Interaction Effect between Price And Time Preference On Smoking Behavior Of Pregnant Women

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ABSTRACT

In this paper, I explore the smoking behavior of pregnant women in NLSY79 (National Longitudinal Surveys 79). A key aspect of this research is the availability of smoking participation before and during pregnancy. Thus, I consider the probabilities of quitting while pregnant and re-starting after giving birth as outcomes. Individuals who are more present-oriented are more likely to smoke and to consume larger amounts of cigarettes given that they do smoke than those who are more future-oriented. Moreover, those who discount the future more heavily will be more sensitive to the money price of cigarettes than those who are more future- oriented. The reason is that a one percent change in the money price of cigarettes represents a larger percentage change in the full price for the former group. I focus on the role of time preference and the interaction between time preference and price in determining these outcomes.

INTRODUCTION

Attributable risk is widely used to represent the relationship between smoking and its health risks. It is defined as the maximum proportion of a disease that is attributed by certain characteristic factor, holding other factors being equal level for all people. (Lilienfeld). Attributable risks are distinguished between the smoking and nonsmoking group. In tobacco prevalent countries, smoking related circulation and respiratory diseases remarkably account for chronic illness. Especially, pregnant women who are smoking face more risk than that of the general public. For example, fertilization ability tends to be lower and the risk of osteoporosis is accelerated. Women smoking during pregnancy have a greater risk of natural miscarriage than other women. Smoking during pregnancy can be a risk factor for low birth weight.

Apparently, by the wide health education and recent research, the harmful consequences due to smoking are well known among smokers. Because of addiction, it is difficult for people who would be willing to give up smoking to quit tobacco. A Finnish survey shows that (N=752) 58 percent of smokers who attempted to stop smoking face a failure of quitting (Sosiaal,1988). Whereas pregnancy is one of the good opportunities for people, especially for young women to stop smoking. Compared to the general population, pregnant women are a future oriented group who are more caring about their future children's health. In this paper I am going to focus on how the probability of pregnancy women quitting smoking changes if the price and discount factor change. According to the hypothesis, the money price elasticity is smaller for individual who are more future-oriented.

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The concept of the full price of cigarettes is the sum of the money price and the monetary value of the expected future harm due to smoking. To determine the monetary value of risky outcomes, the discount rate is used to account for the value of risk behaviors (Markku P). The future risky outcomes can be discounted today by a discount factor DF=1/(1+r), where r is the discount rate. The higher the discount rate, the lower the discount factor and the less value is assigned for the future outcome. As the discount rate rises, people are more likely to prefer instant gratification, which would result in less monetary value of the risky consequence. The point here is that a one percent change in cigarette price is a bigger percentage change in the full price the smaller is the discount factor. In spite of the case of time consistent preference, the same person may also face time inconsistent preference. People likely delay their actions in the short run (Harris, 2000). People are more likely to act on instant rewards and less to act to the future rewards (Laibson,1997; Cohen,2004). The risk outcomes are evaluated by individual preference, although the income level is another important concept for evaluating health risk.

This paper places a high focus on the cause-effect analysis in both health and economics meaning. First, because drug using restricts the reproductive ability of the offspring, I want to examine how much pregnant women individually or collectively reduce their smoking behavior responding to the price and personal preference. People would like to sacrifice some present happiness to achieve a reduction in the probability of future harmful outcomes (Laibson,1997; Cohen,2004). Second, same harmful consequences caused by smoking can be interpreted differently by the people who have various future discount rate. Interacting the price with discount factor can be more precise in interpreting the price effect through individual time preference.

Except for health risks caused by a smoking mother, economic consequences of smoking during pregnancy also are big costs for government healthcare. This paper can also examine how government cigarette tax policy influences the smoking behavior in pregnant women, and thereby results in a reduction of healthcare expenditure on the pregnant medical benefit.

I will use NLSY quasi-hypothetical reward question to measure personal preference. Referring to the paper of (Johnson, 2002) and (Madden, 2003), quasi-hypothetical questions have similar results as empirical experiments. I will use the measure of time preference rate in NLSY79 by following (Courtemanche, 2011), which is available only in 2006.

