The impact of 5 a day

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Motivation

- Diet related disease is a major concern in most developed countries
- World Health Organization recommends eating at least 5 portions of fruit and vegetables as means of reducing chronic disease
- Principle response of many governments is to increase the provision of information

Motivation

- UK introduced 5 A DAY information campaign in 2001
- What impact did it have on fruit and veg consumption?
- Confounding factors to evaluation:
  - national campaign, no natural control group, so difficult to control for general time trend in preferences for fruit and vegetables
  - exogenous variation in prices
  - endogenous response by firms to the policy - pricing and private advertising

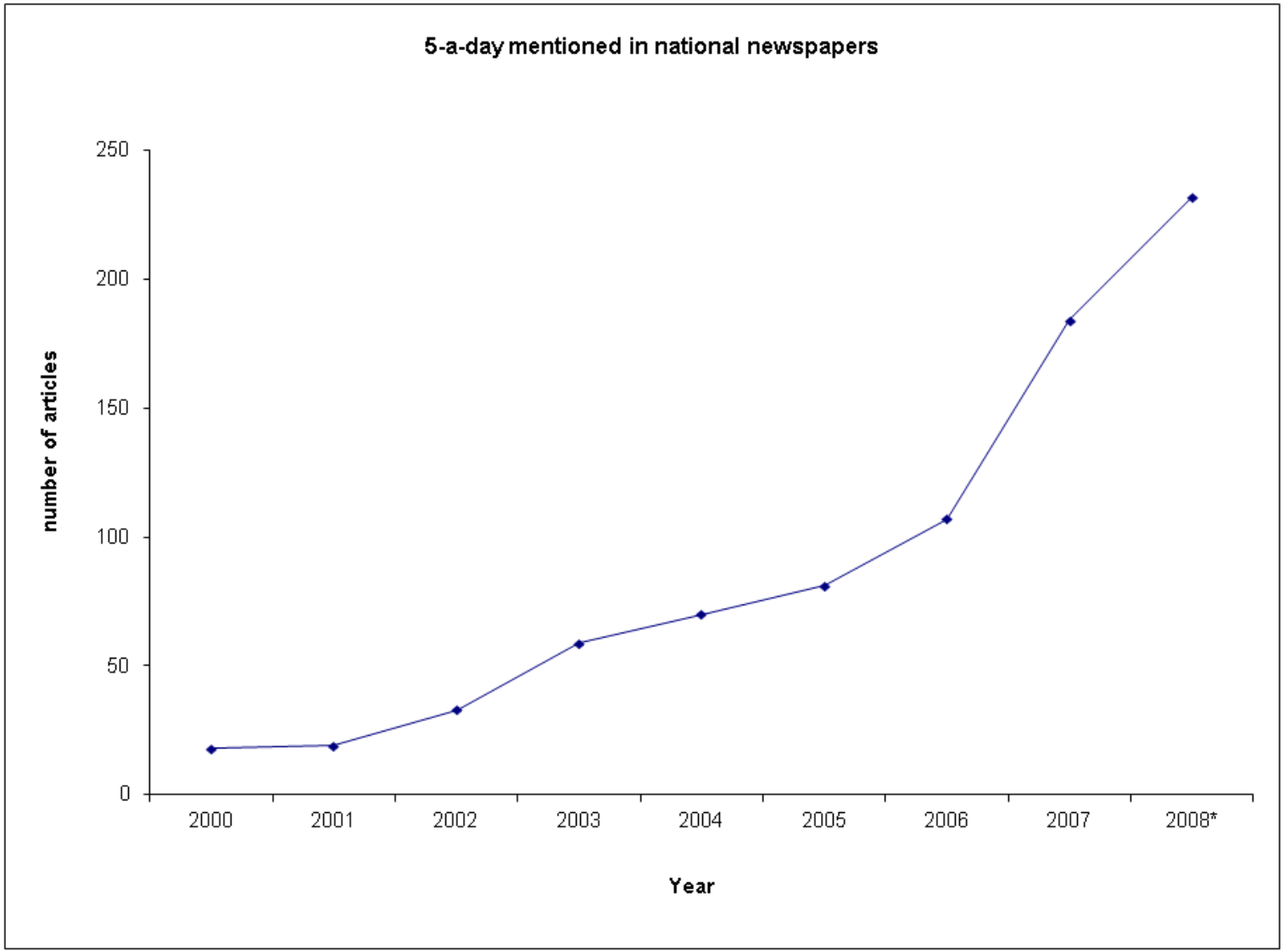
Outline of talk

- Describe 5 A DAY
- Look at data
  - purchases of fruit and veg
  - prices
  - advertising
- Discuss how to model demand (and supply) of fruit and veg
- Present some preliminary estimates
- Outline where we are heading

The 5 a day campaign

- Several strands to the campaign
  - Schools fruit and veg scheme
  - Small scale community initiatives
  - The Communications Programme
  - Encourage voluntary labelling by firms
- The Communcations Programme is our main focus
- TV information campaign run from August 2004 to July 2006
- Adverts were run on commercial TV and promoted consumption of 5 portions of fruit and vegetables a day

Mentions of 5-a-day in the press



- Notes:

