An Offer You Can't Refuse: Who Uses Cigarette Price Discounts? *

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Abstract

We investigate whether and how current sales of cigarettes vary with past and future sales made under two different types of in-store price discounts: those that require a smoker to buy a carton (10 packs) and those that require a smoker to only buy a single pack. We hypothesize that different types of consumers respond to these promotions. We posit that smokers who utilize discounts tied to a pack may be less committed smokers or smokers who act impulsively. We posit that smokers who utilize discounts tied to cartons may be more committed smokers who have a longer time horizon and are more cost-conscious. Existing cigarette demand studies find that consumers exhibit rationally addictive behavior because current consumption varies with past and future consumption as the model of rational addiction predicts. We modify the empirical rational addition model to allow for consumers to be heterogeneous in the effect of past consumption on present consumption and in the weight they place on future utility. We

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use data from 1995-2007 on cigarette price and quantity for 49 geographically separate markets and local unemployment rates to examine how current sales vary with past and future discounted sales of different types. Our empirical results suggest that consumers of discounted cigarettes differ from other consumers both in terms of the effect of past consumption and the rate at which they discount future utility. Results continue to support the prediction that smokers are rationally addictive. However, our results also indicate that smokers who take advantage of pack discounts experience a stronger addictive effect and discount the future more heavily than smokers who do not. We find the opposite for smokers who take advantage of carton discounts: they experience a weaker addictive effect and have a higher discount rate. Our results also suggest that manufacturers take addiction into account when setting prices and offering discounts.

Keywords: Cigarette marketing; price discounts; price discrimination; rational addiction

1 Introduction

According to the Federal Trade Commission, 43 percent of the $11.2 billion cigarette companies spent on advertising and promotion in 2001 was devoted to promotions such as "buy one pack, get one free" campaigns (Federal Trade Commission 2007). An additional $602 million was spent on coupons for discounted cigarettes. Despite these heavy expenditures, few studies have examined how consumers respond to these promotions. This study fills a gap in the literature by using detailed aggregate price and quantity data from supermarket scanners to examine in-store price promotions–cents-off discounts and multipack discounts–focusing on whether consumers respond differently to the addictive effects of consuming discounted cigarettes than they do to non-discounted cigarettes. Such a difference in the addictive effect of discounted cigarettes could indicate the presence of different types of consumers that manufacturers are able to target with these discounts.

While we focus on cigarette markets, characteristics of that market are relevant to broader economic questions. First, cigarettes are studied as a prototypical addictive good. Becker & Murphy (1988) derive implications of addiction for a rational consumer. One main implication is that demand will be linked across time periods. While their model applies to addictive goods of all types, most of the empirical literature that tests the predictions of the rational addiction model focuses on cigarettes (Chaloupka (1991); Becker, Grossman, & Murphy (1994); Baltagi & Griffin (2001); Gruber and Koszegi (2001)). The findings of this empirical literature generally support its implications. Our study is an extension of this work, allowing for heterogeneous responses to prior and future consumption.

Second, cigarette markets are highly concentrated, with the available evidence suggesting that cigarette manufacturers have market power - in part because the federal government forbids sales of cigarettes across state borders. Keeler *et al.* (1996) and Sumner (1981) both present evidence that suggests that cigarette manufacturers have some market power. Sumner (1981) finds that cigarette manufacturers raise prices by more than the amount that cigarette taxes increase - a result consistent with how economic models predict a firm with monopoly power would adjust price after a tax increase. Keeler *et al.* (1996) also find evidence of price discrimination in state cigarette markets. Using the Herfindahl index, a measure of how much of the cigarette market sales are concentrated in one firm, they find that market concentration helps explain the degree of pricing power that cigarette makers can exercise in a given state. Studying price discounting in cigarette markets should yield some general insight into price discrimination in concentrated markets.

Finally, cigarettes belong to a class of goods whose (over) consumption is identified with serious deleterious consequences (alcohol is another member of this class). Because the over-consumption of these goods involves major public health issues, social scientists, public health advocates, and policy makers are interested in better understanding what influences people to consume cigarettes, alcohol and other goods in this class. The scientific and policy communities want to better understand how consumption varies with factors that can be

(easily) manipulated by public policies, with the goal of using public policy to affect behavior. For example, a recent public health initiative, Healthy People 2010 (USDHHS 2000), aims to halve adult smoking prevalence, from the current rate of about 24 percent to 12 percent.

