Can a Cart Nudge Affect Consumer Food Choice? Evidence from a Supermarket Experiment

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Abstract

Healthy food choice is an emerging topic of interest, as the rapid increase in the prevalence of dietary-related diseases is a remarkable phenomenon both domestically and globally. This study examines the effect of a point-of-purchase nudge device installed on supermarket carts on fruit and vegetable consumption of Korean consumers in a supermarket experiment setting and using point-of-sales (POS) data as well as the exit survey data conducted for the supermarket customers (n=3,106). We find that a nudge device designed and installed on supermarket carts to make consumers feel like they should fill the carts with fruits and vegetables has increased fruit and vegetable consumption by statistically significant amount. This implies that point-of-purchase nudge-type intervention could improve the dietary life of consumers in a more effective way.

Keywords: Cart nudge, Fruit and vegetable consumption, Supermarket experiment
JEL Codes: D12, Q13, Q18

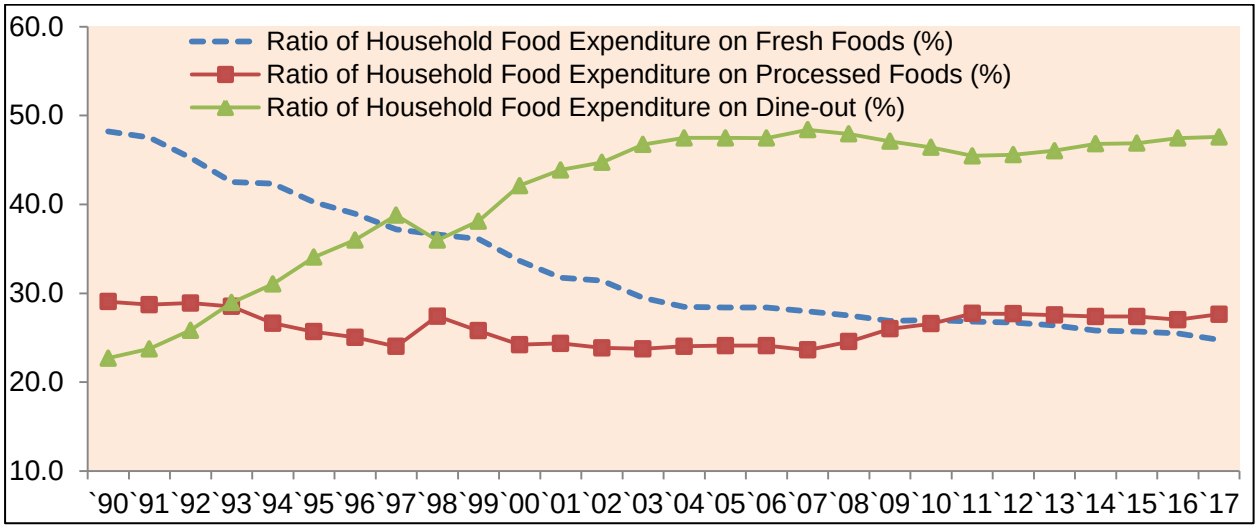
Motivation

"Healthier food choice" is an emerging topic of interest, as the rapid increase in the prevalence of dietary-related diseases is a remarkable phenomenon both domestically and globally. Healthier food choice is literally defined as "behavior of choosing" healthier foods, whatever they are, rather than unhealthier foods. Foods are considered as healthier in the literature when they contain less sugar, sodium, fat, and cholesterol. Fresh foods such as fruits and vegetables are also generally considered to be healthier compared to processed foods. To summarize, healthier food choice can be defined as the behavior of choosing/purchasing healthy foods or nutrients such as fruits and vegetables "more", or choosing/purchasing unhealthy foods or nutrients such as sugar and salt "less". As confirmed in its definition, healthier food choice emphasizes the behavior of food choice itself at the point of choice in the place of choice.

In Korea, household food consumption is changing in a less healthy manner. Household expenditure on fresh foods accounted for approximately 50% of the total food expenditure in 1990, but it decreased to less than 30% in 2017. On the other hand, the proportion of household expenditure on eating out has changed in a completely opposite direction, from around 20% in 1990 to approximately 50% in 2017 (Kim et al., 2018). This proportion of expenditure on eating out of the Korean households is remarkably higher than the OECD average, which is less than 30% (Lee et al., 2017) (see Figure 1). In addition to this X-shape change in composition of household food expenditure, there exists a wide variety of evidence of change toward unhealthy food choice in Korea such as an increase in the proportion of fat in total energy intake and a high sugar/salt intake.[1]

[1] The proportion of carbohydrates in total energy intake has decreased from 80.8% in 1970 to 62.2% in 2016, while the share of fat in total energy intake has nearly tripled from 7.2% in 1970 to 22.9% in 2016.

