The impact of government advertising on the market for fruit and vegetables

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Abstract

Governments seek to alter consumption patterns through advertising. If successful, this advertising will impact consumer demand directly. However, in oligopolistic markets firms will likely respond to changes in demand, by altering product prices. In this paper we study one particular government advertising campaign which sought to increase fruit and vegetable consumption (the 5-a-day campaign). We estimate the effect of advertising on fruit and vegetable demand and on firms' equilibrium pricing. Modelling firm response is important as some of the contemporaneous fruit and vegetable price increases could be an endogenous response to the government's advertising, diminishing its effectiveness.

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1 Introduction

Diet related chronic diseases are a major public health concern in most developed countries. In the UK, poor diet is estimated to account for about one-third of all deaths from cancer and cardiovascular disease (FSA (2009)) and almost 60 percent of adults are now classified as either overweight or obese (NHS (2009)). Medical research has identified associations between obesity and a range of illnesses such as heart disease, stroke, high blood pressure, cancers of the colon, breast, and prostate, and diabetes.[1]

Numerous policies aimed at improving diet have been suggested and implemented, including policies that provide consumers with information on the nutritional value of specific foods. One such policy is the communication programme of the 5 A DAY campaign. The intervention aims to increase consumption of fruit and vegetables, and through this reduce the instance of diet related disease. The World Health Organisation (1990) and the UK Committee on Medical Aspects of Food and Nutrition Policy (COMA 1994, 1998) recommend eating at least five portions of fruit and vegetables a day, and the Department of Health (2000) claims that increasing intakes of fruit and vegetables could reduce the risk of deaths from chronic disease such as heart disease, stroke and cancer by up to 20%. Other research suggests increases in fruit and vegetable consumption may also help lower the risk of weight gain, help reduce blood pressure, help the management of diabetes, delay the development of cataracts and improve bowel function (for details see Cullum (2003)).

The 5 A DAY campaign in the UK consisted of television adverts promoting the message to consume at least five portions of fruit and vegetable each day, along with a logo on food products, indicating the number of portions of fruit and vegetables they contain. The national television campaign ran in winter 2004/05. The national nature of the campaign means that a well defined control and treatment group do not exit. We exploit variation in the intensity with which households were potentially treated. Our measure is based on the

[1] Ascherio et al. (1999), Must et al (2000), Stoeckli and Keller (2004).

amount of television households report watching - the more TV a household watches, the higher is the probability that they will have encountered one of the adverts. We embed our intensity of treatment measure into a structural model of consumer demand for fruit and vegetables. This allows us to control for the impact of contemporaneous price trends which may have had confounding effects on demand. As the demand model we use also enables us to identify all the own and cross price elasticities of demand of the products in the (fruit and vegetable) market, we are able (when coupled with an assumption about firm competition) to estimate the supply side of the market. This, in turn, enables us to gauge how much of the price variation was an endogenous response to the government's advertising campaign.

Previous studies (see, for instance, Capicci and Mazzochi (2011)) have used continuous demand models to estimate the impact of the campaign on consumer demand, controlling for contemporaneous changes in prices. However, these studies have treated price variation as exogenous to the campaign. Yet, as in most countries, the UK retail food market is characterised by oligopolistic competition. In this setting firms, depending on how government advertising shifts demand, will reoptimise their prices. We use a structural model of fruit and vegetable demand and supply to estimate not only the initial impact of government advertising on consumer demand, but also the influence on firms' price setting. In an oligopolistic setting, firm response could be a crucial determinant of the effectiveness of a government information campaign.

The paper is structured as follows. Section 2 describes the 5 A DAY campaign. Section 3 outlines a structural model of demand for fruit and vegetables and Section 4 outlines our model of firm behaviour. Section 5 introduces the data and provides some reduced form descriptive evidence of the impact of government advertising on the quantity of fruit and vegetables purchased. Section 6 presents the results and a final section concludes.