Taken together, the above evidence–that cigarette manufacturers have market power, that consumers exhibit rationally addictive behavior, and that manufacturers spend considerable amounts on promotions and coupons–suggests that examining how cigarette price discounts affect consumer behavior will be of substantial interest both in terms of public policy and in terms of a more general understanding of producer behavior in markets for addictive and harmful goods.

In this study, we investigate the following questions:

1. Do coefficients on past and future sales in a model of rational addiction change when one accounts for past and future cigarettes sold under discount?

2. Do past and future discounted sales have a different effect from past and future total sales?

3. Are there differential effects of discounts that require a consumer only buy a pack versus discounts that require a consumer buy a carton?

We argue that discounted cigarettes tend to be purchased by consumers who differ from other smokers in the marginal effect that past consumption has on current utility, i.e. the addictive effect of consumption. Further, they are likely to show differences in their future discount rates. Accounting for these differences in behavior will change the estimated coefficients on past and future consumption. We expect that consumers of pack discounts (which are usually multipack, such as buy-one-get-one-free offers) are less experienced smokers, and will have a higher addictive response and discount the future more heavily. Consumers of carton discounts are likely to be more experienced smokers, and will have a smaller addictive

response and discount the future less heavily than other smokers. These consumers may also stockpile cigarettes.

To examine these questions, we use supermarket scanner data from 49 US markets for the years 1995-2007. These data contain detailed information on price and quantity sold, and allow us to account for heterogeneity in groups of cigarette consumers.

Several previous studies have examined the demand for cigarettes in the framework of an addictive good, generally concluding that consumers are forward-looking. In Becker, Grossman, & Murphy's (1994) empirical test of rational addiction, they find that future cigarette sales have a positive impact on present consumption. This result indicates that consumers consider the addictive nature of cigarettes when making consumption decisions. Gruber & Koszegi (2001) provide additional evidence that consumers are forward-looking by examining how smokers respond to cigarette tax increases that have been enacted but have not yet taken effect. They also extend the theoretical model to examine the case where preferences are time-inconsistent, finding that time-inconsistent preferences are consistent with the empirical results, but have different policy implications. Coppejans *et al.* (2007) show that teenagers' smoking prevalence varies with the volatility in cigarette price in addition to the mean expected price.

Two studies find some evidence that consumers hoard cigarettes prior to a tax increase. Gruber & Koszegi (2001) find that cigarette sales increase during the period between when a tax is enacted and when it takes effect. Keeler *et al.* (1993) use a dummy variable for the month prior to a tax increase to show that consumers stockpile cigarettes prior to the tax increase.

In what follows we examine patterns of cigarette sales to determine whether and what role disounts play in a model of rational addiction. In section 2, we discuss the data we use and develop the estimation equations. Our central goal is to uncover the relationship between current sales and sales made under two types of discounts that, we conjecture, select out two

different types of smokers. In particular, we test whether current sales vary with the amount sold in the recent past, and whether that relationship differs when the cigarettes sold in the past were sold under discounts. We also examine whether manufacturers react to future tax increases in ways that suggest they account for the heterogeneity among different types of consumers. To do so we use 12 years of supermarket scanner data for 49 geographically distinct markets. In section 3, we present and interpret the results. Our evidence suggests that the inclusion of per capita discounted sales does affect estimates of rational addiction; that purchasers of pack discounts experience a greater effect of past sales on current sales than other smokers, and purchasers of carton discounts experience a smaller effect; that purchasers of discounted cartons are more forward looking (i.e. they care more about future consumption) than other smokers; and that purchasers of discounted packs are less forward-looking. In section 4, we conclude by discussing the implications of our results or various theories of price discrimination, for tobacco control policy in particular, and for the regulation of markets for addictive goods more generally.

2 Data and Methods

We use proprietary data collected by AC Nielsen from supermarket scanners on prices charged and specific discounts awarded in small geographic marketing areas. AC Nielsen compiles and sells data from supermarket scanners of stores in a contiguous georaphic area that generally corresponds to metropolitan areas. Our unit of analysis is a market area as defined by AC Nielsen. To test our primary question of whether firms use discounts to expand the size of markets, we focus on total sales within a market, rather than brand-level sales. This measure highlights the relationship between total (per capita) sales and discounted sales without having to consider the possibility that discounts cause smokers to switch brands.

We use data on the average price and quantity of cigarettes sold over six-month periods (January to June and July to December) from July 1995 through June 2007. These data cover all supermarkets with annual sales over $1 million for 49 market areas in the US. Data are at the product level, where a product is defined as a brand of cigarettes sold at a certain price and in a certain quantity. Thus, the data include packs and cartons sold at the regular price, at discounted prices (with the size of the discount listed), and in discounted quantities (e.g. buy 1/get 1 free). Market areas are sets of counties roughly centered around major cities.