2. Empirical Work

2.1 Model

To test my hypothesis, I assume the individual lives for two periods. The lifetime utility function is

$$V = U(H_o, X, C) + \beta U(H, X_1, C_1) \qquad (1)$$

Here H_0 is initial health and is exogenous. X is consumption of a good other than cigarettes in period 0. C is consumption of cigarettes in period 0. The price of X is \$1, and the price of cigarettes is p. The variables H , C_1 and X_1 are health, cigarette consumption, and the other good in period 1. β is the time discount factor. For simplicity, I assume that lending and borrowing are not possible and ignore the selection of X_1 and C_1. Hence the relevant budget constraint is:

$$I = X + PC \qquad (2)$$

Finally, an increase in C lowers health in period 1 ($\partial H/\partial C \equiv H_C < C$)

The Lagrange function is:

$$L = U(H_0, X, C) + \beta U(H, X_1, C_1) + \lambda(I - X - pC)$$

where λ is the marginal utility of income.

The first order condition for C is

$$U_C + \beta U_H H_C = \lambda p$$

The second term on the right-hand side of the last equation is negative since $U_H > 0$ and $H_C < 0$. Rewrite the last equation as

$$U_C = \lambda(p - \beta \frac{U_H H_C}{\lambda})$$

Note that $f \equiv -\beta \frac{U_H H_C}{\lambda}$ defines the discounted monetary value of the loss in utility in period 1 due to smoking in period 0. Hence the full price of cigarettes (π) is

$$\pi \equiv p + f$$

Clearly, the full price is higher the larger is the value of β.

One way to proceed is to specify a general demand function without assuming anything about the form of the utility function:

$$C \equiv C(I, \pi)$$

Now differentiate C with respect to p, with f and I held constant

$$C_p \equiv C_\pi$$

So

$$-C_p \frac{p}{C} \equiv -C_\pi \frac{\pi}{C} \frac{p}{\pi}$$

Define ϵ as $-C_\pi \frac{\pi}{C}$, and note that ϵ is the elasticity of C with respect to full price π. Hence

$$e = (p/\pi)\varepsilon$$

Clearly, if ϵ is constant, e rises as β falls because p/π rises as β falls. In words, people who discount the future heavily have a more elastic demand function than those who do not because as one percent change in money price is a larger percentage change in full price for the former group.

2.2 Probit Estimation

According to the paper (Ai and Norton, 2003), assuming a probit model as

$$E[y \mid x_1, x_2, X] = \Phi(\beta_1 x_1 + \beta_2 x_2 + \beta_{12} x_1 x_2 + X\beta)$$

where X is a k x 1 vector of independent variables, including control variables, year dummy and state dummy depending on the different model. To derive the interaction effect, respect to x_1

$$\frac{\partial \Phi(\cdot)}{\partial x_1} = \Phi^{'}(\beta_1 + \beta_{12} x_2)$$

then respect to x_2

$$\frac{\partial^2 \Phi(\cdot)}{\partial x_1 \partial x_2} = \beta_{12}\Phi^{'}(\cdot) + (\beta_1 + \beta_{12} x_2)(\beta_2 + \beta_{12} x_1)\Phi''(\cdot) \quad (5)$$

The expected y can be represented as Cumulative Distribution Function $E[y \mid x] = F(x, \beta)$. The interaction effect $\frac{\partial^2 \Phi(\cdot)}{\partial x_1 \partial x_2}$ could be written as $\frac{\Delta^2 F(x,\beta)}{\Delta x_1 \Delta x_2}$.

