Supermarket Interventions and Diet in areas of Limited Retail Access: Policy Suggestions from the Seacroft Intervention Study

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Abstract:

Globally supermarkets have been seen as a remedy to the problems of poor diets in deprived neighbourhoods where access to healthy foodstuffs has been limited. This study seeks to quantify the consequences of one such United Kingdom intervention, in Seacroft, Leeds. Where previous work often focused on fruit and vegetables, this paper presents evidence on all food and drink consumed before, and after, the new opening. It is shown that utilising large format retailers can also bring significant negative consequences for already unhealthy diets, exactly the opposite of what policy makers set out to achieve. Suggestion is therefore made that policymakers consider using price, or education, interventions rather than promoting large shops, which, while stocking cheap healthy food also offer shoppers the unhealthy produce they like at low prices.

Keywords: food desert intervention, diet, healthy eating, supermarkets

JEL Classification: I14 I18

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1 Introduction

Supermarkets with their large product ranges and low prices have been held as the perfect solution for bringing greater varieties of healthy food to low income residents in areas of otherwise limited retail accessibility. Countless studies of fruit and vegetable intake have shown that average consumption does increase when access is made easier by a new supermarket (Wrigley et al, 2003; Wetherspoon et al, 2013; Pearson et al, 2014; Aggarwal et al, 2014). However some concern has been raised here that this support for large format intervention stores should be tempered and further analysis undertaken about what exactly is happening to diets. If fruits and vegetables are to increase then why not the other products, less healthy items, that consumers regularly buy in their shopping? Amongst those which consider the wider diet and the role of supermarkets there is some evidence of negative association (Cummins et al, 2005a; Lear et al, 2013; Aggarwal et al 2014, Pearson et al, 2014). As yet no in depth examination has been made of an intervention store whose design purpose has always been the promotion of a healthy diet. It is this gap which the current study seeks to fill.

Datasets exploring the before and after food consumption landscape surrounding the opening of a new store that was designed to improve healthfulness are few and far between. This holds despite the prevalence of such stores in the UK and the USA. In the latter financial incentives remain in place to encourage supermarkets to locate in suburbs that have been shown to be food deserts (United States Department of Treasury, 2014). Meanwhile in the former development continues a pace, Tesco plc having opened more than 40 such stores, including one already this year[1]. Here use is made of the Seacroft Intervention Study (Wrigley et al, 2004b) which reviews one such UK intervention in Leeds, West Yorkshire, complete with before and after food diary data. The value of the study is extolled by Donald (2013) and as yet it remains the only suitable source which can be adopted to answer the questions presented here. Generalisation from Seacroft to other communities facing similar problems is straightforward, especially given the continued prevalence of such areas and such interventions.

This study proceeds with a more detailed look at the literature on supermarket interventions, food access and diet, particular focus also given to the study area. Section 3 then presents the data that is used and some preliminary two-sample comparisons designed to bring out key features therefrom. Linear regressions on a series of food groups are run in part 4, with section 5 concluding on the policy implications.

2 Background

Supermarkets are an established part of the retail landscape throughout the developed world and are an increasingly common sight in the developing world (Hawkes, 2008). Wherever in the world they open, large format retailers are having real impacts on the communities surrounding them. Moreover they are also having indirect effects on the areas they do not serve, sucking out the money of those who can travel while leaving individuals unable to reach them with an ever poorer retail offer (Wrigley et al, 2003; Caspi et al, 2012a). For those left behind there is naturally real concern, with a huge literature directed towards the dietary aspects. Wrigley et al (2002), the base

[1] Tesco reports opening 40 in a review in 2011 (Tesco, 2011) and has just opened a new large format Extra outlet in the centre of Rotherham, South Yorkshire.

paper for the dataset used here, is just one of many papers to take a snapshot of household health in a community affected adversely by retail change.

For many the solution to the problem is to incentivise supermarkets to also open outlets in areas which had poor accessibility. As noted the US Department of Treasury provides financial inducements to supermarkets to open new outlets in poorer neighbourhoods. In the UK planning permission has become near impossible for out-of-town developments forcing the supermarkets to adhere to a planning preference schedule if they wish to open new locations. Wood et al (2006) describes precisely the planning regulation changes that have brought this situation about and documents how the major food retailers have engaged with the process to find suburban sites where they can make a difference, and still access car borne commuters passing by. Consequently there has been a continuous raft of openings, Tesco has opened more than 40 alone and Asda have been involved in projects in Manchester Sport City and Hulme, Greater Manchester amongst many many others. Similar has happened throughout Europe as noted in Wood et al (2006), and elsewhere.