For the purpose of analysis, we convert all quantity data to packs and calculate the per capita number of packs sold in a market during either a year or a six-month period quarter. We construct price as the sales-weighted average price across all brands sold in each market.

We construct corresponding measures of per capita sales of cigarettes that were made under different types of discounts. We compute per capita discounted sales for the past, current, and future 6-month period for sales under discounts that required a smoker to buy either a full carton (10 packs) or only a single pack of cigarettes.

We include the local unemployment rate to control for local market business cycles. Data on the labor force are available from the Census Bureau at the county-month level; we aggregate these data up to the market and six-month period.

Table 1 presents summary statistics. We present per capita discounted sales for all brands and by the quantity a smoker had to buy to take advantage of the discount (pack or carton). The summary statistics reveal that packs are much more likely than cartons to be sold in multipack bundles, while cartons are more likely than packs to be sold with cents-off discounts. Pack sales are also much more common than carton sales, both in terms of volume and in terms of the total number of offers.

We examine two ways in which demand is possibly linked over time. First, we adopt the

Table 1: Summary Statistics

	Observations	Mean	Std. Dev.	Min	Max
Undiscounted price	1029	2.653	0.707	1.388	4.716
Per capita sales	1029	5.038	3.137	0.552	18.871
Unemployment rate	1029	4.957	1.368	2.009	11.736
Average dollar discount (cents-off only)	1029	0.376	0.332	0	1.50
Average percentage free (multipack only)	1029	0.373	0.071	0.200	0.472
Number of carton discount offers	1029	10.764	16.090	0	91
Number of pack discount offers	1029	59.811	27.772	3	148
Per capita discounted pack sales	1029	0.071	0.071	0.001	0.505
Cents-off	1029	0.000	0.001	0.000	0.011
Multipack	1029	0.071	0.071	0.001	0.505
Per capita discounted carton sales	1029	0.009	0.030	0.000	0.351
Cents-off	1029	0.008	0.030	0.000	0.351
Multipack	1029	0.001	0.003	0.000	0.049

assumption that cigarettes are addictive. As Becker and Murphy (1988) show, this assumption implies that demand, and therefore sales, will be linked over time. Past sales should have a positive effect on current sales due to the effect of addiction, while future sales may have a positive effect on current sales because the consumer will anticipate the effect that current consumption will have on future utility. Past sales may affect different consumers to different degrees–some will become more addicted than others. Demand may also be linked over time because smokers can buy and store cigarettes for future consumption. In contrast to the above implication, the "buy and store" effect suggests that more discounted sales in the past will lower current sales.

To operationalize these effects in an empirical model, we regress total cigarette sales in a given year (half-year) (Q) on last period's sales (Q_{t-1}), expected sales (next period's sales) (Q_{t+1}), price (P), the past and future per capita number of packs sold at a discount ($Disc$), and a vector of market demographic variables (X) that includes market fixed effects and a linear time trend. We also specify and estimate a model, that includes a market-specific (linear) time trend. We separate discounts into those that require smokers to buy either a carton or a single pack to take advantage of the discount. We do so to allow for the fact that firms may target these two types of discounts at different groups of consumers. We also control for the generosity of currently offered discounts. Note that the past, current, and future per capita sales includes past, current, and future per capita sales of cigarettes that were sold at a discount. Therefore, the coefficient on the per capita discounted sales provide a test of whether current per capita sales vary with the fraction of past (future) per capita sales that were sold under a discount (of a particular type).

The quantity equations are an extension of the empirical model of Becker, Grossman, and Murphy (1994, hereafter BGM). Our specification is:

$$Q_{it} = \gamma_0 + \gamma_1 Q_{i,t-1} + \gamma_2 Q_{i,t+1} + \gamma_3 P_{it} + \gamma_4 Disc_{it} + \gamma_5 QDisc_{i,t-1} + \gamma_6 QDisc_{i,t+1} + X_{it}\beta + \varepsilon_{it} \quad (1)$$

where i refers to the market, t is the month, and the other variables are defined as above.

Disc is a vector containing the per capita sales in packs of discounts. Note that excluding the vectors of per capita discount sales would yield the BGM model.