In order to get the correct standard error, the paper of Ai and Norton (2003) suggests to use the Delta method for the variance calculation, which is derived from Taylor expansion (Xu and long, 2005). The normal distribution of interaction effect is shown as

$$\hat{\mu}_{12} \sim \mathrm{N}(\mu_{12}, \frac{\partial}{\partial \beta^{'}}[\frac{\Delta^2 F(x,\beta)}{\Delta x_1 \Delta x_2}]\hat{\Omega}_\beta \frac{\partial}{\partial \beta}[\frac{\Delta^2 F(x,\beta)}{\Delta x_1 \Delta x_2}] \quad (6)$$

And estimated variance is

$$\hat{\sigma}_{12} = \frac{\partial}{\partial \beta^{'}}[\frac{\Delta^2 F(x,\beta)}{\Delta x_1 \Delta x_2}]\hat{\Omega}_\beta \frac{\partial}{\partial \beta}[\frac{\Delta^2 F(x,\beta)}{\Delta x_1 \Delta x_2}]$$

The t statistic is t= $\hat{\mu}_{12} / \hat{\sigma}_{12}$. It is easy to test the hypothesis by using the t statistics.

3. Data

The data is from NLSY79 except the cigarette price. Data is available from 1979 to 2010. The dependent variable is pregnant women smoking participation, which is available in 1983, 1984, 1985, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008 (15 year periods). (there is 2010 data, but I only have cigarette price data until 2009 so I use data until 2008). Dependent variable will be the quitting indicator. The pregnant women smoking status is available in the questionnaire, whereas for before pregnancy, smoking status can only be obtained from general drug use answers, which is only available in 1984,1992,1994,1998,2008. Participation data in 1984 is structured differently from 1992, 1994, 1998, 2008. There is no question on 100 cigarettes smoked in entire life time for the 1984 participation. But since a lot of women have born baby in 1984, so I estimate the model with 1984 data in order to keep a larger of pregnant women information. All the independent variables are from time series data, except AFQT from 1988 and discount factor from 2006.

I am mainly interested in the smoking behavior change. Quit refers to the women who smoke before pregnancy and stop smoking after pregnancy. The total data sample is the women who are smoking before pregnancy and either continuously smoking or stop smoking after pregnancy. The quit percentage is 56/205=0.27, which is consistent with the finding as Colman (2003}. I consider both one time pregnant case (31/124=0.25) and two time continuous pregnancy (25/81=0.31). In the latter case, the women who stop smoking during either pregnancy are categorized as stop smoking. The available observation year of before pregnancy is 1984 (17/73=0.23), 1992 (20/63=0.32), 1994 (14/49=0.29), 1998 (5/20=0.25). In the quit sample, I did not consider about the after smoking status.

Data for prices and taxes come from Tax Burden on Tobacco (Volume 44, 2009). Data is at county level for the period from 1984 to 2009. Both price and tax are in the real term. The base period of CPI is 1967=100. Real tax is equal to (Federal + state+ county) tax.

I use monthly data (cigarette interview date) in NLSY79 to merge with cigarette prices to more precisely match with the state and county tax.

Time preference variables (DF1) are calculated from NLSY79 reward question in 2006 wave. "Suppose you have won a prize of $1000, which you can claim immediately. However, you have the alternative of waiting one year to claim the prize. If you do wait, you will receive more than $1000. What is the smallest amount of money in addition to the $1000 you would have to receive one year from now to convince you to wait rather than claim the prize now?"

Discount factor 1 (DF1) is calculated from the answers (amount1) by following formula:

$$DF1 = \frac{1000}{1000 + amount1}$$

DF1 (β) is the annually discount factor. DF1 is a measure of future orientation in the sense that the larger is DF1 the more future oriented is the person or the smaller is DF1the more present oriented is the person.

In addition to the price and discount factor, I also include demographic variables: Age, Gender, Race, Marital status; human capital: Armed Forces Qualification Test (AFQT) (1988) and schooling dummies as independent variable. For example, college is equal to 1 if highest grade completed is 16th or over 16th. Labor includes work hours and occupation. I classify the occupation as white collar, blue collar and service referring to Courtemanche (2011). Finally I add income, income squared, net worth as financial variables into the independent variables.