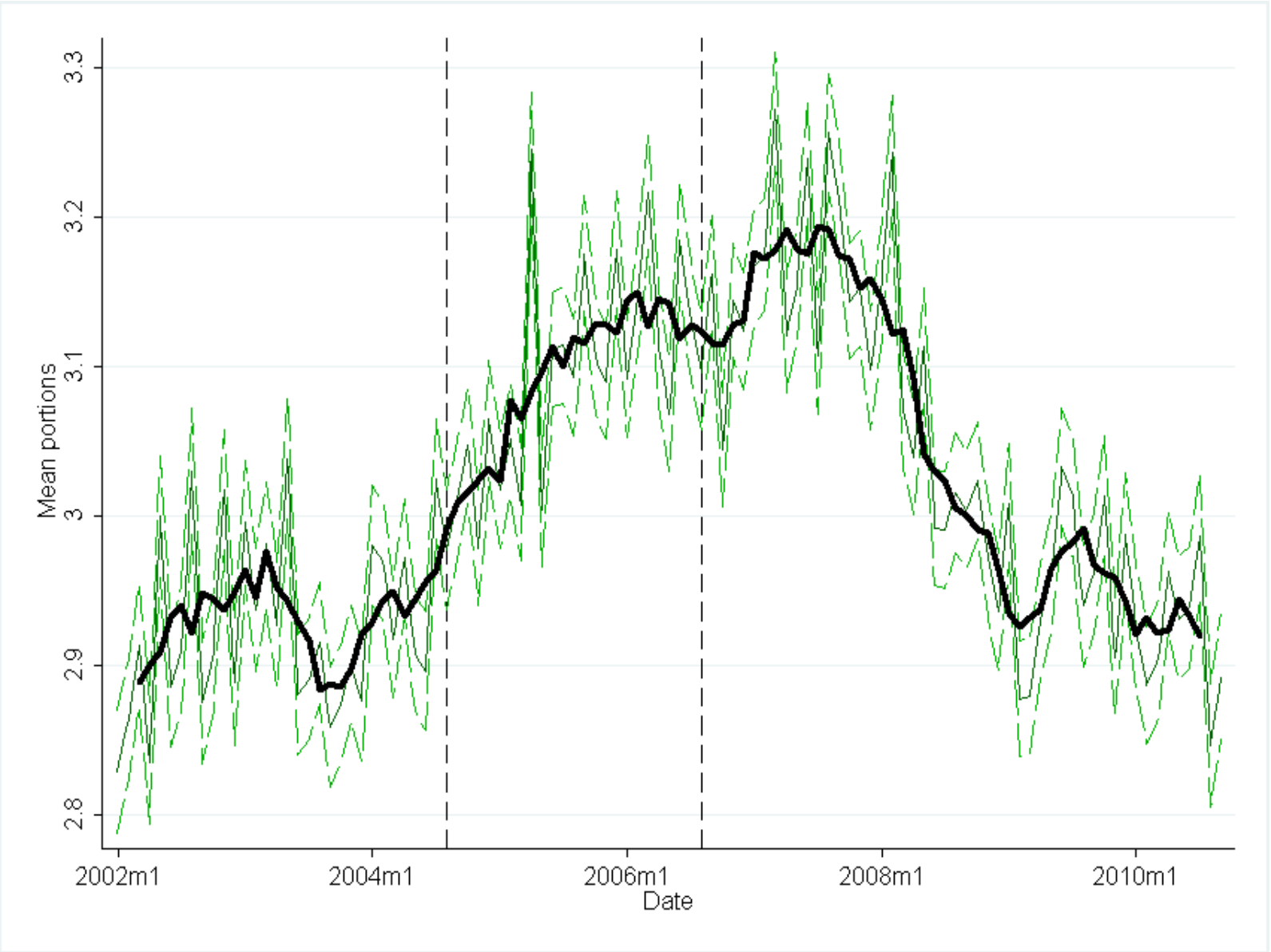
Data on purchases

- Detailed data at individual product and transaction level
- Information on product, price, quantity and store
  - e.g. household A bought a 1 kg bag of Cox Apples at Tesco on Goodge St in London for £2.49
- Contains all purchases of food for consumption in the home, 2002-2010
- Approx. 15,000 households at any point in time, households remain in sample for several years
- Collected by market research firm TNS (now called Kantar) using scanners in the home
- Demographic and self-reported behavioural information from households

What are fruit and vegetables?

- What counts is clearly defined in 5 A DAY campaign
- Fruit
  - Apples, Bananas, Canned fruit, Citrus fruits, Fruit juice (max 1 portion), Pears, Berries, Apricots, Nectarines Peaches Plums, Cherries, Grapes, Tropical fruit
- Vegetables
  - Brassicas (Broccoli, Cauliflower, Cabbage, Brussel Sprouts), Greens, Canned and Frozen Veg, Legumes, Tomatoes (actually a fruit!), Mushrooms, Carrots, Onions, Other Root Veg, Salad, ...
- Not potato, ketchup, pizza, processed fruit or veg that has substantial amounts of added sugar, salt or fat
- A portion is 80g, or approx. what fits in a the palm of your hand

Mean fruit and veg portions purchased per person

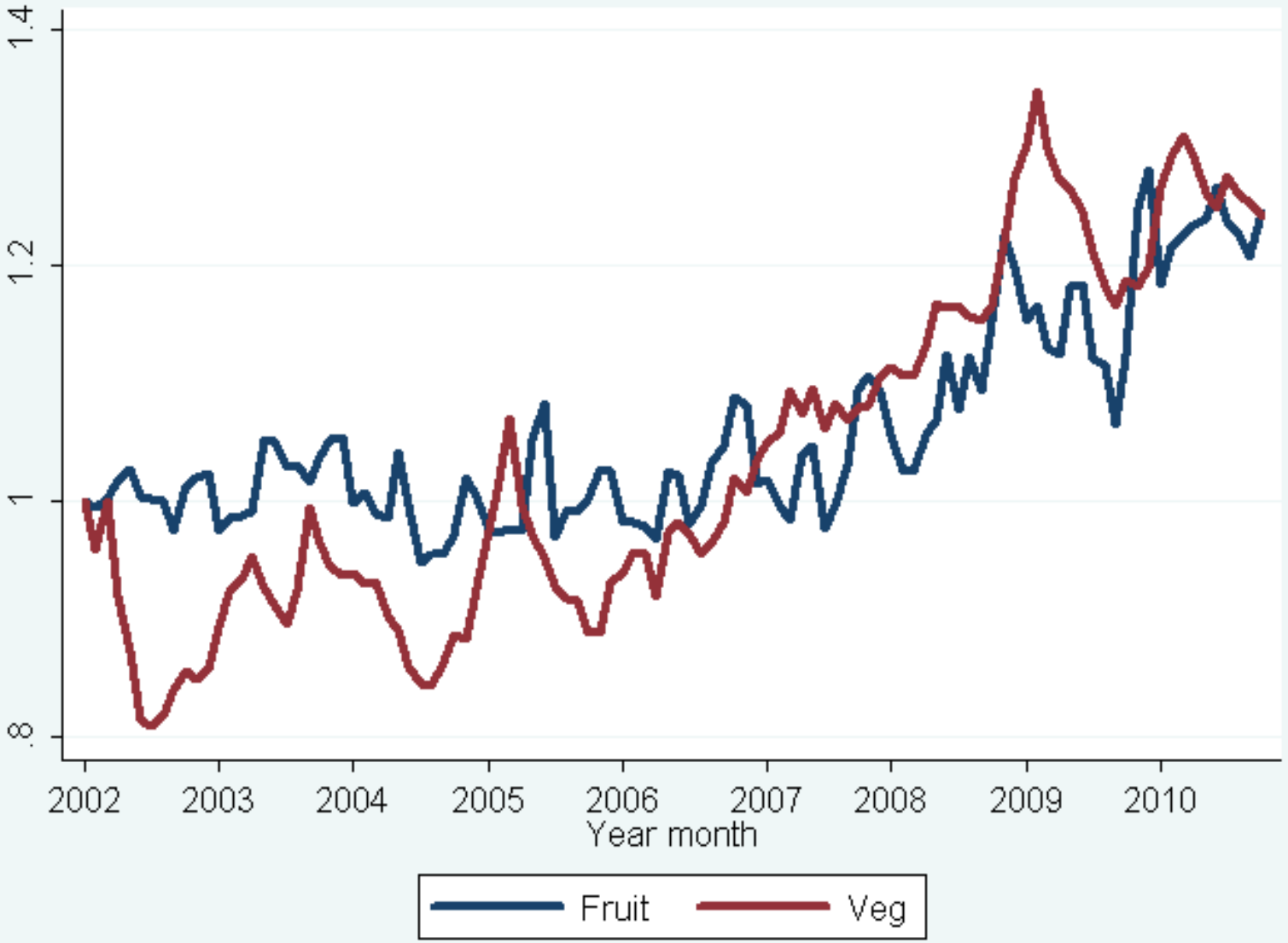


Notes: Mean deseasonalised fruit and vegetable portions purchased per household member per day

Fruit and vegetable portions

- Mean ranges from 2.9 to 3.2, well below recommended 5 a day
- Very low for households with kids, below 2 portions per person per day
- Increase in mean during Communications Programme and just after, but then dramatic decline

Retail price index for Fruit and Vegetable



Notes: Fruit and vegetable components of office RPI

Purchases of fruit and veg portions

Table 1

Dep var: purchases of	(1) fruit and veg portions	(2) fruit and veg portions	(3) fruit and veg portions	(4) fruit portions	(5) veg portions
(Aug 2004	-0.0283***				
- Nov 2010)	(0.0034)				
(Aug 2004		0.0555***	0.0894***	0.0576***	0.0225***
- July 2006)		(0.00384)	(0.00387)	(0.00224)	(0.00243)
(Aug 2006		-0.0980***	0.276***	0.0845***	0.101***
- Nov 2010)		(0.00370)	(0.00689)	(0.00315)	(0.00422)
Price fruit			-1.451***	-0.731***	
			(0.0303)	(0.0157)	
Price veg			-0.702***		-0.769***
			(0.0274)		(0.0153)
Constant	3.072***	3.085***	5.250***	2.143***	2.437***
	(0.00290)	(0.00490)	(0.0307)	(0.0163)	(0.0153)
Observations	1,076,736	1,076,736	1,076,736	1,076,736	1,076,736
Number of hhno	32,530	32,530	32,530	32,530	32,530
HH Effects	Yes	Yes	Yes	Yes	Yes
Month	Yes	Yes	Yes	Yes	Yes

Note: An observation is a household month.