BGM set out the basic predictions for the coefficients on price and past and future quantity. The coefficient on price, γ_3, should be negative. Future price affects current consumption through its effect on expected future consumption, so it does not enter into the equation directly. Assuming sales equal consumption, if cigarettes are addictive, then γ_1 will be greater than zero (higher past consumption leads to higher present consumption). We refer to the impact of past consumption on current consumption as the addictive effect. If consumers are rational, γ_2 will also be positive and significant (higher expected future consumption should lead smokers to consume more in the current period and vice versa), and smaller than γ_1. Further, the ratio of the future coefficient to the past coefficient equals the discount rate δ, so that $\gamma_2 = \delta\gamma_1$.

We extend the general analysis of aggregate consumption or sales by allowing there to be more heterogeneity among consumers. This heterogeneity could occur across several dimensions. First, the effect of past consumption may differ, i.e. some smokers may experience a larger increase in current utility from an additional cigarette smoked in the past. Second, discount rates may differ across different groups of smokers, so that some smokers place larger or smaller values on their utility in the future. Finally, consumers may differ in their price responsiveness. One possibility is that consumers can be separated into more committed and less committed smokers. The more committed smokers will have found a stable level of consumption and will be conscious of the addictive effect of their habit. They would thus experience a smaller marginal effect of past consumption, and would put more weight on future utility than less-committed smokers. Less-committed smokers may still be experimenting with cigarette consumption, and would therefore experience a larger effect of past consumption on current consumption. They may also be less inclined, or less able, to predict future consumption and to factor it into current consumption. If two such consumer types coexist, they may differ by the types of discounts they take advantage of. In our model, the

result of such differences in consumption behavior would be that past and future sales of discounted cigarettes may have effects that differ from the effects of total sales because the discounts select out consumers with different underlying responses.

We examine three sets of models. The first set of models allow us to examine whether estimates of rational addiction change when one accounts for the fraction of past and future sales that were made under discounts. If smokers are rational and the discounts induce smokers to buy more than they otherwise would have, then the coefficient on past discounted sales will increase current consumption. In this case, the coefficient on the "core" past sales should be greater because one separates out sales made to smokers that may be less addicted.

Our primary coefficients of interest are γ_5 and γ_6. Discounts fall into two categories according to whether they are tied to the sale of a pack only or the sale of a carton. If the discount is targeted at consumers who tend to get more addicted than others, then γ_5 (the coefficient on past discounted quantity) will be positive (if they also consume more than they otherwise would have). In this case, past purchases of discounted cigarettes increases current sales above and beyond the effect that past total quantity already has. However, if the discount is primarily used by consumers who have a smaller addictive effect, then γ_5 will be negative. A negative coefficient could also indicate the possibility that some consumers stockpile cigarettes, shifting into the previous period some of the purchases that would have been made in the current period.

The coefficient on γ_6 is somewhat less easy to sign. If less committed smokers experience a stronger addictive effect, then γ_5 will be positive. If they also discount the future more heavily (since they are likely to be younger and less aware of their potential for addiction), the ratio $(\gamma_2 + \gamma_6)/(\gamma_1 + \gamma_5)$ to be greater than γ_2/γ_1. If more committed smokers are more aware of their future consumption, that ratio will be lower than for undiscounted cigarettes. The actual coefficient on γ_6 could be positive, negative, or zero in either case.

We expect that impulsive or less committed smokers take advantage of pack discount offers

because the discounts do not require them to commit very much money. We also conjecture that more committed smokers will be more likely than less committed smokers to take advantage of carton discount offers, since purchasing a carton requires taking on some costs of storage. We therefore estimate two variants of our empirical model. First, we use combined past and future discounts of any type. Second, we separate past and future discounted sales into those that required the purchase of only a single pack and those that required the purchase of a carton. A carton consists of 10 packs, and is usually sold at a lower price per pack than an individual pack. Thus, carton sales will most likely appeal to consumers whose storage costs are low relative to their price sensitivity.

As in BGM, we treat past and future quantity as endogenous to account for potential autocorrelation in sales. We instrument for these variables using past and future prices and unemployment rates. We treat per capita sales of cigarettes at discounts as endogenous and instrument as described above. We make the same assumption of endogeneity for per capita sales of each type of discounted cigarettes. We instrument for past and future discounts using measures of the generosity of these discounts. Because our data separately track "cents-off" discounts (direct reductions in the price) and "buy one get x free" discounts, we include separate measures of the generosity of each type of discount. For free pack offers we measure generosity of the discount as the average implied discount the free packs constitute (e.g buy 1 get 1 free is an implied discount of 50%) and the number of free pack discounts offered. For cents-off discounts we measure generosity as the average amount in dollars of the discount offer and the number of cents-off discounts offered. In the models where we split discounts by pack or carton, we use the corresponding percent free or discount amount for each category (carton discount size for carton sales, etc.).