4. Empirical analysis

4.1 Time consistent discount factor model

I use a general linear probability model for cigarette consumption to examine how discount factor affects consumption. This panel data permits the slope coefficients to vary over both individual and time except for the discount factor. The estimating regression equation is

$$Q_{it} = \alpha_0 + \alpha_1 DF1_i + \alpha_2 DEMO_{it} + \alpha_3 HC_{it} + \alpha_4 LABOR_{it} + \alpha_5 FIN_{it} + \alpha_6 P_{ct} + \alpha_7 DF1_i P_{ct} + \varepsilon_{it} \qquad (7)$$

where Q is smoking quit probabilities during pregnancy. i represents individuals. DF1 is the annual discount factor. DEMO includes age, gender, race and marital status. HC (Human Capital) includes AFQT score and schooling dummies. LABOR includes work hours and occupation (For example, workers' blue collar, white collar and service indicators). FIN (Financial) has income and income squared and net worth. P_{ct} is the cigarette price varying in the county level and the time. Discount factor is defined as DF1 = 1/(1+r) , where r is the rate of time preference. Suppose r is bigger than 0 for the future benefit, then DF1 is always less than 1. I want to examine how the discount factor influences the cigarette consumption through prices

4.2. Quitting Probability

Table 1 shows that in order to obtain correct partial interaction coefficient of Probit and its standard error , it is important to use cross derivative of the expected value of smoking participation, instead of considering marginal effect computed by Stata software packages as interaction effect.(Ai and Norton, 2003). Additionally, standard error of interaction effect is calculated by Delta Method. My results do support the hypothesis that cigarette price increase quit probability, and the bigger the discount factor (smaller discount rate, patient people), the smaller the price effect is. When discount factor coefficient interacts with the positive price coefficient, the sign of interaction term is positive.

The results shown in table 1 prove the hypothesis of quit probabilities. First, for Probit model, The interaction effect of Probit is calculated from cross derivative of the expected value of smoking participation. And its standard error is the result from delta method, the hypothesis here is that price increases the quitting probability of smoking. The price effect will be smaller for the people who have higher discount factor. That results the negative sign for interact effect. In table 1 column (3) and column (4), I find positive price participation elasticity and negative coefficient for interaction term which confirm the hypothesis. Second, in linear probability model, in table 1 column (1) and column (2), the price elasticity is correctly positive, and interaction effect is negative which is consistent with that I expected.

Table 1. Results for quitting smoking.

	(1) quit	(2) quit	(3) quit	(4) quit
DF1	1.226	0.412	4.555	1.417
	(0.97)	(0.29)	(1.08)	(0.24)
Price	0.015	0.012	0.053	0.056
	(1.79)	(0.93)	(1.77)	(1.13)
DF1*price	-0.012	-0.004	-0.046	-0.016
	(0.014)	(0.016)	(0.046)	(0.065)
Price elasticity	2.67	3.21	3.50	5.73
	(1.60)	(2.94)	(2.10)	(4.65)
Interact effect			-0.019	-0.006
(for Probit)			(0.04)	(0.025)
Control Vars.	Yes	Yes	Yes	Yes
Year fix effect	Yes	Yes	Yes	Yes
State fix effect	No	Yes	No	Yes
Regression	OLS	OLS	Probit	Probit
N	205	205	205	176
R^2	0.144	0.316		
pseudo R^2			0.134	0.264

Standard Eorror in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ DF1 = Discount factor 1

Conclusion

This paper studies the effect of cigarette prices on the probability of pregnancy women quitting smoking varies if the time preference changes. I find that people who discount the future consequences of their current actions heavily are likely to be more sensitive to price than those who do not. The reason is that people define the full price of cigarettes as the sum of the money price and the monetary value of the expected future harm due to smoking. A one percent increase in the money price results in a larger percentage increase in the full price for those who discount the future heavily than for other individuals.

All results show that the coefficient of discount factor is positively related to the quitting probability of smoking. Price elasticity is positive. The positive effect becomes smaller if pregnancy women's discount factor is bigger. So interaction effect is negative. I could conclude that among the pregnant women, the person who are present oriented, i.e., do not value the future highly, are more likely to smoke and more sensitive to price than those who do not.

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