What drove dramatic and sustained price increase?

- Food prices rose around the world, but they rose more and stayed higher in the UK
  - commodity prices increased worldwide
  - depreciation of sterling
- Griffith, O'Connell and Smith (2011) investigate the extent to which input prices explain consumer prices
  - domestic and imported producer prices
  - labour costs
  - fuel costs
- Estimate suggest that for fruit and veg they do not fully explain consumer price increase

What drove dramatic and sustained price increase?

$$\Delta lnp_t^c = \alpha + \sum_{k=0}^{3} \beta_k \Delta(lnp_{t-k}^p) + \gamma_1 \Delta(lnw_t) + \gamma_2 \Delta(lnf_t) + \sum_{q=1}^{3} \delta_q D_q + \epsilon_t \quad (1)$$

p_t^c : consumer price
p_t^p : producer price
w_t : retail wage
f_t : fuel price
D_q equals 1 for quarter q
$\sum_{k=0}^{3} \beta_k$: elasticity of consumer price wrt producer price

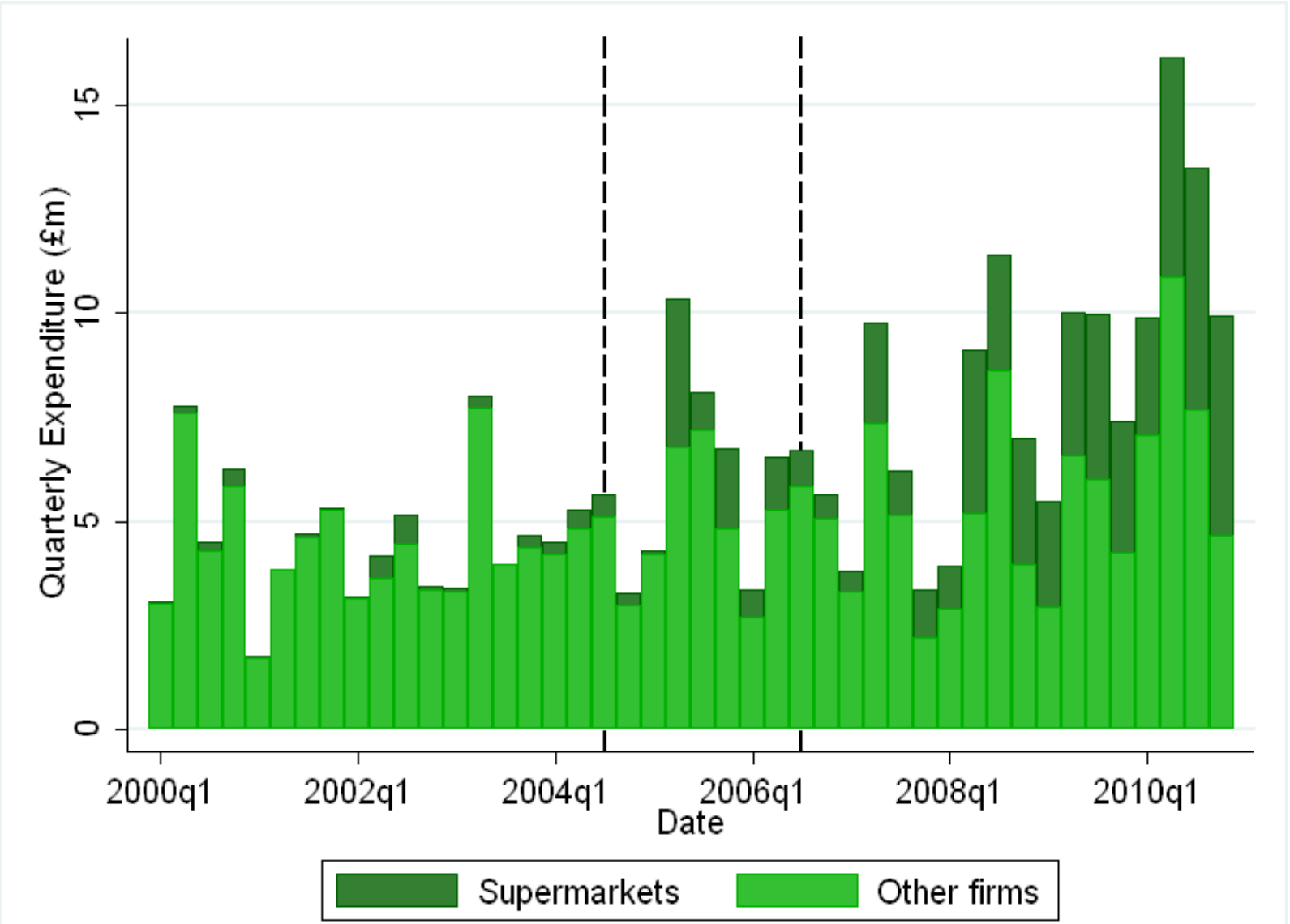
What drove dramatic and sustained price increase?

Δlnp_t^c	Fruit	Vegetables
Δlnp_t^p	0.187	0.164
	(0.157)	(0.057)
Δlnp_{t-1}^p	0.141	0.166
	(0.152)	(0.057)
Δlnp_{t-2}^p	0.016	0.076
	(0.145)	(0.056)
Δlnp_{t-3}^p	0.081	0.096
	(0.150)	(0.056)
Δlnw_t^p	-0.160	-0.065
	(0.160)	(0.125)
Δlnf_t^p	-0.039	-0.105
	(0.118)	(0.091)
R^2	0.308	0.297
$\sum_{k=0}^{3} \beta_k$	0.425	0.501
p-value $\sum_{k=0}^{3} \beta_k = 0$	0.201	0.0000
p-value $\sum_{k=0}^{3} \beta_k = 1$	0.085	0.0000