2 The 5 A DAY campaign

The national component of the 5 A DAY campaign was the Communications Programme,[2] which aimed to communicate to the general public a clear and consistent message about the health benefits of eating at least five fruits and vegetables each day. As consumers were already likely to be aware of the general health benefits of eating more fruits and vegetables, the campaign focused particularly on clarifying the health implications of increased consumption, specifying what constitutes a portion and the variety of foods that count towards 5 A DAY. The Communications Programme was promoted through a series of TV advertisements run from October 2004 to February 2005. The campaign was also publicised in UK national newspapers through the media coverage, beginning at the campaign's launch in 2001, but with a stark increase in newspaper advertising in 2005 (see Figure 1). The Communications Programme also featured the introduction of a 5 A DAY logo, which did not become widespread until after 2005. Our particular interest lies in evaluating an intensive TV advertising campaign ran as part of the 5 A DAY programme, in winter 2004-05.

2.1 Rationale for government intervention

What role is there for public policy intervention in food markets? Most people would agree that, in general, individuals are best able to decide what foods to eat and when to eat them. The pricing mechanism is an efficient way to allocate scarce resources, and individuals are best able to trade off the costs (price and other costs) and benefits that they derive from consuming a particular food, leading them to consume the quantity and type of food that maximises their utility. So what role is there for public policy? The case for public policy interventions rests on failings in the market that lead consumers to make decisions that are not optimal. The most obvious reasons that consumers may make

[2] These are the Schools Fruit and Vegetable Scheme, Local 5 A DAY initiatives, National/local partners – Government Health Consumer Groups, Work with industry and Communications Programme
(see http://www.nhs.uk/livewell/5aday/pages/5adayhome.aspx/

suboptimal decisions in food consumption are the following:

- Information and cognitive failures: An individual may not have all of the relevant information needed to calculate the full costs and benefits of consumption, or they may fail to appropriately process or make decisions based on the information that they do have.
- Externalities: Some of the costs associated with one individual's consumption may accrue to others, and these additional costs may not be taken into account when the individual decides what or how much to consume.

These types of market failure are present in many markets, and governments intervene in a number of ways to counteract their effects. For example, it is generally accepted that they are present in the markets for alcohol and tobacco (Bernheim and Rangel, 2005; Crawford, Keen and Smith, 2010; Gruber, 2010). Governments intervene in these markets through policies that seek to restrict product availability, increase their relative prices and educate the public of the dangers of (excessive) consumption. Other examples of policies aimed at tackling these types of market failure include taxes levied on fuel, based on the fact that the pollution caused by burning fuel affects not only the individual who makes the purchase decision, and the taxfavoured treatment of pensions, based on the idea that individuals may not be fully informed or do not fully account for the future when making saving and investment decisions.For details of these broad market failure may apply to food markets see Griffith and O'Connell (2010).

3 Demand for fruit and vegetables

We assume that on any given day consumers have a fixed number of potential fruit and vegetable consumption occasions. For each of these consumption occasions the consumer chooses whether or not to consume a portion of fruit or vegetables, and if so which type to consume. We assume that purchase decisions over each consumption occasion are independent of one another, but by allowing for the existence of individual specific preference parameters, we allow

for correlation in the unobserved portion of utility across consumption occasions. As we allow consumers to select the outside option on each consumption occasion, the only restriction imposed by assuming a fixed number of potential occasions is that we place an upper bound on total fruit and vegetable consumption. However, we are free to select an upper bound which is unlikely to prove binding.

Specifically, each household $h \in 1, ..., H$ faces a number of potential fruit and vegetable consumption occasions $t \in 1, ..., T_h$. On each occasion the household must decide a fruit and vegetable type $j \in 0, ..., J$ (where $j = 0$ denotes the option of consuming no fruit or vegetables) and they must choose a retailer $r = 1, ..., R$ from which to purchase their fruit or vegetable. We refer to a product as a particular (j, r) pair. The utility that housheold h obtains on consumption occasion t from the product (j, r) is given by

$$u_{htjr} = \sum_k x_{hjr}^k \beta_h^k + \xi_j + \varepsilon_{htjr}$$

where x_{hjr}^k are $k = 1, \ldots, K$ observable product characteristics (which may vary across decision-maker), β_h^k are individual specific preferences parameters, ξ_j is an unobservable fruit and vegetable type characteristic and ε_{htjr} is an idiosyncratic shock. To capture the impact of unobservable fruit and vegetable type characteristic ξ_j we include J fruit and vegetable type specific constants a_j. We assume that $\beta \sim f(\beta)$ where $f(.)$ is a parametric density function and ε_{htjr} are i.i.d. Type 1 extreme value random variables.

