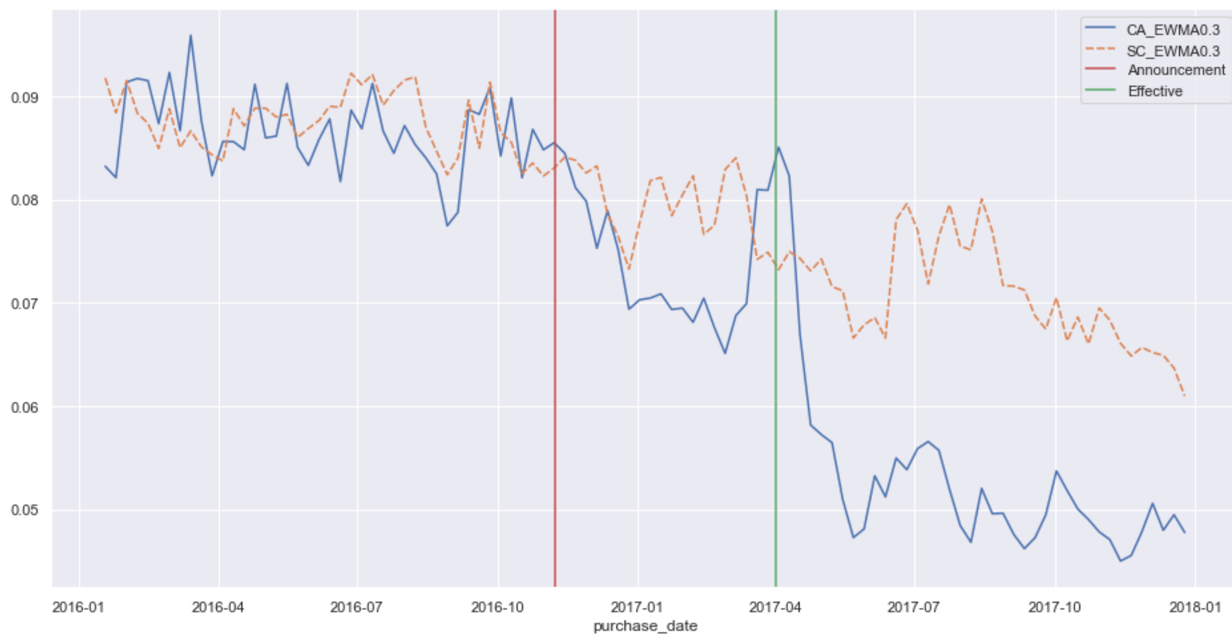

Figure 1: weekly cigarette sales per capita

The result of weight is shown in table 1.

state	weight	state	weight	state	weight
CO	0.015	MA	0.037	NY	0.405
CT	0.137	ME	0.022	OH	0.002
FL	0.062	MS	0.045	RI	0.090
IA	0.038	MT	0.005	SD	0.053
IN	0.015	ND	0.011	UT	0.063

Table 1: Weight for Synthetic California

By using the weights in table 1, I constructed synthetic-California that could resemble actual California but for tax increase announcement and actual tax increase. Thus, by comparing the synthetic California and actual California after the period of treatment (either tax increase announcement or actual tax increase), it automatically explains the treatment effect. The graph of synthetic California and actual California is given in figure 1.

The blue line is the sales for California, and the orange line is the sales for synthetic California. After the tax increase announcement (November 8, 2016, marked as red line), consumers in California decreased their purchases until the time right before the effective date. Right before the effective date, the sales skyrocketed. After the effective date, the sales returned to the decreased amount, much lower than the synthetic California.

The graph above shows that people changes their purchases after the tax increase announcement before the actual tax increase. In reaction to the announcement, people tries to reduce the smoking amount to alleviate the burden of increased future price. At the time of effective date, people increased purchase only for a short period to stockpile.