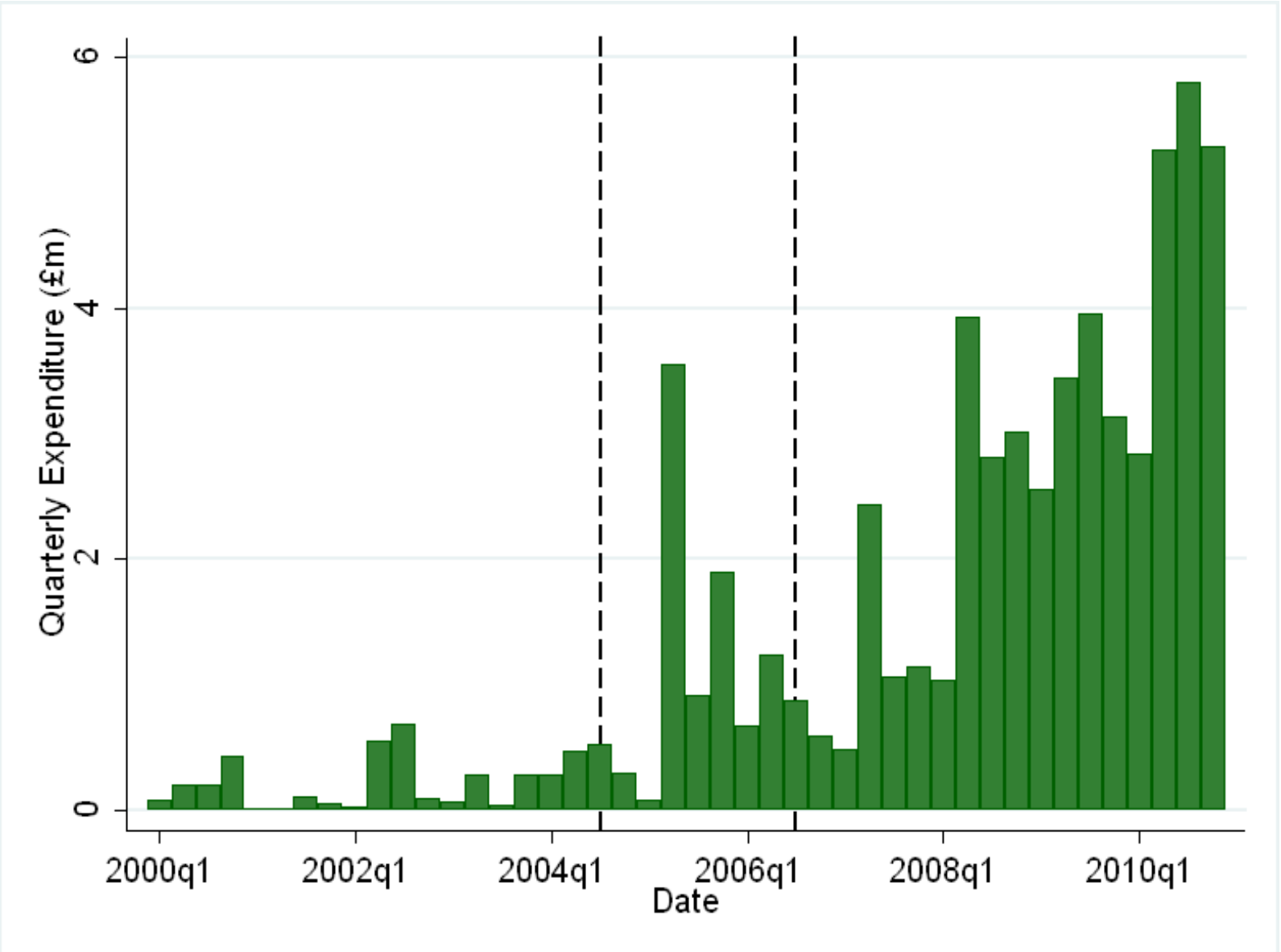
Private advertising

- Firms also advertise
- Data on all expenditure on TV, radio, press and internet advertising in the UK, 2002-2010
- Collected by Nielsen in Advertising Digest
- We identify advertising on
  - fruit and veg, other foods
  - by big four retailers and by others
- The big four retails substantially increased advertising expenditure following the government 5 A DAY advertising campaign

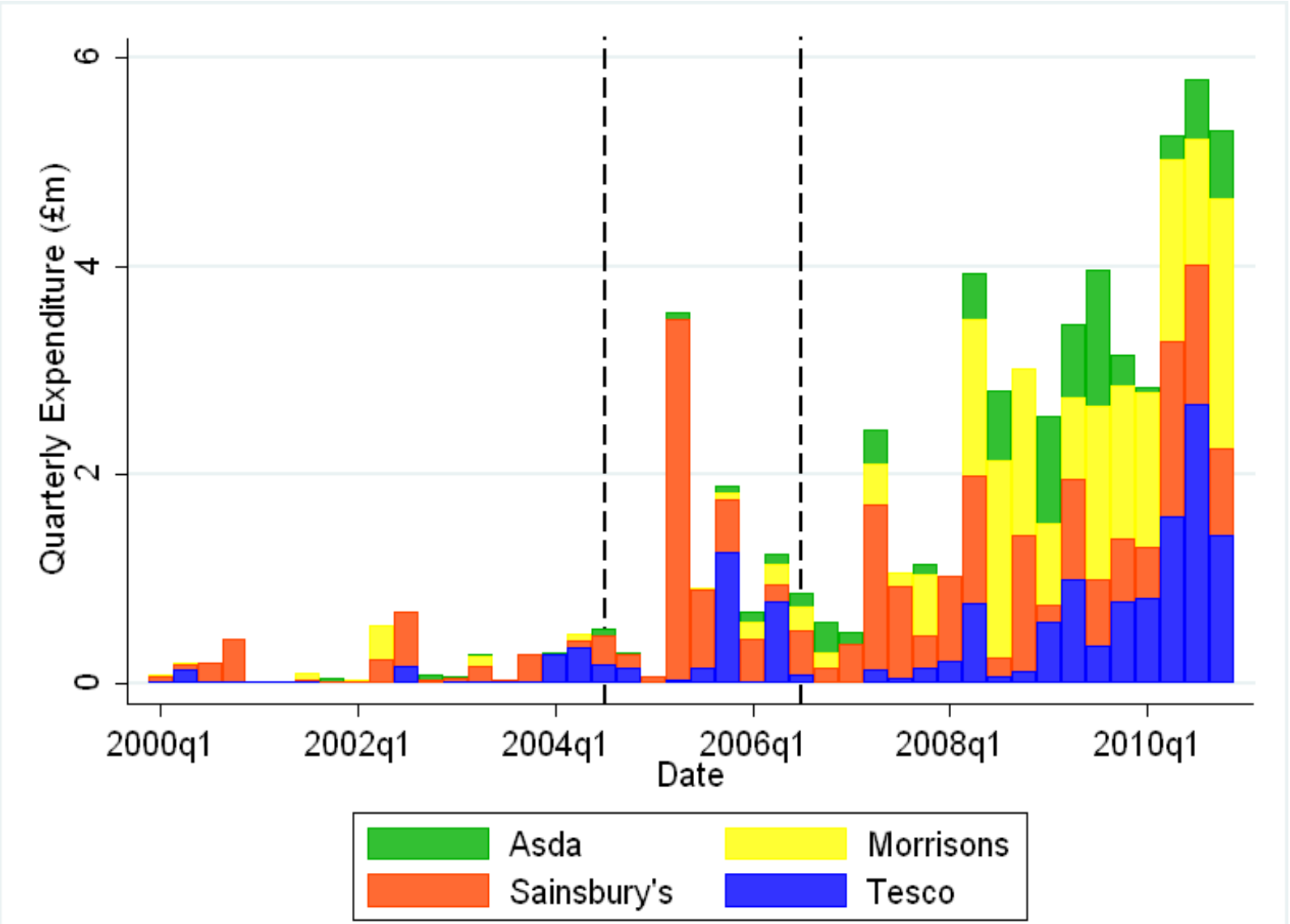
Advertising expenditure on fruit and veg by producers and retailers