Figure 1. Trend of Composition of Household Food Expenditure, 1990-2017



Data: Statistics Korea, Household Income and Expenditure Survey, 1990-2017.

In particular, this study focuses on low fruit and vegetable consumption of Koreans. The percentage of Koreans who consume more than 500 grams of fruit or vegetable per day was 39.9% in 1998 and 42.1% in 2001, and has decreased down to 35.3% in 2016. Furthermore, household real expenditure on fruit and vegetable has been in a sharp downward trend since 2000, as shown in Figure 2. It is significantly low relative to other OECD countries. The OECD average of per capita fruit supply is 147.8 kilograms, while it is only 66.9 kilograms for Korea (OECD Stat,

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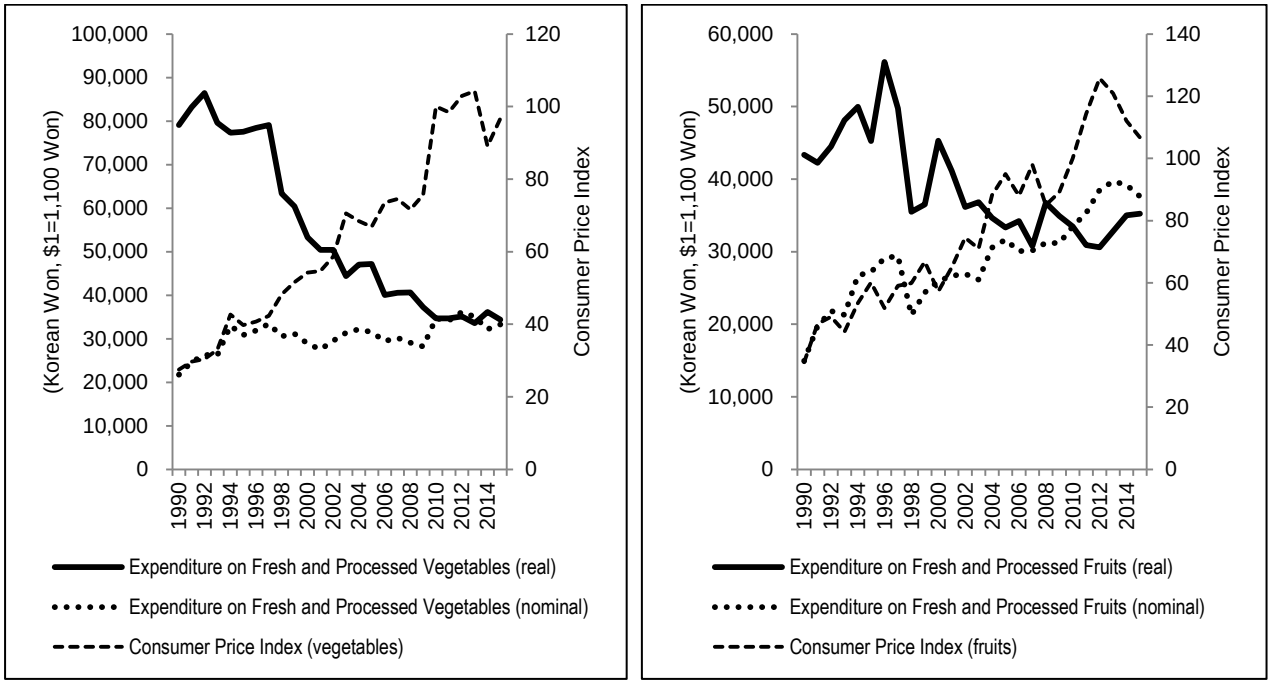
Even though the percentage of people who have more than 2,000 milligrams of sodium per day, which is the daily recommendation, has dropped from 93.2% in 2005 to 79.5% in 2016, it still remains high. It is particularly higher for male (88.9%), those in their 20s (80.4%), in their 30-40s (83.6%), those with their household income in the third quartile (82.0%), and in the fourth quartile (81.4%). The average daily sodium intake of Koreans is 4,103 milligrams, which is higher than other developed countries including Japan (3,807 milligrams), U.S. (3,756 milligrams), and U.K. (3,200 milligrams).