5.2 Distinguishing motivation of addiction and stockpiling

The purpose of this analysis is to disentangle the purchasing behavior during the tax increase announcement period into two different motivations. Following the idea of Schmacker (Schmacker 2020), I distinguished how different motivations of addiction and stockpiling changed purchasing behavior in response to tax increase announcement. Especially, by applying difference-in-differences design, I found how consumers in California changed their behavior in response to the tax increase announcement. I used two proxy variables to find the change of purchase incidence/quantity caused by addiction, and two proxy variables to find the same change caused by stockpiling.

5.2.1 Base Model

The base model without considering difference-in-differences design is as follows.

$$X_{it} = \mu + \beta_1 \tilde{x}_{i,t-1} + \beta_2 x_{i,t-1} + \beta_3 \sum_{k=1}^{4} x_{i,t-k} + \beta_4 pr_{i,t-1} \tilde{x}_{i,t-1} + \alpha_i + \alpha_t + \varepsilon_{it} \tag{2}$$

In the model, $\tilde{x}_{it}$ denotes the incidence of cigarette purchase of consumer i for time t and x_{it} denotes the purchase quantity of consumer i for time t. The dependent variable X_{it} is either the incidence of cigarette purchase, $\tilde{x}_{it}$, or the purchase quantity, x_{it}, depending on the model. α_i and α_t capture the household and week fixed effects.

In the model, whether the consumer bought cigarette in the previous week or not, $\tilde{x}_{i,t-1}$, and sum of purchased quantity in the previous four weeks, $\sum_{k=1}^{4} x_{i,t-k}$, try to capture the addiction. The purchase quantity in the previous week, $x_{i,t-1}$, and whether the purchase in previous week was made or not during the price discount, $pr_{i,t-1}\tilde{x}_{i,t-1}$, try to capture the stockpiling.

If addiction matters, the purchase incidence in previous week captures positive state dependence between purchases of the previous week and the current week. On the other hand, if stockpiling matters, the purchase quantity in previous week reduces the probability to purchase in current week. Conditional on the last week, the total quantity purchased during the last four weeks does not contribute to stockpiling much, since consumers are free to adjust stock every week. Thus, it captures the influence of addiction. Lastly, if a cigarette was purchased on sale, it is more likely that the purchase was due to stockpiling.

5.2.2 Applying Difference-in-Differences Design

The variables of interest under the situation of tax increase announcement is the change in the effect of positive/negative state dependence, not the state dependence itself. If there is a tax increase announcement, people would change their purchase by the motivation of addiction or stockpiling. In order to extract the treatment effect of tax increase announcement on change in motivation of addiction and stockpiling, I applied difference-in-differences design.

The control period is the pre-announcement period, and treatment period is after the announcement but before the actual increase. The control group is households that are not living in California, and the treatment group is households in California. The number of CA households is 340, the number of non-CA households is 4494. The number of total weeks is 61. Controlling for household fixed-effect and week fixed-effect, the result is given in Table 2.

The result in table 2 is consistent with the theory proposed by rational addiction and consumer inventory behavior. The variables of interest are 'CA * Time * Prev. Purch.', 'CA * Time * Prev. Quant.', 'CA * Time * Prev. 4-week Quant.', and 'CA * Time *

	(1) purchase	(2) pack_quantity
Previous purchase incidence	0.033***	-0.282***
	(0.002)	(0.080)
Previous purchase quantity	-0.002***	-0.091***
	(0.000)	(0.003)
Previous 4-week purchase quantity	0.001***	0.042***
	(0.000)	(0.001)
Deal on previous purchase	0.014***	0.131
	(0.005)	(0.155)
CA * Prev. Purch.	-0.049***	-0.677**
	(0.009)	(0.294)
CA * Prev. Quant.	-0.000	0.000
	(0.000)	(0.010)
CA * Prev. 4-week Quant.	-0.000*	-0.072***
	(0.000)	(0.005)
CA * Prev. week deal	-0.006	0.036
	(0.018)	(0.571)
Time * Prev. Purch.	0.003	0.323***
	(0.004)	(0.121)
Time * Prev. Quant.	0.000**	-0.060***
	(0.000)	(0.005)
Time * Prev. 4-week Quant.	-0.000*	0.013***
	(0.000)	(0.002)
Time * Prev. week deal	-0.016**	-0.349
	(0.008)	(0.248)
CA * Time * Prev. Purch.	-0.031**	-0.833*
	(0.014)	(0.458)
CA * Time * Prev. Quant.	0.001**	0.193***
	(0.001)	(0.016)
CA * Time * Prev. 4-week Quant.	-0.000**	-0.061***
	(0.000)	(0.006)
CA * Time * Prev. week deal	0.046*	0.273
	(0.028)	(0.915)
Constant	0.270***	2.595***
	(0.005)	(0.161)
Observations	294874	294874
Time FE	Week	Week
Unit FE	Household	Household