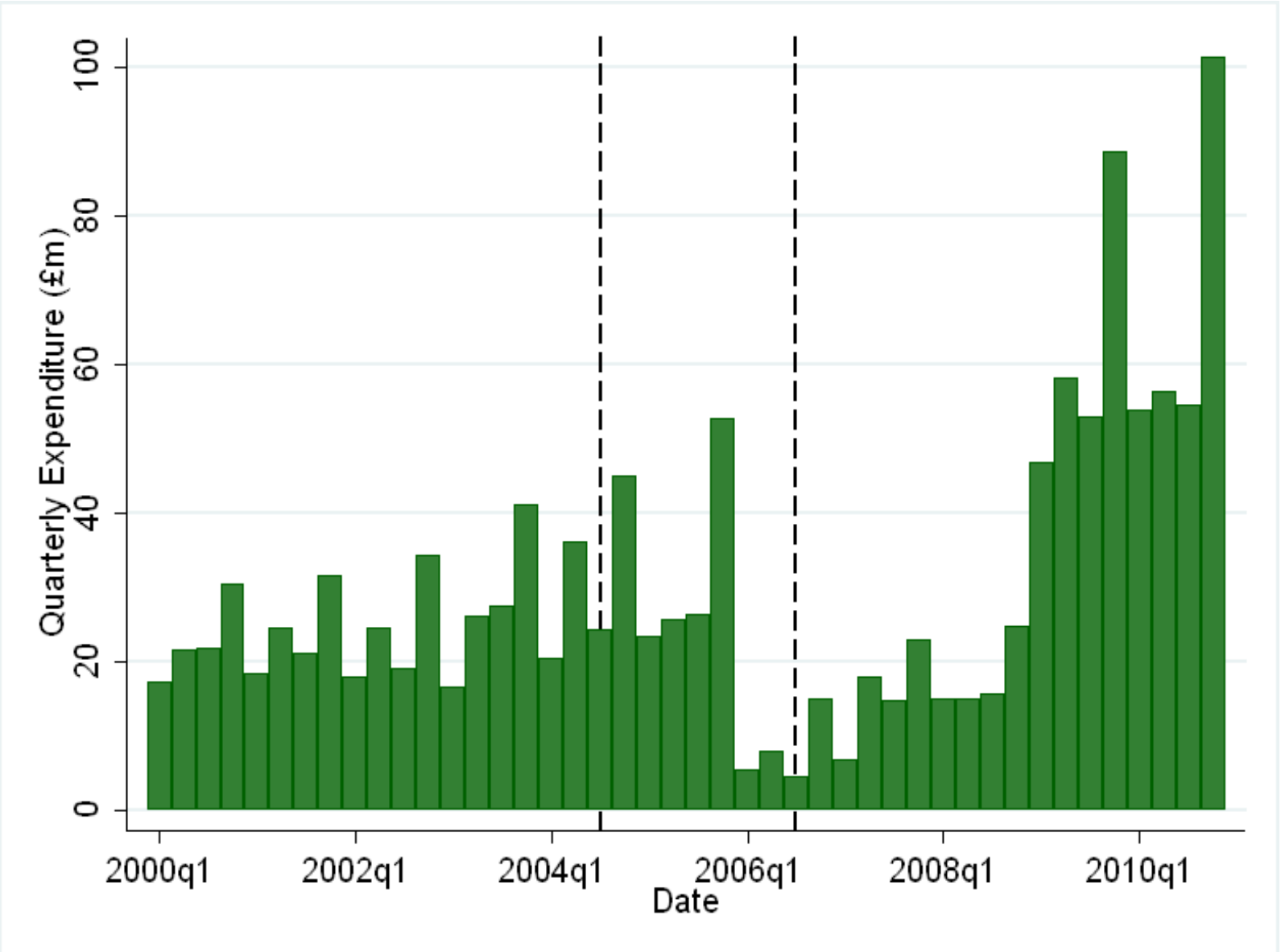
Advertising expenditure on fruit and veg by big four retailers



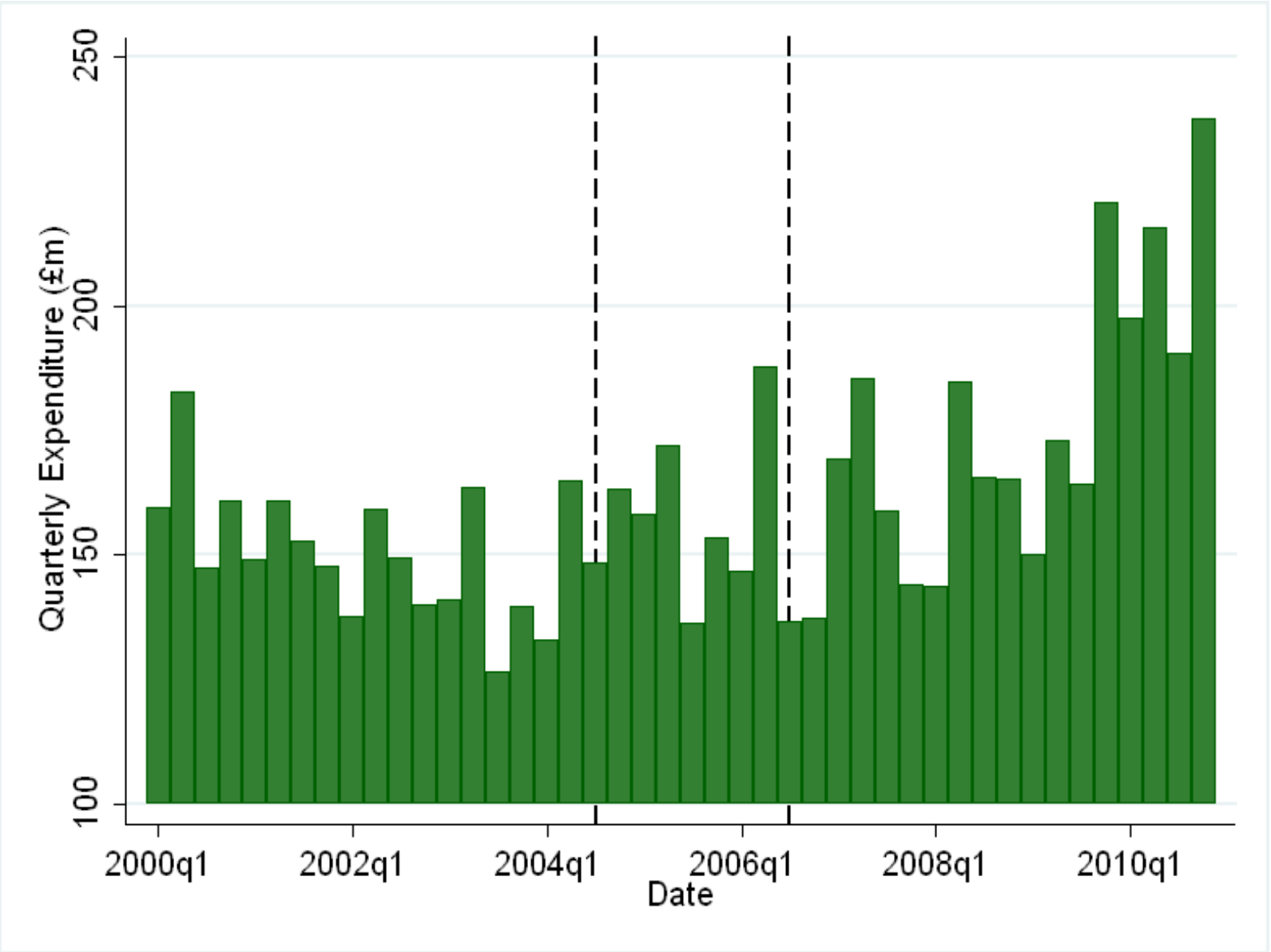
Advertising expenditure on fruit and veg broken down by big four retailers