Figure 2. Trend of Household Expenditure on Vegetable (left) and Fruit (right), 1990-2015



Data: Statistics Korea, Household Income and Expenditure Survey, 1990-2015.

2013).[2] For this reason, policymakers in Korea are highly interested in how to stimulate fruit and vegetable consumption.

Policy options conventionally considered to encourage consumption of a specific food include dietary education, food labelling, and fiscal policies including tax and subsidy. In addition to these options, the concept of "point-of-purchase nudge" has been recently applied to food consumption arena in many countries. According to Just and Payne (2009), point-of-purchase nudge is "a device or a simple adjustment to induce behavior of consumers to certain direction without limiting their choices, at their point of purchase of food through retail channels for

[2] Per capita fruit supply is 52.9 kilograms in Japan, 93.9 kilograms in China, 127.4 kilograms in the United Kingdom, 104.5 kilograms in U.S., France in 114.3 kilograms, and 200.8 kilograms in Luxemburg.

agricultural and food products, such as a large retail store, convenience store, or traditional market."[3] Examples of point-of-purchase nudge in the area of food choice include supermarket cart design, cart partitioning, shelf labeling, shelf/store lightening, rearrangement of food items along the shelves, check-out-point marketing, and so on (Payne et al., 2014, 2015; Stilley et al., 2010). Among these tools this study focuses on the impact of partitioning of supermarket, in particular, a nudge device that makes consumers feel like they should pick-up and put fruits and vegetables in the supermarket cart.

When trying to encourage consumers to purchase certain food categories in supermarket, two constraints that consumers face must be considered. The first constraint is budget constraint. Based on traditional microeconomic theory, reasonable consumers will choose the optimal quantities (q^*) that maximize their utility at a given income and price level. Under this constraint, consumers who have solved the utility maximization problem will have a consumption behavior in which they allocate the predetermined level of budget to purchase q^*. Purchasing an unplanned product can affect (or reduce) the purchases of other products because the available budget is reduced due to the unplanned purchase. However, given the possibility that consumers are sometimes willing to allocate some of their available budget to unplanned purchases, it is not appropriate to rule out the possibility that the nudge device leading to increasing the choice of healthy food (fresh fruits and vegetables) without reducing the total expenditure of the consumer can work effectively (Payne et al., 2014, 2015; Stilley et al., 2010).

[3] According to Thaler and Sustein (2003), "a nudge is any feature of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing material incentives. Influencing behavior without coercion in such manners is referred to as libertarian paternalism and the influencers as choice architects."

The second constraint to be considered is the spatial constraint of the supermarket cart. While the volume of supermarket carts is limited, the volume of fresh fruits and vegetables is not negligible. For this reason, the nudge device to encourage the consumption of fruits and vegetables can affect (or reduce) the purchase of other food or noon-food products. Observing how consumers' purchasing behavior will change when these two constraints that consumers face are interacted with the nudge device installed on supermarket cart will be a very interesting research topic.

To the author's knowledge, no study has examined the impact of such point-of-purchase nudge on fruit and vegetable consumption in Korea. Furthermore, no such a nudge has been designed and applied in a field (supermarket) experiment setting in Korea (Kim et al., 2018). Whether or not such a point-of-purchase nudge installed on supermarket carts is effective in stimulating fruit and vegetable consumption is especially of interest both from a policy perspective and from an academic point of view, as there are a number of advertising signs on the common supermarket carts in Korea, which can interfere with the effectiveness of the nudge instrument.

The study adds to the food consumption and policy literature by being the first to examine the impact of a point-of-purchase nudge installed on supermarket carts on healthy food choice of Koreans (*i.e.*, fruit and vegetable consumption). A particular focus of the supermarket experiment is to identify the change in fruit and vegetable sales caused by the installed nudge as well as the change in the sales of other products including processed foods. The sales of other products are especially important for supermarket managers as they are directly associated with their financial performance.