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Difference-in-Differences for distinguishing the effect of addiction and stockpiling

Prev. week deal', which are the four proxy variables were affected by the treatment. If people expect future price increase, in terms of addiction, people purchase addictive goods less. The motivation of addiction, purchase incidence previous week and purchase quantity previous 4 weeks, have negative coefficient, which mean consumers purchase less. In terms of stockpiling, people purchase storable goods more if the price is expected to increase. The motivation of stockpiling, purchase quantity previous week and whether previous purchase was on sale, have positive coefficient, which mean consumers purchase more.

5.3 Effect of Announcement and Actual Tax Increase on Price

The purpose of this analysis is to find the treatment effect on price. I estimated the effect of tax increase announcement and actual tax increase on price. Likewise, the focus is the treatment effect of tax increase announcement/actual tax increase, so I applied difference-in-differences design.

The specification is slightly different from traditional tax passthrough literature. Since I'm only focusing on the treatment effect on the price during the treatment period in California, I used an indicator for treatment that the coefficient would represent how much the level of price changed, not the percentage change.

The treatment is either tax increase announcement or actual tax increase. The subsequent control period would be period before the announcement or actual increase, and the treatment period would be after the announcement or actual increase. The treatment group is households in California, and the control group is households not in California. The specification is as follows.

$$
\begin{aligned}
P = & \beta_1 * \text{Premium} + \beta_2 * \text{Discount} \\
& + \beta_3 * \text{Treated time} * \text{Premium} + \beta_4 * \text{Treated time} * \text{Discount} \\
& + \beta_5 * \text{CA} * \text{Premium} + \beta_6 * \text{CA} * \text{Discount} \\
& + \beta_7 * \text{Treated time} * \text{CA} * \text{Premium} + \beta_8 * \text{Treated time} * \text{CA} * \text{Discount} \\
& + \varepsilon
\end{aligned} \tag{3}
$$

In order to estimate, I controlled household income, number of members in household who are not adult, and the age of head in household. I also used difference-in-differences setting, using non-California states as control states, California as treatment state, and tax increase announcement / actual tax increase as treatment. The unit of observation is actual transaction happened on a weekly basis. The result is given in table 3.

In the table 3, "Time * CA * Premium" and "Time * CA * Discount" represent the treatment effect on the price of premium cigarettes and discount cigarettes respectively. CA represents the California effect during pre-treatment period and TR represents the treatment period effect on non-Californian state.

Column (1) shows the effect of announcement on price. The coefficients of "Time * CA * Premium" and "Time * CA * Discount" are not statistically significant, although they are negative. It represents that announcement itself does not have effect on price, both for premium and discount. Column (2) shows the effect of actual tax increase on price. The coefficient of "Time * CA * Premium" is 1.7842, while the coefficient of "Time * CA * Discount" is 1.4866. Keeping in mind that the increased amount of tax was $2, the actual price of premium 20-cigarette-pack increased $1.7842, while the price of discount 20-cigarette-pack increased $1.4866.

treatment dependent var.	(1) announcement price	(2) actual increase price
Time * CA * Premium	-0.0345 (0.080)	1.7842*** (0.171)
Time * CA * Discount	-0.0579 (0.125)	1.4866*** (0.206)
CA * Premium	-0.3550*** (0.112)	-0.3640*** (0.117)
CA * Discount	-0.4359*** (0.152)	-0.4554*** (0.155)
Time * Premium	0.1384*** (0.028)	0.3456*** (0.043)
Time * Discount	0.1911*** (0.072)	0.0866*** (0.033)
Premium	6.3148*** (0.313)	6.4899*** (0.401)
Discount	5.1322*** (0.312)	5.3203*** (0.402)
Other Controls	Household income, number of non-adults, head age	
Unit FE	Household	Household