Whether this policy was wise hinges on two important questions. Firstly, did it actually affect dietary behaviour amongst the intended target groups? Secondly, would alternatives have been able to perform as well, or better, given the policy goal of increased dietary healthfulness? For the former there are a large number of studies, of which this is an important extension born of many reviews of one opening in the UK. Papers finding a positive role of supermarkets on diet in recent times have studied the situation in America (Sofi et al, 2014; Lenardson et al, 2014; Aggrawal et al, 2014), in Asia (Kelly et al, 2014; Liu et al, 2014; Umberger et al, 2015) and in Europe by Shaw (2012). Common amongst all these reviews, and UK studies outside of the area considered here, such as Guy et al (2004) are that supermarkets are broadly seen as beneficial to diet. On the same Seacroft Intervention Study, Wrigley et al (2003) also finds positive results on fruit and vegetable consumption. A picture is pained entirely in favour of large format intervention, but amongst all this there are contradicting voices such as Cummins et al (2005), Gill and Rudkin (2014) and Ghosh-Datsidar et al (2014), for Scotland, Seacroft and Seattle interventions respectively.

Other interventions have been trialled with differing levels of success. Farmers markets are a certain way to improve the range of fruit and vegetables, but are by their very nature seasonal. Often it is those who are willing to think about their diet, and seek out the markets during their restricted opening hours, that will benefit from such interventions. This conflict between the stated health improvement objective and self-selection means that aggregate improvements do not always translate to goals being achieved (Wetherspoon et al, 2013; Jilcott-Pitts et al, 2014). Circumventing the opening hours issue are the interventions which subsidise fruit and vegetables within convenience stores. Such schemes mean households do not need to change shopping patterns but are presented with healthy choices. Positive effects are found in the USA by Gittelsohn et al (2009) and many others, but in the UK the results were less encouraging (Adams et al, 2012). Broadly these alternative interventions have pointed to the conclusion that access is only one part of the picture. A general review of interventions and their effectiveness in one district of New York is provided by Hosler and Krammer (2014). It is by no means certain that the supermarket will indeed be the only effective way to achieve policy goals on healthful diet, or that access is the only issue.

Where a household does their weekly shop will be influenced by many factors, a large proportion of which would not appear in the simplest economic modelling on the issue. Many do not use their nearest store, for example and others may simply prefer to use outlets or chains with which they are familiar (Gustat et al, 2015). Equally once inside the store there are any number of things which can determine what actually gets purchased, including store promotions (Martin-Biggers et al, 2013, Rusmevichientong et al, 2014). Gill and Rudkin (2014) demonstrates that pre-intervention consumption of fruit and vegetables is a key determinant of post-intervention levels, in Seacroft including their relative position on the overall intake distribution. Volpe et al (2013) studies homescan data from the USA to analyse the impact of having large format retailers close to hand, again pointing to habit as a major actor. For French data Caillavert et al (2014) is a good study in the complexities of food choice and the habit nature of consumption. While two of these three focus attention on fruit and vegetables all of their conclusions are highly relevant as we begin to understand wider implications.

A recurring factor in the focus group analysis of Wrigley et al (2004a) is the role that children play in influencing shopping behaviour. Whether it is where to shop, at the time of the survey respondents report their children "not wanting to go to school with a Netto[2] carrier bag" (Wrigley et al, 2004a), or what to buy children have an important role (Wingert et al, 2014). In their focus group studies of American caregivers Wingert et al identify the stark differences between the standard budgetary focus and the desire to placate the children. Parents reported being pestered by children at displays of unhealthy snacks, especially sweets, chocolate and crisps (Wrigley et al, 2004a; Wingert et al, 2014). As a new larger supermarket opens not only is it the environment for the head of household that alters it is also the opportunities for children to have influence.