As an auxiliary analysis, we examine whether manufacturers react to future tax increases in a way that would be expected, given the different types of consumers that purchase discounted pack and carton cigarettes. BGM (1994) and Showalter (1999) note that a monopolist selling an addictive good should price below marginal cost to increase consumers' addictive stock

and thereby increase future profits. An increase in the future tax rate will lower future profits, making it more valuable to sell at a higher price to current consumers than to sell at a lower price to encourage higher future consumption. Showalter (1999) notes that the size of the increase depends on two factors: the size of the addictive effect and the size of the price response.

Our specification for the price analysis is:

$$P_{it} = \delta_0 + \delta_1 Tax_{it} + \delta_2 Taxdif_{i,t+1} + X_{it}\beta + \nu_{it} \tag{2}$$

where X contains the unemployment rate, market fixed effects, and either a global time trend or market-specific time trends. The variable of interest, $Taxdif$, is the difference in the tax rate between the current period and the next period. We estimate this equation for the undiscounted price, for the average pack discount price, and for the average carton discount price. If firms in the cigarette industry have some degree of market power, δ_1 and δ_2 should be positive in all three models–current tax increases the price, while an increase in the future tax rate also increases the price. In the absence of market power, firms would not be able to raise current prices in response to the increase in future taxes, in which case δ_2 would equal zero.

If all three groups of consumers have the same degree of price responsiveness, the coefficient on $Taxdif$ should be largest when the effect of past consumption is largest. This is because a monopolist in an addictive goods market should put increasing weight on future sales when this addictive effect increases. Thus, when the addictive effect is larger, the monopolist will set the price farther below marginal cost than when the addictive effect is smaller. When future costs increase, as in the case of a future tax increase, the shift from future to present profits will be larger when the addictive effect is larger.

Previously, we described the expected results for pack and carton discounts: we expect past pack discounts to have an effect over and above the effect of total sales, while carton sales will have an effect less than the effect of total sales. This would also lead to the prediction

that the coefficient on $Taxdif$ should be largest for the pack discount price and smallest for the carton discount price. However, if pack discount consumers are more price responsive, this could change the relative sizes of the coefficients.

3 Results

Table 2 presents results from the aggregate sales model. We ignore discounts in columns (1) and (2). In columns (3) and (4) we include per capita packs of cigarettes sold under discount in the past and future. In columns (5) and (6) we disaggregate the discounted sales according to whether the discount required a smoker to buy only a single pack or a full carton. Odd numbered columns (1), (3), and (5) present results from models that include market specific fixed-effects and a general linear time trend. Even numbered columns (2), (4), and (6) present results from models that include a market specific fixed-effect and a market specific linear time trend. We include the first-stage F statistic for all instrumented variables in brackets underneath the p-values.

The coefficient on price is negative and significant in all models. The coefficient on unemployment is negative in most models, but not statistically significant in any of them. The coefficients on past and future sales are positive and statistically significant across the different model specifications. However, in the models with a global time trend, the coefficient on past consumption is smaller than the coefficient on future consumption. This result is not what the model of rational addiction predicts. However, when we include market-specific time trends, the coefficient on future purchases is always smaller than the coefficient on past purchases. [1]

[1] A comparison of the coefficients on past and future total consumption between models (1) and (2) and models (3) and (4) shows that the coefficients do change when one accounts for discounting. However, when we add controls for current discounts, that difference disappears.

To discuss the results on discounts, we focus first on results from models (3) and (4), which contain all combined past discounts and all combined future discounts. Past per capita discounts are positive in both models, but only significant in model (4), which contains market-specific time trends. However, as noted previously, this specification is preferred to the model with a global time trend, since it appears to control better for trends in cigarette consumption. The positive coefficient on past discounts indicates that these discounts raise current sales over and above the effect of past total sales. The coefficient on future discounts is also positive, but only significant in the model with a global time trend. Thus, the results are inconsistent across our two specifications. This inconsistency could arise because discounts are targeted at more than one type of consumer. Models (5) and (6) explore this issue further.

Models (5) and (6) break discounts down further into pack and carton sales. In the previous section, we described how the expected signs on the pack and carton discount coefficients depend on the types of consumers who use them: the coefficient on past discounted carton sales is likely to be negative, since the consumers who purchase these discounted cartons are likely to be more committed smokers who have achieved some stability in their smoking habit. Likewise, the coefficient on past discounted pack sales is likely to be positive, since the consumers who purchase these products are likely to be newer smokers who have not reached a stable level of consumption.