Research Methods and Data

Design of Supermarket Experiment

Two most similar mega-marts, E-mart which is one of the greatest supermarket chains in Korea, were selected for this supermarket experiment from Gwangju metropolitan area: one for controlled supermarket (Gwangsan E-mart) and another for treated supermarket (Bongsun E-mart). The supermarket experiment was conducted for two weeks: in the first week (Period 1) no nudge device was installed on carts in both supermarkets, and in the second week (Period 2) the nudge device was installed only on carts in the treated supermarket (Bongsun).

Table 1 summarizes the design of the supermarket experiment. For the controlled supermarket, the sales of fruit and vegetable are X2 and (X2+a) for the first and second period, respectively. As no nudge device is installed on the carts in the controlled supermarket, the change in sales of fruit and vegetables, indicated by “a”, can be seen as a natural change, or a benchmark change. On the other hand, for the treated supermarket, the sales of fruit and vegetable are X1 and (X1+a+b) for the first and second period, respectively. The change in sales of fruit and vegetable for the treated supermarket, indicated by “a+b”, is sum of natural change and treatment effect. Here, the treatment effect is measured by “b”. We try to measure “b” from the supermarket experiment to identify the treatment effect of the nudge device installed on the supermarket carts on the sales of fruit and vegetable.

< Table 1. Design of Supermarket Experiment >

	Fruit and Vegetable Sales		
	Period 1	Period 2	Change
Supermarket 1 (Gwangsan E-mart) Treated Supermarket	X1 (none)	X1+a+b (treated)	a+b
Supermarket 2 (Bongsun E-mart) Controlled Supermarket	X2 (none)	X2+a (none)	a
Net change (= treatment effect)			b

< Figure 3. Design and Installation of the Nudge on Supermarket Cart >

Source: designed by authors

For this field experiment, the authors designed a nudge device to be installed on supermarket carts (see Figure 3) to make consumers feel like they should pick up fruits and vegetables and fill their carts with them. The features of this nudge include 1) a feeling of green, 2) a feeling of confidence from the 'OECD' phrase, 3) an image of future generations of children laughing brightly with fruits and vegetables in full of their arms, 4) a mark of smile, 5) arrow signs delivering the message to fill fruits and vegetables until this line, 6) marks representing GAP (Good Agricultural Practice) and organic certification, and 7) rural background. In addition, green-colored duct-tape is vertically attached in the supermarket carts to deliver a three-dimensional message to fill the carts with fruit and vegetable until this high.

We installed this nudge device on approximately 550 carts in Gwangsan E-mart which is the treated supermarket of this experiment, and have checked if this device is well-attached along the experimental periods.

Data

Headquarter of E-mart provided us with point-of-sale (POS) data for the two supermarket branches on a daily basis for the experimental periods as well as previous periods. In particular, we analyzed daily sales data for fruits and vegetables as well as the other products including processed foods and non-food products.

In order to capture household heterogeneity in the impact of the nudge device, we implemented random sample exit surveys for 3,106 consumers to collect their socioeconomic information as well as their shopping receipts. Socioeconomic information includes gender, age, household size and income, and whether or not they are vegetarian. From the receipts collected from the exit surveys, we were able to identify the itemized individual-level (or household-level) purchases. In order not to offset the effect of the nudge device, the group of consumers who were carrying children in carts or consumers who did not fill more than 20 percent of carts children in the carts was excluded from the exit survey.

Econometric Model

In analyzing the impact of this point-of-purchase nudge device on fruit and vegetable consumption using data from the exit surveys, we employed a Tobit difference-in-differences (DID) framework to identify the treatment effect ("b") (see equation below and Table 1).

$$Y_{it} = \alpha + \mathbf{X}'_{it}\beta + \theta_1 P2_{it} + \theta_2 T_{it} + \theta_3 (P2_{it} * T_{it}) + \epsilon_{it}$$

where Y_{it} = outcome variable(e.g., fruit expenditure), $\mathbf{X}_{it}$ = individual-specific control variables, $P2_{it} = 1$ if period 2, $T_{it} = 1$ if treated, $(\alpha, \beta, \theta_1, \theta_2, \theta_3)$ = parameters to be estimated, and ϵ_{it} = error term.

Among the survey participants, there are consumers whose expenditure on fruits and vegetables is zero, so the Tobit model is estimated. Moreover, the DID framework is widely used econometric technique when a treatment effect is to be identified.