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Difference-in-Differences for estimating the effect of treatment on price

6 Structural Form Analysis

By building a structural model with underlying demand parameters that are invariant to policy change, it is possible to do counterfactual analysis. In this paper, I would change the time gap between tax increase announcement date and effective date and inspect how the time gap affects steady state consumption in the long run. In order to do so, I build dynamic discrete choice model with rational addiction and consumer inventory behavior.

6.1 Period Utility

Consumer's period utility function is composed of three parts: consumption utility, purchase utility, and inventory cost.

$$U(c_{it}, d_{it}, s_{it}; \theta_i) = u_c(c_{it}, a_{it}; \alpha_i) + u_p(d_{it}, P_t; \gamma_i, \xi_i) - C(I_{it}; h_i) \tag{4}$$

Consumers make decision on quantity consumed, c_{it}, and which products to buy and how much to buy, d_{it}. In here, $d_{itjq} = 1$ if product j is purchased by the amount of q, and $d_{it} = \{d_{itjq}\}_{jq}$ is a vector, such that $\sum_{jq} d_{itjq} = 1$.

Period consumption utility is as follows.

$$u_c\left(c_{it}, a_{it}; \alpha_i\right) = \alpha_{i0} I\left\{c_{it} = 0\right\} + \alpha_{i1} c_{it} + \alpha_{i2} c_{it}^2 + \alpha_{i3} a_{it} + \alpha_{i4} a_{it}^2 + \alpha_{i5} a_{it} c_{it} \tag{5}$$

The variable a_{it} represents the addiction level of individual i at time t, and it is a stock variable. The quadratic form is flexible so that it could capture the "adjacent complementarity", which could be the reinforcement of past stock that changes the current marginal utility. The formation of addiction stock is as follows.

$$a_{i,t+1} = (1 - \delta_i) a_{it} + c_{it} \tag{6}$$

where $0 \leq \delta_i \leq 1$ is depreciation rate.

Period purchase utility is as follows.

$$u_p\left(d_{it}, P_t; \gamma_i, \xi_i\right) = \sum_{j,q} d_{itjq}\left(\gamma_i p_{tjq} q_{itj} + \xi_{ijq} + \varepsilon_{itjq}\right) \tag{7}$$

In the subscript, j represents the product tier and q represents the quantity. q_{itj} is the purchase quantity, p_{tjq} is the price, and γ_i is the parameter for price sensitivity. ξ_{ijq} is the fixed-effects for products, and ε_{itjq} is the unobserved shock that is distributed i.i.d. extreme value.

Inventory cost is as follows.

$$C(I_{it}; h_i) = h_i I_{it} \tag{8}$$

The inventory I_{it} is also a stock variable, and it is formed by the following law of motion

$$I_{i,t+1} = I_{it} + \sum_{j,q} d_{itjq} q_{itj} - c_{it} \tag{9}$$

6.2 Price Expectation

Following previous literature on price process (Erdem, Imai, and Keane 2003), I assume price process without the regime change follows 1st order Markov process. Furthermore, I assume consumers make expectation on price the same way. The price process during normal phase is as follows.

$$\begin{pmatrix} \ln(P_{t0}) \\ \ln(P_{t1}) \end{pmatrix} = \begin{pmatrix} \gamma_{10} + \gamma_{20} \ln(P_{t-1,0}) + \gamma_{30} \ln(P_{t-1,1}) \\ \gamma_{11} + \gamma_{11} \ln(P_{t-1,1}) + \gamma_{31} \ln(P_{t-1,0}) \end{pmatrix} + \begin{pmatrix} \nu_{t0} \\ \nu_{t1} \end{pmatrix} \tag{10}$$