In the case of both pack and carton discounts, the sign of the coefficient on future sales is not meaningful in and of itself. However, the ratio of the effect of future sales to the effect of past sales is meaningful, since this ratio equals the discount rate. We expect the discount rate to be lower for pack consumers, who are likely to be less committed and therefore less likely to consider the effect of present consumption on future utility, while the discount rate should be higher for carton consumers, who are more likely to plan their purchases across time.

The model shows that pack and carton discount purchasers appear to follow patterns that are different from each other and from other consumers. In the case of carton discounts, the past coefficients are negative and significant in both models. This result is consistent with either stockpiling or a smaller effect of addiction for purchasers of these products. The coefficient on future discounted carton sales is positive in both models, but only significant in the model with a global time trend. Past per capita pack discounts are positive but insignificant in the model with a global time trend, but positive and marginally significant (P=0.077) in the model with market-specific time trends. The coefficient on future pack discounts is insignificant in both models. First-stage F-statistics are uniformly strong, so we can be reasonably certain of the validity of these estimates.

Next we examine the implied discount rate for different groups of consumers, based on assumptions about how often they purchase discounted cigarettes. Table 3 presents these results. On average, total discounts make up 1.9 percent of total sales, pack discounts make up 1.75 percent of total sales, and carton discounts make up 0.15 percent of total sales. We calculate the addictive effect and the discount rate assuming individuals purchase no discounts, assuming they purchase the mean percentage, and assuming they purchase a percentage one standard deviation above the mean. We assume that people purchase either packs or cartons. The addictive effect is then the coefficient on past discounted sales multiplied by the percentage discounted sales, plus the coefficient on past total sales. To calculate the discount rate, we made this same calculation for future sales, and divided the resulting value by the addictive effect. The discount rate calculation proceeds directly from the BGM model.

Table 3 shows a more complete profile of the different types of consumers who use pack and carton discounts. Consumers who use pack discounts experience a larger effect of past consumption on current consumption and place less weight on future utility than consumers who do not use discounts or consumers who use carton discounts. Consumers who use carton discounts are just the opposite: they experience a smaller effect of past consumption

Table 2: Quantity Results–Semiannual

	(1)	(2)	(3)	(4)	(5)	(6)
Price (excluding discounts)	-0.162	-0.941	-0.159	-0.680	-0.083	-0.581
	(P=0.001)	(P=0.000)	(P=0.001)	(P=0.000)	(P=0.157)	(P=0.000)
Last pd sales	0.359	0.274	0.449	0.410	0.362	0.348
	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)
	[F=19.05]	[F=30.85]	[F=12.46]	[F=18.96]	[F=10.71]	[F=12.95]
Future sales	0.448	0.091	0.464	0.209	0.498	0.281
	(P=0.000)	(P=0.263)	(P=0.000)	(P=0.006)	(P=0.000)	(P=0.000)
	[F=25.53]	[F=29.1]	[F=16.05]	[F=17.57]	[F=11.5]	[F=12.22]
Unemployment rate	-0.022	0.026	-0.021	-0.014	-0.022	-0.016
	(P=0.084)	(P=0.122)	(P=0.093)	(P=0.414)	(P=0.111)	(P=0.360)
Average pack discount			-0.059	0.059	-0.134	-0.014
			(P=0.363)	(P=0.426)	(P=0.053)	(P=0.852)
Average carton discount			-0.069	-0.052	-0.076	-0.049
			(P=0.032)	(P=0.130)	(P=0.022)	(P=0.158)
Past per capita discounts (all)			0.071	1.158		
			(P=0.890)	(P=0.035)		
			[F=32.28]	[F=26.23]		
Future per capita discounts (all)			0.767	0.285		
			(P=0.020)	(P=0.418)		
			[F=26.42]	[F=25.76]		
Past per capita discounts (cartons)					-4.689	-3.975
					(P=0.005)	(P=0.012)
					[F=24.93]	[F=21.55]
Past per capita discounts (packs)					0.120	0.902
					(P=0.817)	(P=0.077)
					[F=23.87]	[F=19.61]
Future per capita discounts (cartons)					2.323	1.466
					(P=0.021)	(P=0.143)
					[F=23.34]	[F=17.00]
Future per capita discounts (packs)					0.222	0.187
					(P=0.568)	(P=0.612)
					[F=19.30]	[F=19.56]
Constant	1.734	4.493	0.943	2.960	1.110	2.729
	(P=0.000)	(P=0.000)	(P=0.011)	(P=0.000)	(P=0.000)	(P=0.000)
Observations	1029	1029	1029	1029	1029	1029

All models contain market fixed effects and controls for average current discount offers. Models (1), (3), and (5) contain a global time trend; models (2), (4), and (6) contain market-specific time trends. First-stage f-statistics are in brackets.