In areas where income is low it is of little surprise that price is a critical variable in determining diet. Sadler et al (2012) consider the opening of new food stores in a Michigan food desert, reviewing the cost of a healthful basket of groceries in relation to access problems. Entry by two retailers drastically brought down the cost of groceries, in keeping with general observations on supermarkets passing on economies of scale benefits. Large format outlets may not be the cheapest source however, as Pearson et al (2014) show in suburbs of Wellington and Christchurch, New Zealand. Their work points to farmers markets as being much cheaper, creating a trade off between their low prices and limited opening house discussed earlier. It is by no means certain that this balance would come out in favour of healthfulness. Dimitri et al (2014) show that to get the most out of farmers markets financial incentives should be given to help poorer households to buy more.

Finally there is no market unless consumers may access it, and food deserts are perceived on problems of access. In this paper the distance between households and the new Tesco store is computed via the Ordnance Survey Integrated Transport Network (ITN) Layer to better capture the real distances that households must travel to reach Seacroft. Such consideration massively improves the understanding of accessibility (Caspi et al, 2012b; Schwanen, 2015) and gives an improved feeling for how the new store might influence perceptions of shoppers food environment. Ghosh-Dastidar et al (2013) studies two neighbourhoods in Pittsburgh, Pensylvania where one receieves an intervention but the other does not. What emerges is a negative correlation between access and

[2] Netto was one of the earlier European discounter entrants into the UK market, but became increasingly associated with negative stereotypes due to its' discount status. As the economy picked up so its' market contracted and only recently has it made a return to the UK

obesity, those who are obese living further from a store than others. More telling was that those who shopped at cheaper stores were more likely to be obese. Evidence is found that suggests once in the discount stores low income shoppers are more influences by promotions, especially of unhealthy goods, a result which also comes through in this study. Elsewhere strong associations are drawn between access and health by Aggrawal et al (2014), Black et al (2014) and Hollywood et al (2013). Promotions will thus be a very relevant part of any strategy to make best use of retailers as health interventions.

All three of the key drivers reviewed here can be theoretically linked to likely behaviours that can be tested within the study data. In what follows each is reviewed individually and included withing the multivariate regression models. A clear advantage of the Seacroft Intervention Study is that it allows the analysis of changes in consumption between the before intervention and post-intervention periods. Wrigley et al (2002) provides an excellent start point to the discussion of the study area and its characteristics before the new outlet opened its doors. Updating their work Wrigley et al (2003) represents the most comprehensive review of the post-intervention situation. Both look at accessibility, how consumers travel to and from their shop of choice in terms of the mode used to do so and the distance travelled making the trip. As the crow flies straight line distance is used, which Gill and Rudkin (2014) shows acts as a poor substitute for the ITN network given the specifics of the area. However for understanding the backdrop against which this study is set both are invaluable.

Seacroft is a local authority operated development of almost 40,000 residents in the North East of Leeds, and is one of the most deprived areas of England (Wrigley et al, 2003). The area is bisected by the main Leeds to York A64 and the Leeds outer ring road. This creates distinct islands within the study zone and means that many are trapped away from large format stores, in areas only housing small stores of the type linked to obesity by Ghosh-Dastidar (2013). To the south-west, just outside the study area, is a large Asda supermarket, while there are also two Tesco stores within three miles range to the North West and South East of Seacroft [3]. Over 70% of the study area was a food desert under the 500m definition prior to the new store opening, Wrigley et al (2003). Tesco opened its doors in November 2000 at the heart of the area, but trapped away from much of it by the main roads it neighboured. It stands as a symbol of the then Labour government's commitment to inner-city renewal (PR Newswire, 2001). Seacroft is typical of so many similar suburban communities on the edge of Britain's cities, and indeed of other cities around the world. It's study has lessons for all.

Against this background a study of the basic constituents of household diet before, and after, a major large format retail intervention is studied. Section 3 now discusses the basic data of the paper and the information it gives about the study area and those who reside within it.

3 Data and Two Sample Analyses

Uniqueness of the Seacroft Intervention Study is provided by having food diary information before and after the opening of a large format retailer as an intervention store in a low-income community previously seen as a food desert. A novel feature of this paper is the use of the Ordnance Survey Integrated Transport Network (ITN) layer for the measuring of access from residence to store, but

[3] There are two Tesco superstores near the study area, one in the North-West at Roundhay and one in the South-East at Cross Gates. Both were near to main roads and smaller than the intervention store that was built at Seacroft.