Advertising expenditure on food excl fruit and veg by big four retailers



Total food advertising by all firms



Notes: Data from Nielsen Advertising Digest; includes all expenditure on TV, press, outdoor, radio and cinema advertising in the

Estimating demand

- Government information may shift and/or tilt the demand curve facing individual firms
- This will elicit a change in equilibrium prices in an oligopolistic market (like the UK food market)
- How equilibrium prices change depends on how the firm level demand curves shift
- To get a complete view on the impact of 5 a day will need to incorporate these equilibrium effects

Impact of advertising

- Government advertising is captured by a time effect
- Private advertising measured by expenditure; include advertising by retailer visited, and separately advertising by all other firms
- Both government and private advertising may shift demand curve facing retailers by
  - changing the intercept
  - changing the slope
  - changing the composition of consumers shopping in a given retailer

Structure of model

- How to estimate firm level demand curve?
- 1000s of products, pricing decision largely taken by retailer
- Purchases vary in quantity
- Use a discrete-continuous model of consumer demand
  - Consumers choose between the stores
  - Conditional on store choice, consumer chooses quantity of fruit and vegetables
- Fruit and vegetable advertising influences decision through impact on within store indirect utility
- All other (non-fruit and vegetable) store advertising included as a store characteristic

Demand model

- Use a discrete-continuous model of consumer demand
- Conditional on choice of store (s), household (h) chooses optimal quantity of product j (fruit, vegetables and other food): $q_{hsj} = f(p_{hs}, y_h; \theta_h)$
  - Decision yields conditional indirect utility $V(p_{hs}, y_h; \theta_h)$
- Consumers choose the store which maximises their payoff
  - $max_s U_{hs} = g(V(p_{hs}, y_h; \theta_h), x_{hs}; \zeta_h)$
  - q_{hsj} : quantity of good j demanded by household h in store s
  - p_{hs} : price in household's basket in store s
  - y_h : income of household h
  - θ_h : household h's preference parameters over goods
  - x_{hs} : characteristics of store s (e.g. distance, size)
  - ζ_h : household h's preference parameters over stores

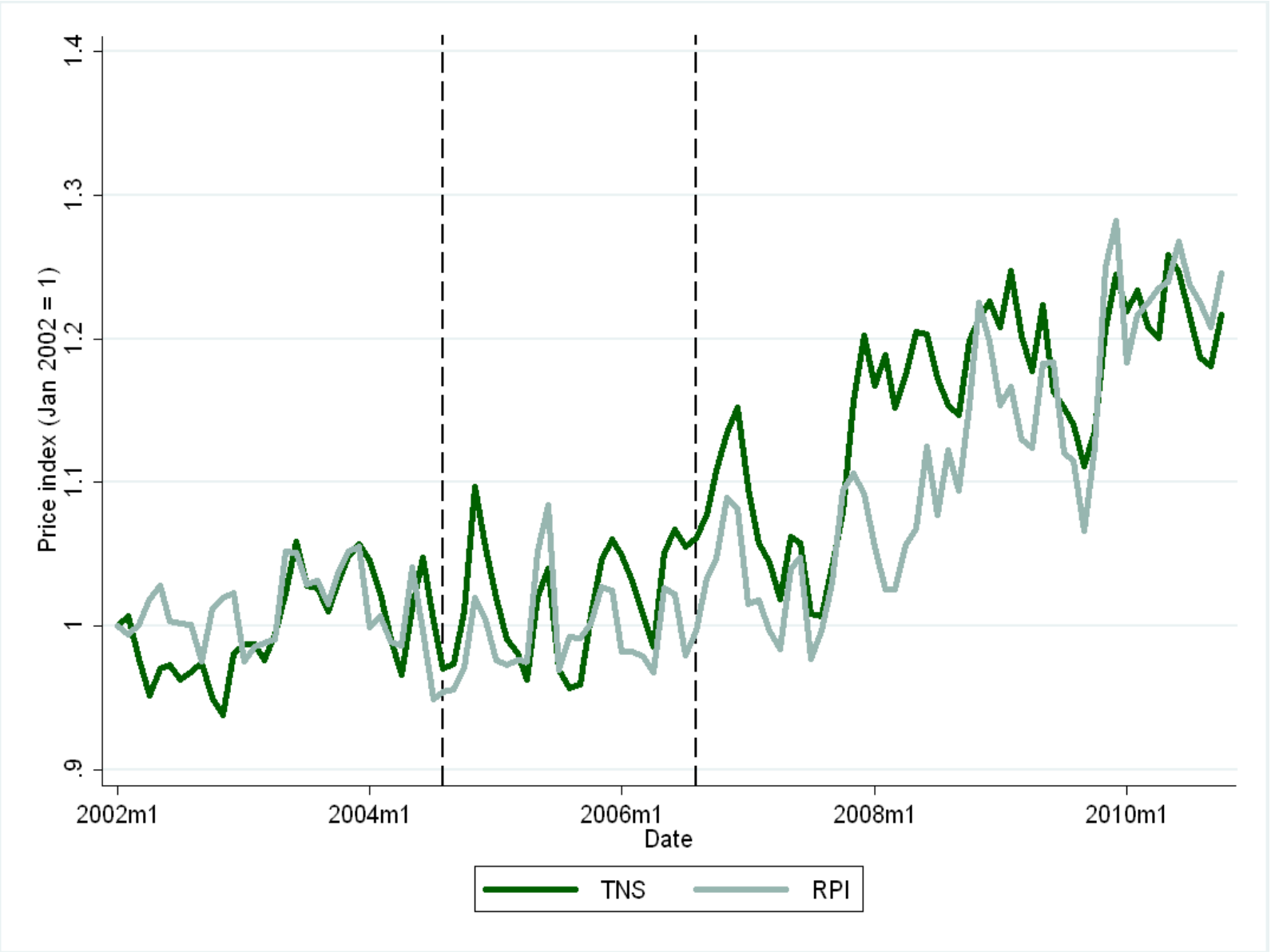
Demand model

- Assume AIDS functional form for demand conditional on store choice
  - Estimated at the shopping trip level
  - Use trips on which both fruit and vegetables are purchased
  - Estimate trip expenditure share of fruit, vegetables and other food, as a function of fruit, vegetable and other food prices and total trip expenditure
- Logit specification for store choice
- Incorporate heterogeneity in preferences across different household types