Preliminary Results

Results for POS Data Analysis

As can be seen in Table 2, fruit sales have increased by 59.65% in the treated supermarket, while it has increased only 9.28% in the controlled supermarket. Vegetable sales have increased by 2.39% in the treated supermarket, while it has even decreased in the controlled supermarket. The decrease in vegetable sales in the controlled supermarket may stem from the high vegetable price during the period. As the entire food sales could be more important for supermarket owners, we also analyzed it. Daily average food sales in the treated supermarket were $100,971 and $157,001 for the first and second period, respectively. The difference in daily average food sales between the two periods was 55.49%. On the other hand, daily average food sales in the controlled supermarket were $122,772 and $159,586, respectively. The difference was only 29.99% for the controlled supermarket, implying that the nudge device installed on the supermarket carts has had significant consumption-stimulating impacts.

< Table 2. Change in Fruit and Vegetable Sales (unit: 1,000 Won ≈ $1, %) >

	Gwangsan E-mart – Treated			Bongsun E-mart - Controlled		
	Daily Average Sales			Daily Average Sales		
2018	Period 1 (9.5-11)	Period 2 (9.12-18)	Change (%)	Period 1 (9.5-11)	Period 2 (9.12-18)	Change (%)
Fruit Sales(F)	8,620	13,762	59.65%	16,126	17,622	9.28%
Vegetable Sales(V)	5,269	5,394	2.39%	8,973	7,951	-11.39%
F+V(FV)	13,889	19,156	**37.93%**	25,100	25,573	**1.89%**
Food Sales(FS)	**100,971**	**157,001**	**55.49%**	**122,772**	**159,586**	**29.99%**
F-FS Ratio	8.54%	8.77%	+0.23%p	13.14%	11.04%	-2.10%p
V-FS Ratio	5.22%	3.44%	-1.78%p	7.31%	4.98%	-2.33%p
FV-FS Ratio	13.76%	12.20%	-1.56%p	20.44%	16.02%	-4.42%p

< Table 3. Change in Quality of Sales >

Gwangsan-Bongsun Ratio		Sales				Ratio of Customers Who Purchased FV		
		Total	FV	F	V	FV	F	V
Period 1	(9.5-11)	77%	52%	48%	58%	77%	64%	80%
Period 2	(9.12-18)	82%	61%	54%	69%	80%	66%	86%
Change		6%p	9%p	6%p	12%p	3%p	2%p	6%p

Gwangsan-Bongsun Ratio		Sales per Customer			Number of Items Purchased		
		FV	F	V	FV	F	V
Period 1	(9.5-11)	82%	91%	87%	93%	94%	98%
Period 2	(9.12-18)	90%	96%	94%	102%	96%	106%
Change		8%	5%	8%	9%	1%	8%

Data: POS data from E-mart headquarter

Table 3 summarizes the change in quality of sales between the two periods. All the numbers in Table 3 are Gwangsan-Bongsun ratios (treated-controlled ratios). By the installment of the nudge device for the second period, the ratio of customers who purchased fruits and vegetables, sales per customers, and the average number of items purchased by customer have all improved.

Results for Exit Survey Data Analysis

Table 4 represents the descriptive statistics of the exit survey. Compared with the first period, the average purchase amount of fruits and vegetables for consumers of controlled supermarket has decreased in the second survey period, while the average purchase of vegetables has increased in the treated supermarket. The percentage of fruit (F) and vegetable (V) expenditure to the total food expenditure ((F+V)/Food) or the total consumption (C) expenditure ((F+V)/C) has decreased in the second period compared to the first period for the controlled supermarket (18%

→ 16% and 15 → 13 %, respectively), while it has increased in the treated supermarket (14% → 17% and 11% → 12%, respectively).

< Table 4. Descriptive Statistics of Exit Survey >

(Unit: Won, %)

	Average Expenditure per Consumer					
	Controlled (Bongsun)			Treated (Gwangsan)		
	Period 1	Period 2	Change	Period 1	Period 2	Change
Fruits(F)	6,564.89	5,162.17	-21%	5,065.91	4,722.58	-7%
Vegetables(V)	5,509.62	5,042.59	-8%	4,378.78	4,689.65	+7%
F+V(FV)	12,074.51	10,204.75	-15%	9,444.68	9,412.23	0%
FV/Food	18%	16%	-2%p	14%	17%	+3%
FV/Entire Purchase	15%	13%	-2%p	11%	12%	+1%

Data: Exit Survey (n=3,106)

Table 5 shows the results of Tobit regression estimation. The results confirmed that the nudge device makes a significant contribution to the increase of fresh food consumption of individual (or household). The nudge device has the effect of increasing the expenditure on fruits and vegetables by KRW 2,919 compared to the benchmark group. In addition, the ratio of fruit and vegetable expenditure to total food expenditure is increased by 7.6%, and the ratio of fruit and vegetable expenditure to total expenditure is also increased by 3.6%.