The probability of household h on consumption occasion t choosing product (j, r) is given by:

$$P_{htjr} = \int L_{htjr}(\alpha, \beta) f(\beta) d\beta$$

where $L_{htjr}(\alpha, \beta)$ is the standard logit probability of household h on consumption occasion t choosing product (j, r) evaluated at the parameters β. The contribution of household h to the likelihood function is:

$$l_h = \ln \int \prod_t L_{htjr}(\alpha, \beta) f(\beta) d\beta$$

Letting θ denote the parameters of the multivariate density of individual specific preference parameters, we estimate (α, θ) by maximising the log likelihood function.

3.1 The impact of advertising on demand

We allow for both government and private advertising to impact on consumer demand by including measures of advertising intensity (as well as their interaction with price) in the product characteristics x^k_{hjr}. We allow the impact of advertising on demand to vary across households based on their exposure to advertising.

The literature on the impact of firm advertising on consumer demand (see Bagwell (2007) for a comprehensive survey) highlights two broad forms of advertising. The first, informative advertising, tends to convey information about product existence, price or quality to potentially uninformed consumers. In monopolistic models, this tends to increase demand without changing the price elasticity of demand. In oligopolistic models (e.g. Butters (1977)) this type of advertising tends to intensify competition, making demand more elastic. The second type of advertising, persuasive advertising, seeks to alter consumer tastes and, if successful, tends to make demand for the brand in question less elastic, increasing the advertising firm's market power. We include in our model a measure of the intensity of treatment to government advertising in such a way as to remain agnostic about the various effects that the advertising may have on demand. This ensures that conclusion about the impact of government demand of consumer demand are driven by the data.

4 Firm behaviour

As is common in the empirical industrial organisation literature, we assume that producers set prices and compete in a Bertrand-Nash game, holding the menu

of products on offer constant. See Nevo (2001) for example. Let $S_{jrm}(p_m)$ be the market share of product (j,r) in market m when the vector of prices in the market is p_m. Let F_r be the set of products sold by retailer r. Then, the profits for retailer r in market m are given by

$$\Pi_{rm} = \sum_{j \in F_r} (p_{jrm} - c_{jrm}) N_m S_{jrm}(p_m) - K_{jrm}.$$

where c_{jrm} is the marginal cost of product (j,r) in market m, K_{jrm} is the fixed cost of selling the product in market m and N_m is the size of the market.

In this setting, the vector first-order conditions for retailer r are given by

$$S_{jrm}(p_m) + \sum_{k \in F_r} (p_{krm} - c_{krm}) \frac{\partial S_{krm}(p_m)}{\partial p_{jrm}} = 0 \tag{1}$$

for all $j \in F_r$.

We use the first-order conditions to estimate retailers' marginal costs and to compute counterfactual equilibria. Since we observe p_m and estimate $\left(S_{jrm}, \frac{\partial S_{jrm}}{\partial p_{krm}}\right)$ for all $j \in F_r$ and $k \in F_r$ and for all r, we can recover marginal costs. For each r, we recover the marginal cost of each product in each market, c_{jrm} by inverting the system of equations (1). After computing c_{jrm} for all j, r and m, we simulate counterfactual equilibria.

5 Data

We use data from the Kantar World Panel. The data are a nationally representative panel. We use information on approximately 24,750 households over the period 2002-2006.