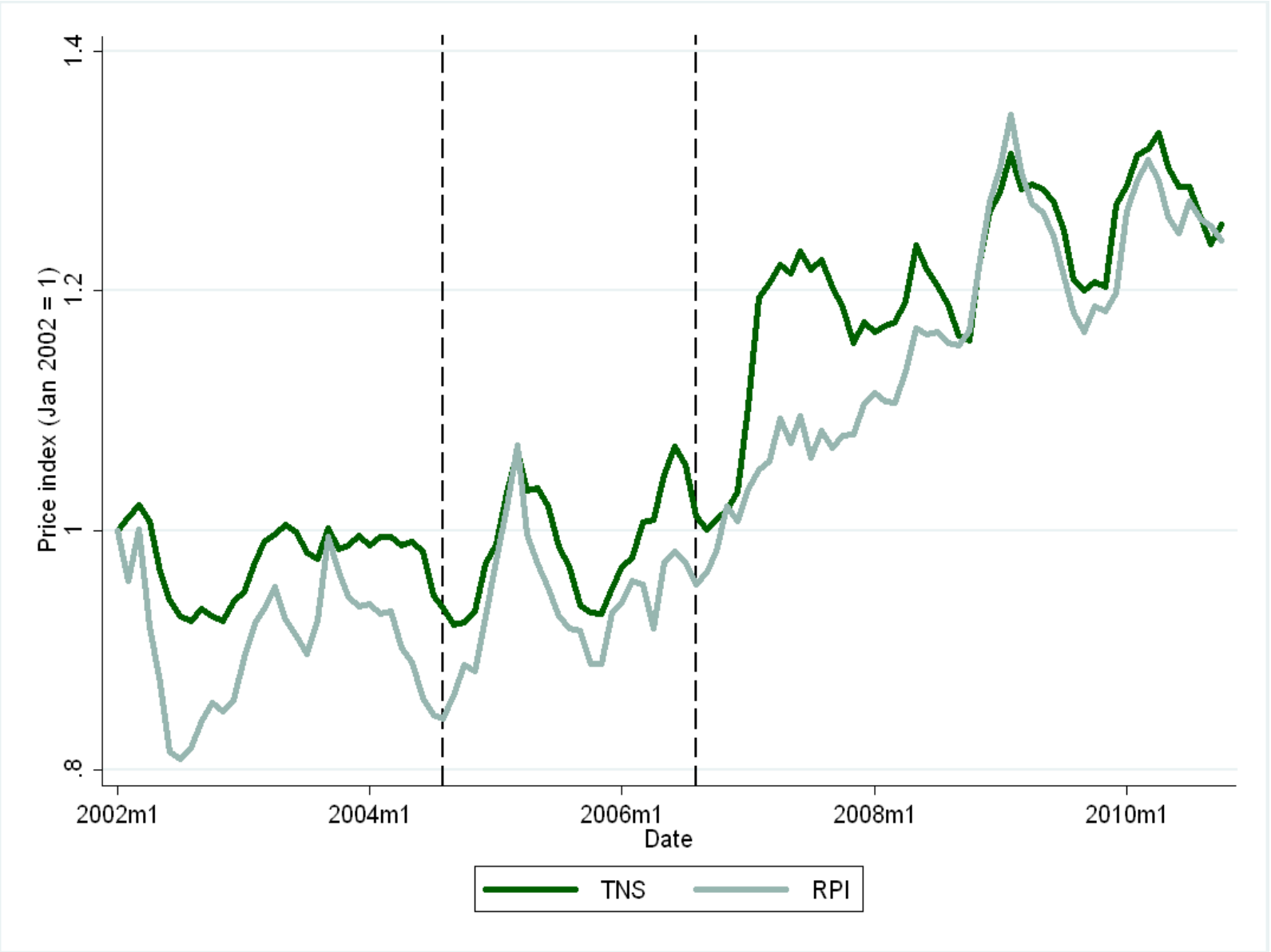
Construction of prices

- 1000s of different fruit and vegetable products in data
- We define 15 fruit and 14 vegetable categories (e.g. apples, bananas, broccoli, ...) and compute mean price paid in each **store, month, region**
- Compute share of expenditure on each category for each **household demographic group and region - we plan to do by household**
- Compute fruit price in store s at time t in region r (for demographic group d) as
  $\pi_{fstrd} = \sum_{c=1}^{15} p_{cstr} \bar{w}_{crd}$
- So in each region and for each demographic group the price of fruit differs across stores and time

Comparison with RPI - Fruit



Comparison with RPI - Vegetables



AIDS share equation

- Take household h (from demographic group d)
- Facing government and firm advertising a
- Expenditure share when in store s on fruit, denoted f (vegetables and other food are denoted v and o) is
  $w_{hsf} = \alpha_f^d(a) + \gamma_{ff}^d(a)\ln(p_{fstrd}/p_{ostrd}) + \gamma_{fv}^d(a)\ln(p_{vstrd}/p_{ostrd}) + \beta_f^d \ln(y_h/\pi(p_{strd}))$
- Where:
  - $\alpha_f^d(a) = \alpha_f^{dt} + \alpha_f^{ds} a_{ft}^s + \alpha_f^{d-s} a_{ft}^{-s}$
  - $\gamma_{ff}^d(a) = \gamma_{ff}^{dt} + \gamma_{ff}^{ds} a_{ft}^s + \gamma_{ff}^{d-s} a_{ft}^{-s}$
  - $\gamma_{fv}^d(a) = \gamma_{fv}^{dt} + \gamma_{fv}^{dfs} a_{ft}^s + \gamma_{fv}^{df-s} a_{ft}^{-s} + \gamma_{fv}^{dvs} a_{vt}^s + \gamma_{fv}^{dv-s} a_{vt}^{-s}$

Elasticities

- Demand model yields estimates of the own and cross price elasticities of fruit and vegetables across 4 price setting firms (Asda, Morrisons, Tesco, Sainsbury's)
- For instance, for a given household the own price elasticity of fruit (f) in store s is:
  $\epsilon_{fs} = \left(\frac{\partial Pr(S=s)}{\partial V_s}\frac{\partial V_s}{\partial p_{fs}}\right)\frac{p_{fs}}{Pr(S=s)} + \left(\frac{\partial q(f|s)}{\partial p_{fs}}\right)\frac{p_{fs}}{q(f|s)}$
- i.e. % change in fruit demand conditional on being in store **plus** % change in probability of visiting store due to change in indirect utility from shopping there

Coefficient estimates

	Pensioner		No kid		Kids	
VARIABLES	w_f	w_v	w_f	w_v	w_f	w_v
pre5ADAY	0.447***	0.381***	0.438***	0.397***	0.408***	0.349***
	(0.00122)	(0.00141)	(0.00100)	(0.00124)	(0.000934)	(0.00116)
5ADAY	0.453***	0.380***	0.445***	0.404***	0.415***	0.360***
	(0.00125)	(0.00149)	(0.00103)	(0.00132)	(0.000945)	(0.00122)
post5ADAY	0.459***	0.386***	0.446***	0.413***	0.424***	0.372***
	(0.00124)	(0.00147)	(0.00103)	(0.00130)	(0.000951)	(0.00119)
adstore_f	0.0137***		0.000472		0.00404*	
	(0.00348)		(0.00261)		(0.00235)	
adother_f	0.000470		0.00408***		0.00393***	
	(0.000821)		(0.000668)		(0.000598)	
adstore_v		-0.00129		0.0256***		-0.0207**
		(0.0105)		(0.00917)		(0.00807)
adother_v		-0.00789***		-0.00689***		-0.00888***
		(0.00205)		(0.00181)		(0.00161)
lnp_f_pre5ADAY	0.0364***	0.0308***	0.0459***	0.0288***	0.0482***	0.0258***
	(0.00304)	(0.00217)	(0.00199)	(0.00159)	(0.00173)	(0.00141)
lnp_f_5ADAY	0.0428***	0.0188***	0.0400***	0.0248***	0.0407***	0.0247***
	(0.00296)	(0.00216)	(0.00207)	(0.00167)	(0.00175)	(0.00142)
lnp_f_post5ADAY	0.0533***	-0.00529***	0.0477***	0.00942***	0.0516***	0.000359
	(0.00194)	(0.00148)	(0.00156)	(0.00124)	(0.00142)	(0.00111)
lnp_v_pre5ADAY	0.0308***	0.0490***	0.0288***	0.0531***	0.0258***	0.0582***
	(0.00217)	(0.00227)	(0.00159)	(0.00184)	(0.00141)	(0.00171)
lnp_v_5ADAY	0.0188***	0.0589***	0.0248***	0.0457***	0.0247***	0.0504***
	(0.00216)	(0.00253)	(0.00167)	(0.00210)	(0.00142)	(0.00190)
lnp_v_post5ADAY	-0.00529***	0.0512***	0.00942***	0.0280***	0.000359	0.0312***
	(0.00148)	(0.00176)	(0.00124)	(0.00148)	(0.00111)	(0.00133)