As for the control variables showing statistically significant results, both the amount and ratio of the expenditure on fresh foods (fruit + vegetable) is lower for male, and higher for the high-income individual (or household). It is straightforward that both the amount and ratio is higher for vegetarians than non-vegetarians.

We also considered the day effect in the estimation model because it is highly likely that the expenditure in the supermarket will increase as it gets closer to the weekend. As expected, a positive impact has been found on the day variables, implying that food expenditure itself is higher for weekend than weekdays. In particular, expenditure on fresh foods is higher on Saturday by KRW 7,412.

We tried various combinations of control variables for the robustness check of the results, and we found very consistent results.

< Table 5. Tobit Regression Estimation Results >

		Fruits (F)	Vegetables (V)	F+V	(F+V)/ Food Total	(F+V)/ Total Expenditure
	Treated (T)	2849.2**	611.0	2004.5*	0.0352*	0.0350***
		(1248.1)	(996.2)	(1185.5)	(0.0200)	(0.0129)
	Period 2 (P2)	-3339.7***	-1244.0	-2830.6**	-0.0398*	-0.0321**
		(1264.0)	(1017.9)	(1208.6)	(0.0204)	(0.0131)
	T*P2	2460.2	1815.0	**2919.0***	**0.0760*****	**0.0359****
		(1702.7)	(1349.6)	(1606.9)	(0.0271)	(0.0174)
Socioeconomic Variables	Male	**-2849.8*****	**-539.7**	**-1585.2***	**-0.0512*****	**-0.0254****
		(1030.5)	(804.6)	(958.8)	(0.0162)	(0.0104)
	Age	78.62*	-38.69	20.50	0.000845	0.000669
		(41.53)	(32.73)	(39.04)	(0.000657)	(0.000423)
	Household Size	-219.3	295.4	190.8	-0.00569	-0.00856
		(553.7)	(437.4)	(521.4)	(0.00878)	(0.00566)
	Under 18	-511.6	-1388.6***	-1452.1**	-0.0191*	-0.0110*
		(647.9)	(508.7)	(608.7)	(0.0103)	(0.00662)
	Mid Income ($3~5,000)	651.3	1710.7*	1615.0	0.0177	0.0142
		(1143.2)	(896.1)	(1063.7)	(0.0179)	(0.0115)
	High Income ($5,000~)	**4670.1*****	**3366.5*****	**5151.8*****	**0.0427***	**0.0304****
		(1476.3)	(1165.4)	(1389.2)	(0.0234)	(0.0151)
Dietary Life	Vegetarian?	**2760.4*****	**1301.4***	**2719.7*****	**0.0442*****	**0.0314*****
		(918.4)	(728.4)	(867.3)	(0.0146)	(0.00942)
Vehicle Use?	Yes	1912.0	58.09	624.6	-0.0334	-0.0165
		(1400.0)	(1096.0)	(1297.0)	(0.0217)	(0.0140)
Day Effect (base = Wednesday)	Thursday	2995.8**	857.1	2534.2*	0.0442*	0.0250*
		(1513.7)	(1171.2)	(1391.6)	(0.0234)	(0.0151)
	Friday	3362.3**	3733.4***	4941.7***	0.0574**	0.0365**
		(1508.9)	(1159.8)	(1383.5)	(0.0232)	(0.0150)
	Saturday	5998.0***	4946.9***	7412.3***	0.0497**	0.0330**
		(1493.4)	(1152.9)	(1375.2)	(0.0231)	(0.0149)
	Constant	-18510.5***	-5374.6**	-4831.4	-0.0136	0.00295
		(3281.1)	(2549.5)	(3030.5)	(0.0510)	(0.0329)
	# of Observations	3106	3106	3106	3103	3106

Note: * p < 0.1, ** p < 0.05, *** p < 0.01

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