6.3 Dynamic Decision Problem

I divided the whole periods into three phases. First phase is the period before the tax increase announcement. Second phase is the period after the announcement but before the actual enactment. Third phase is the period after the enactment. The dynamic decision in the third phase is as follows. I wrote it using value function form.

$$V_3(s_{it}) = \max_{c_{it}, d_{it}} \{U(c_{it}, d_{it}, s_{it}; \theta) + \beta \mathbb{E}[V_3(s_{i,t+1}) | s_{it}]\} \tag{11}$$

The decision problem at the starting moment of the second phase is as follows.

$$V_2(s_{iT}) = \max_{\{c_{it}, d_{it}\}} \sum_{t=T}^{T'} \{\beta^{t-T} \mathbb{E}[U(c_{it}, d_{it}, s_{it}; \theta)]\} + \beta^{(T'-T)} V_3(s_{iT'}) \tag{12}$$

The decision problem during the first phase is similar to that of the third phase. The reason is that during the first phase, the tax increase announcement was not made. Thus, consumers do not expect the price increase in the future. In other words, consumers expect the future price would follow the same price process as it was. Thus, the decision problem is as follows.

$$V_3(s_{it}) = \max_{c_{it}, d_{it}} \{U(c_{it}, d_{it}, s_{it}; \theta) + \beta \mathbb{E}[V_3(s_{i,t+1})|s_{it}]\} \tag{13}$$

6.4 Result

Currently, I'm finding the underlying demand parameters using Maximum Likelihood Estimation (MLE). The idea is to find parameters that has the highest likelihood given the data.

The plan after getting the parameters is to do simulations by changing the tax increase policy. Specifically, by changing the time gap between tax increase announcement date and effective date, the counterfactual analysis can show that the time gap could impact on people's purchase and consumption behavior in equilibrium.

Suppose the increase in time gap makes people to adjust their consumption at a slower pace. It could be possible that by reducing the consumption at a slower pace, the addiction level would alleviate at a slower pace. It could imply that if the time gap between tax increase announcement and actual tax increase gets larger, the approaching speed to new steady state would be slower. This slow approaching speed may reduce the possibility of quitting smoking, by "cold turkey". Also, the slower approaching speed than expected could result in a larger tax revenue than expected for a longer time than expected.

7 Discussions and Conclusion

By using the consumer panel data, I found that consumers change their current consumption level in reaction to change in expected future price. Although I aggregated the individual level data to state level in order to perform synthetic control, it is possible to perform synthetic difference-in-differences (SDID) (Arkhangelsky et al. 2019) for the individual level data.

The structural model helps to find underlying preference parameters that are invariant to policy change. Thus, it allows us to perform counterfactual analysis assuming hypothetical policy change. I will update the result after the optimal parameters are found.

References

Abadie, Alberto, Alexis Diamond, and Jens Hainmueller (2010). "Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program". In: *Journal of the American statistical Association* 105.490, pp. 493–505.

Abadie, Alberto and Javier Gardeazabal (2003). "The economic costs of conflict: A case study of the Basque Country". In: *American economic review* 93.1, pp. 113–132.

Arkhangelsky, Dmitry et al. (2019). *Synthetic difference in differences*. Tech. rep. National Bureau of Economic Research.

Becker, Gary S and Kevin M Murphy (1988). "A theory of rational addiction". In: *Journal of political Economy* 96.4, pp. 675–700.

Erdem, Tülin, Susumu Imai, and Michael P Keane (2003). "Brand and quantity choice dynamics under price uncertainty". In: *Quantitative Marketing and economics* 1.1, pp. 5–64.

Hendel, Igal and Aviv Nevo (2006). "Measuring the implications of sales and consumer inventory behavior". In: *Econometrica* 74.6, pp. 1637–1673.

Rust, John (1987). "Optimal replacement of GMC bus engines: An empirical model of Harold Zurcher". In: *Econometrica: Journal of the Econometric Society*, pp. 999–1033.

Schmacker, Renke (2020). *Soft Drink Taxation and Habit Formation*. URL: `https://rschmacker.github.io/files/Soda_tax_and_Demand_Persistence.pdf` (visited on 11/14/2022).