Households record purchases of all food and drink products brought into the home using a hand held scanner. They also send their till receipts to Kantar. The data contain details of the products households purchase, including the price paid, store shopped in and quantity purchased. Households stay in the sample for potentially many years. We use data on the longest period over which the household reports purchases consistently. The average period of time for which a household is in the sample is 45 weeks. The data also contain details

on the individual products purchased (at the barcode level) as well as household characteristics. See Leicester and Oldfield (2009) for further information on the purchase data, and Griffith and O'Connell (2009) for further discussion of the nutrition data.

Our main interest is in fruit and vegetable purchases. From the information on individual purchases, we compute the average number of portions of fruit and vegetables per household member per day that each household purchases. We use the official government definition of a portion of fruit and vegetables: a portion is 80g of fresh, dried or tinned fruit (in natural juice) or 80g of vegetable (fresh, cooked or frozen), excluding potatoes. 150ml of unsweetened fruit juice counts as one portion. Food products that contains added salt, sugar or fat do not count towards the 5 A DAY. For each household we compute the average number of portions they purchase in each month.

To gauge the impact of government advertising on households' demand for fruit and vegetables we include in our demand system a measure of the intensity with which household were treated. This is based on the number of hours of television they report watching in an average day. The idea is that the more TV households report watching, the higher is the changes that they will have encountered one of the government's adverts. Table 1 details the distribution of the average number of hours spend watching TV across households. We regard a household who watched more TV than the median household (i.e. more than 3.5 hours on average per day) to have high TV viewing.

Table 2 shows the mean number of portions of fruit and vegetables per week that households purchase, according to their composition and their socioeconomic status. It shows that after controlling for composition, households from higher socioeconomic groups tend to purchase more portions of fruit and vegetables.

6 Results

6.1 Demand estimates

Table 3 contains preminary estimates from our demand model (it does not report seasonal effects and product fixed effects), under the assumption that $\beta \sim N(b, W)$. Fruit and vegetable type fixed effects interacted with quarter dummies are not reported. The estimates indicate a large degree of heterogeneity in household preferences.

6.2 Elasticities

[To be completed]

6.3 Supply estimates

[To be completed]

7 Conclusions

[To be completed]

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Table 1: Distribution of number of hours of TV households report watching

How many hours do you spend watching TV?	Number of households	% of households	Cumulative sum
Under 1 hour	347	1.74	1.74
1-2 hours	3,756	18.78	20.52
2-3 hours	5,653	28.27	48.78
3-4 hours	4,539	22.7	71.47
4-5 hours	3,127	15.64	87.11
5-6 hours	1,299	6.5	93.61
6-7 hours	559	2.79	96.4
7-8 hours	276	1.38	97.78
8-9 hours	137	0.69	98.47
Over 9 hours	307	1.53	100

Notes: Data based on response to survey question.

Table 2: Average number of portions of fruit and vegetable households purchase per week, by household composition and socioeconomic group

Household composition	Socioeconomic group			Total
	A-B	C1-C2	D-E	
Household with kids	48.13	42.94	36.91	42.05
	(735)	(4396)	(1629)	(6760)
Elderly household	39.64	39.79	37.24	38.38
	(412)	(2136)	(3090)	(5638)
Other households	43.82	39.3	35.47	38.73
	(736)	(4861)	(2005)	(7602)
Total	44.59	40.8	36.64	39.76
	(1883)	(11393)	(6724)	(20000)

Notes: Numbers report the average number of portion of fruit and vegetables households report buying per week in a given month. Numbers are based on random sample of 20000 household-months. Number of observations given in parenthesis.

Table 3: Estimation results

	Mean		Standard deviation	
Variable	Coefficient	Standard Errors	Coefficient	Standard Errors
price	-0.541	0.062	0.948	0.020
Asda	-2.902	0.144	4.063	0.104
Morrisons	-3.500	0.155	4.984	0.133
Sainsburys	-3.015	0.137	3.956	0.107
Tesco	-1.069	0.087	3.297	0.075

Asda/Morrisons/Sainsbury/Tesco=1 if household shopped in Asda/Morrisons/Sainsbury/Tesco
Normal distribution assumed for random coefficients.
Mixed logit includes product fixed effect interacted with seasonal dummies (not reported).

Figure 1: Number of times 5-a-day mentioned in national newspapers