Coefficient estimates

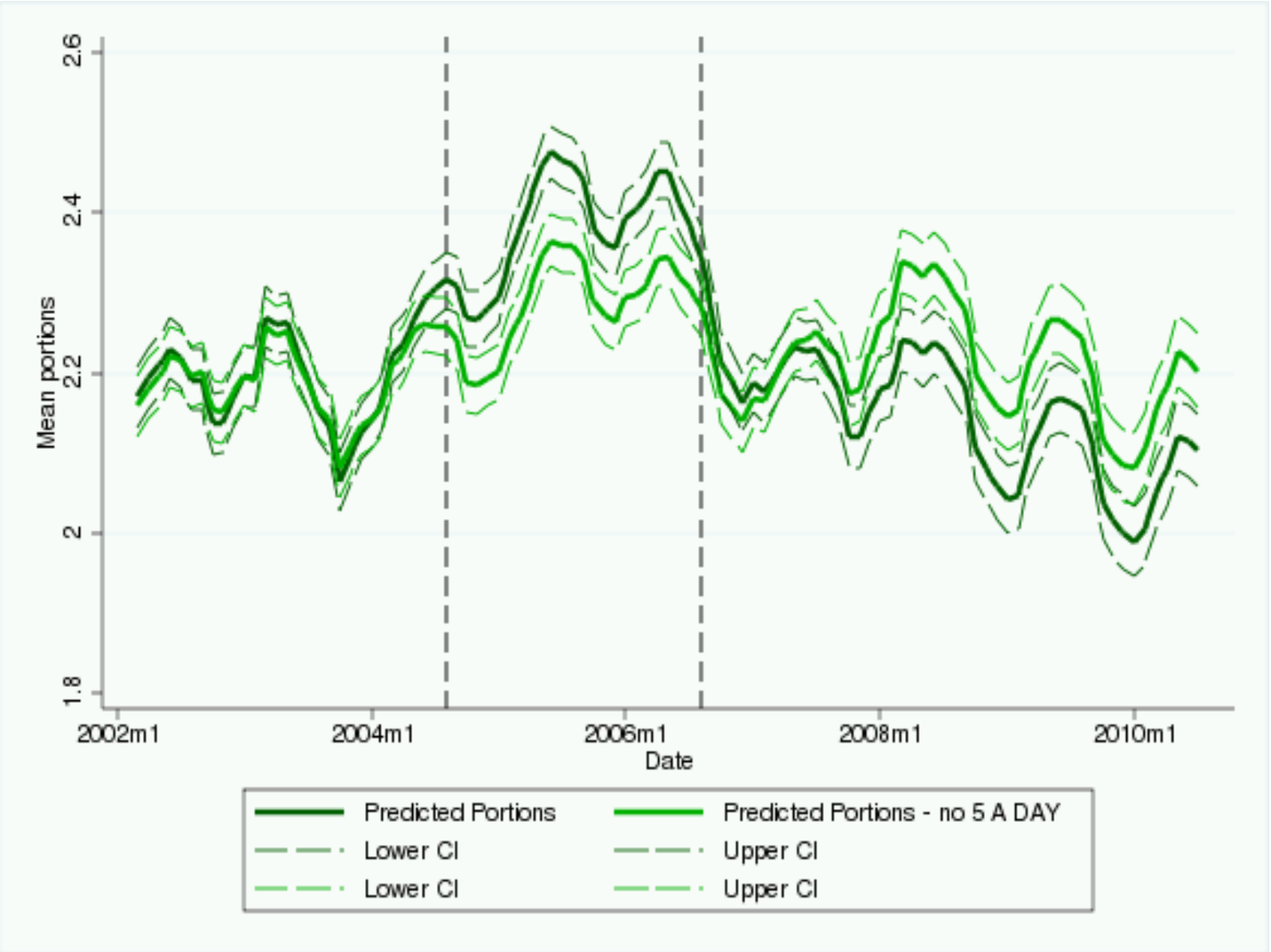
	Pensioner		No kid		Kids	
VARIABLES	w_f	w_v	w_f	w_v	w_f	w_v
lnp_f_adstore_f	-0.0198*	-0.0173***	0.00443	-0.00139	0.00691	-0.00928**
	(0.0104)	(0.00422)	(0.00813)	(0.00396)	(0.00842)	(0.00396)
lnp_f_adother_f	0.00460*	0.000976	0.00261	-0.00588***	0.00356*	-0.00553***
	(0.00272)	(0.00132)	(0.00214)	(0.00124)	(0.00196)	(0.00123)
lnp_f_adstore_v		-0.00868***		0.00235		0.00219
		(0.00278)		(0.00212)		(0.00194)
lnp_f_adother_v		-0.00863***		-0.00758***		-0.00624***
		(0.00113)		(0.000833)		(0.000763)
lnp_v_adstore_f	-0.0173***		-0.00139		-0.00928**	
	(0.00422)		(0.00396)		(0.00396)	
lnp_v_adother_f	0.000976		-0.00588***		-0.00553***	
	(0.00132)		(0.00124)		(0.00123)	
lnp_v_adstore_v	-0.00868***	0.0120	0.00235	-0.0259**	0.00219	0.0342***
	(0.00278)	(0.0155)	(0.00212)	(0.0128)	(0.00194)	(0.0119)
lnp_v_adother_v	-0.00863***	0.0326***	-0.00758***	0.0257***	-0.00624***	0.0302***
	(0.00113)	(0.00392)	(0.000833)	(0.00327)	(0.000763)	(0.00310)
ln_exp	-0.0587***	-0.0430***	-0.0582***	-0.0456***	-0.0529***	-0.0404***
	(0.000157)	(0.000176)	(0.000120)	(0.000145)	(0.000110)	(0.000132)
Month effects	yes	yes	yes	yes	yes	yes
Observations	618,887	618,887	785,063	785,063	744,616	744,616
R-squared	0.675	0.700	0.658	0.700	0.659	0.694

Aggregate elasticities

- Aggregate elasticities over all demographic groups and time

Price	Fruit	Veg	Other	Expenditure
Fruit	-0.17	0.26	-0.14	0.35
Veg	0.44	-0.52	-0.09	0.67
Other	-0.62	-0.18	-0.90	1.13

Predicted portions: All households



Next steps

- **Instrumenting**
  - Shopping trip food expenditure may be correlated with an unobserved demand shifter
    - instrument with household income
  - Price may be correlated with demand shocks
    - instrument with domestic and imported producer prices and other costs data

Next steps

- National nature of campaign complicates identification of treatment effect
- Use variation in exposure/susceptibility to treatment across:
- TV viewing behaviour
  - 5 A DAY ads mainly on TV; more TV viewing, higher probability saw advert
- Social class/education
  - evidence that higher education households more responsive to information campaigns
- Households with kids
  - policy particularly targeted at children

Next steps

- Estimate store choice component of model
- Compute firm level elasticities, and demand estimates to infer supply side parameters
- Simulate optimal prices in absence of 5 A DAY
- Consider endogenous advertising response (?)