Table 3: Quantity Results–Implied Discount Rate

	Percent discounted sales	Addictive effect	Discount rate
Base model	0	0.274	0.332
Combined discounts			
None	0	0.410	0.510
Mean	0.019	0.432	0.496
1 std dev above	0.036	0.452	0.485
Pack discounts			
None	0	0.348	0.807
Mean	0.0175	0.364	0.781
1 std dev above	0.0342	0.379	0.759
Carton discounts			
Mean	0.0015	0.342	0.828
1 std dev above	0.0058	0.325	0.891

Results are based on the models with market-specific time trends.

on current consumption and place more weight on future utility than consumers who do not use discounts or consumers who use pack discounts.

As a final quantity analysis, we are interested in how great a role stockpiling plays in our estimates. Carton purchasers must store cigarettes to at least some degree, unless they consume the entire carton immediately following purchase. However, we would like to know whether they buy and store sufficient quantities to affect the estimates of addiction across our six-month periods. To test for this possibility, we examine the effect of a next-period tax increase on consumption. Forward-looking consumers who are able to stockpile should increase current purchases in response to the tax increase. This effect should be particularly strong when firms offer a larger dollar discount for cartons. We therefore add to the model the future tax rate and the future tax rate interacted with the amount of the carton discount and the number of carton discounts offered in the current period. Table 4 presents the results of this model. In the first two columns, we repeat the estimates from columns (5) and (6) of Table 2. In the next two columns, we add the future tax and interactions, using a global time trend and market-specific time trends as in the previous models.

Table 4: Quantity Results–Stockpiling

	(1)	(2)	(3)	(4)
Last pd sales	0.362	0.348	0.266	0.360
	(P=0.000)	(P=0.000)	(P=0.001)	(P=0.000)
Future sales	0.498	0.281	0.585	0.294
	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)
Price (excluding discounts)	-0.083	-0.581	-0.013	-0.529
	(P=0.157)	(P=0.000)	(P=0.843)	(P=0.000)
Past per capita discounts (cartons)	-4.689	-3.975	-5.522	-4.072
	(P=0.005)	(P=0.012)	(P=0.002)	(P=0.011)
Past per capita discounts (packs)	0.120	0.902	-0.606	0.523
	(P=0.817)	(P=0.077)	(P=0.273)	(P=0.324)
Future per capita discounts (cartons)	2.323	1.466	2.518	1.331
	(P=0.021)	(P=0.143)	(P=0.017)	(P=0.178)
Future per capita discounts (packs)	0.222	0.187	-0.086	0.257
	(P=0.568)	(P=0.612)	(P=0.839)	(P=0.483)
Unemployment rate	-0.022	-0.016	-0.019	-0.012
	(P=0.111)	(P=0.360)	(P=0.200)	(P=0.490)
Average pack discount	-0.134	-0.014	-0.189	-0.045
	(P=0.053)	(P=0.852)	(P=0.010)	(P=0.555)
Average carton discount	-0.076	-0.049	-0.075	-0.043
	(P=0.022)	(P=0.158)	(P=0.034)	(P=0.214)
Number of carton offers			0.005	0.001
			(P=0.061)	(P=0.535)
Number of pack offers			-0.001	-0.002
			(P=0.399)	(P=0.062)
Carton discount * future tax increase			0.083	-0.023
			(P=0.789)	(P=0.936)
Number of carton offers * future tax increase			0.004	0.010
			(P=0.475)	(P=0.067)
Future tax change			0.249	-0.098
			(P=0.117)	(P=0.527)
Constant	1.110	2.729	1.072	2.507
	(P=0.000)	(P=0.000)	(P=0.001)	(P=0.000)
Observations	1029	1029	1029	1029

All models contain market fixed effects and controls for average current discount offers. Models (1) and (3) contain a global time trend; models (2) and (4) contain market-specific time trends.

The results show that evidence for stockpiling is fairly weak. The coefficient on the future tax change is insignificant in both models. The future tax interactions with the dollar amount of the carton discount are not significant in either model. The one piece of evidence that does suggest some stockpiling is the interaction between future tax and the number of carton offers, which is positive and marginally significant (P=0.067) in the model with market-specific time trends. Overall, however, stockpiling does not appear to be a major factor in our results across the 6-month time periods that we study. [2]

3.1 Price results

Table 5 contains the results of a regression of price on current and future taxes and the unemployment rate. As expected, price rises when the future tax increases, since the future tax increase results in a decrease in the future profits that result from keeping prices lower today. The magnitudes of the effects, however, are not entirely in keeping with our expectations. We expected that price would increase least for the products where present consumption has the smallest impact on future consumption, i.e. discounted cartons. Further, we expected that price would increase the most for products where present consumption has the greatest effect on future consumption, i.e. discounted packs. The results show that the discounted carton price responds less to an increase in the future tax than does the undiscounted price. However, the discounted pack price responds the least to a future tax increase. This result could suggest that pack discount consumers are more price responsive than other consumers. However, the quantity results did not show a significant difference in price responsiveness across the discount types. We therefore conclude that the results on discounted pack price do not fit with the predictions of our model, while the results on discounted carton price do fit the model predictions.

[2] It is plausible that stockpiling would be a more important factor over shorter time intervals. As we noted previously, Gruber & Koszegi (2001) find evidence of stockpiling in the month prior to a tax increase.

Table 5: Price results

	Undiscounted price		Carton discounted price		Pack discounted price	
	(1)	(2)	(3)	(4)	(5)	(6)
Current tax	0.786	0.919	0.909	0.963	0.457	0.414
	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)
Next pd tax difference	0.314	0.479	0.274	0.389	0.194	0.212
	(P=0.000)	(P=0.000)	(P=0.013)	(P=0.000)	(P=0.002)	(P=0.000)
Unemployment rate	-0.057	-0.078	-0.003	-0.024	-0.046	-0.060
	(P=0.000)	(P=0.000)	(P=0.804)	(P=0.116)	(P=0.000)	(P=0.000)
Constant	2.150	2.132	1.548	1.268	1.651	1.459
	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)	(P=0.000)
Observations	1029	1029	1029	1029	1029	1029

All models contain market fixed effects and controls for average current discount offers. Models (1), (3), and (5) contain a global time trend; models (2), (4), and (6) contain market-specific time trends.

4 Conclusion

Our results suggest some patterns in consumers' use of in-store discounts. Purchasers of discounted cartons appear to experience a smaller effect of past purchases on current purchases, and put a higher value on future utility than other consumers. Purchasers of discounted packs appear to experience a larger effect of past purchases on current purchases and place a lower value on future utility.

Our results suggest that pack discount consumers become more addicted than other consumers and are also less future-oriented, while carton discount consumers become less addicted and are more future-oriented. Given these facts, it is not surprising that pack discounts tend to be multipack (buy-one-get-one-free), since giving these consumers more cigarettes would likely be a more effective strategy to increase their level of addiction than would offering them a dollar discount on a single pack. Likewise, carton discount consumers would be less likely to react to a multi-carton promotion by increasing their level of addiction. For these consumers, cents-off discounts would make more sense because they would make it easier to plan purchasing. Our results also suggest that manufacturers raise prices in response

to future tax increases, indicating that they have some degree of market power. The carton discount price increases less than the overall price, which one would expect since carton discount purchasers respond more weakly to past consumption than do consumers overall. The pack discount price increases less than both the carton discount price and the overall price, which is contrary to our expectations. Future research will be necessary to determine why manufacturers respond as they do.

One additional finding of note in our results is that global time trends do not control sufficiently for secular trends in consumption. This is evidenced in the fact that the coefficient on past consumption is smaller than the coefficient on future consumption in the models with global time trends, implying a discount rate greater than one. In the models with market-specific time trends, on the other hand, the implied discount rate is between zero and one and the predictions of the BGM rational addiction model are supported by the results.

Our results suggest that stockpiling in the cigarette market is not an important factor over a 6-month time period. However, Gruber & Koszegi (2001) suggest that it may be important over shorter time periods (one month, in their study). Hendel and Nevo (2006) show that stockpiling behavior can lead to inaccurate estimates of long-run price elasticities. Thus, researchers should carefully consider the length of the time period when estimating demand models, particularly if they estimate long-run elasticities.

From a policy standpoint, our results suggest that regulators may want to focus more on pack discounts, since these discounts are more likely to increase addiction than carton discounts. Regulating carton discounts is unlikely to have much effect on addiction, since these smokers experience little additional addictive effect from each cigarette they consume.

Finally, we show that discounted sales can be used to reveal important types of heterogeneity in aggregate data. Although we focused on cigarettes as an addictive good, other goods are also habit-forming. For example, while fast food may not be addictive, it is still possible that individuals develop the habit of eating fast food. It would be worthwhile to look more

broadly at habit-forming goods to see where heterogeneity in the degree of habit formation and discounting of future utility may also apply.

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