Group	Name	Description	Mean	Standard Deviation	Min	Max
Consumption	pre	Pre-intervention consumption of the same group	Na	Na	Na	na
	$post$	Post-intervention consumption of the same group	Na	Na	Na	Na
Shop Choice	$switch$	Main supermarket is Tesco Seacroft	0.4491	0.4978	0	1
	$aasda$	Main supermarket is Asda Killingbeck	0.3239	0.4683	0	1
	$asmkt$	Also shop at another supermarket	0.7479	0.4346	0	1
	$bsmkt$	Shopped at a supermarket before the intervention	0.7713	0.4204	0	1
Distance (km) to Seacroft (d) and 'no car' (nc) interaction	$nc1$	$0 < d \leq 1.2$	0.0931	0.2841	0	1.1865
	$nc2$	$1.2 < d \leq 1.6$	0.1704	0.4591	0	1.5931
	$nc3$	$1.6 < d \leq 2.0$	0.2038	0.5759	0	1.9981
	$nc4$	$2.0 < d$	0.1483	0.5486	0	2.7271
Distance (km) to Seacroft (d) and 'car access' (ca) interaction	$ca1$	$0 < d \leq 1.2$	0.1241	0.3277	0	1.1865
	$ca2$	$1.2 < d \leq 1.6$	0.2209	0.5077	0	1.5931
	$ca3$	$1.6 < d \leq 2.0$	0.2218	0.5972	0	1.9981
	$ca4$	$2.0 < d$	0.4022	0.8788	0	2.9487
Deprivation dummies	$nocar$	Household has no access to a motor vehicle	0.4090	0.4921	0	1
	$unemp$	Household contains unemployed adult	0.1285	0.3350	0	1
	$rent$	Household requires rental support	0.5722	0.4944	0	1
Factors influencing the purchasing decisions of households Employment	$cost$	Cost/budget	0.7312	0.4437	0	1
	$health$	Health advice	0.1603	0.3672	0	1
	$seat$	Spouse eating habits	0.4674	0.4994	0	1
	$ceat$	Children's eating habits	0.4407	0.4969	0	1
	bal	Trying to achieve a balanced diet	0.5342	0.4992	0	1
	$like$	Foods liked	0.6327	0.4825	0	1
	$conv$	Convenience	0.3723	0.4838	0	1
	$spouse$	Presence of spouse/partner shopping	0.1786	0.3834	0	1
	$child$	Presence of children on shopping trip	0.1669	0.3732	0	1
	$hunger$	Hunger	0.2788	0.4488	0	1
	$offer$	Special offers	0.6361	0.4815	0	1
	$wtesco$	Member works at Tesco	0.0434	0.2039	0	1
	$wother$	Member works at other supermarket	0.0301	0.1709	0	1
	$kids$	Household has children living there in 2001	0.3907	0.4833	0	1

Table 1: Variables used in analyses (Source: Own calculations on Wrigley et al, 2004b)

this requires accurate postcode information to geocode the household. 599 cases can be identified for who all necessary information is available, including the key explanatory variables for shopping behaviour. Thus 16 observations from the Wrigley et al (2003) appraisal of healthy eating, through fruit and vegetables, are not present in this study. Quick checks of the resulting data against the Wrigley et al paper confirm that there are no notable changes to their results as a consequence of reduced numbers. Access to stores also depends on the access to motor vehicles, and hence interactions between car ownership are used to make up slope dummies. Previous studies have highlighted the importance of deprivation and consumer attitudes so information from the survey about these is included in the set of explanatory variables here.

Table 1 presents the full set of data series, together with summary statistics for all factors included. Distance quartiles are worked out to be close to the true values, but rounding gives them more meaning for policy interpretation. Splits of 1.2km, 1.6km and 2.0km are used, but the true values are 1225m, 1539m and 1991m for the lower quartile, median, and upper quartile respectively. Consumption in all regressions is referred to using pre and$post$, but for simpler presentation the summary statistics are reported in Table 2. From Table 1 it is clear that the majority of respondents use supermarkets after the intervention (77% use either the new Tesco Seacroft store or the Asda Killingbeck store alone), and this figure is up slightly from the pre-intervention level of 77% at all supermarkets. Looking at the deprivation dummies of$nocar$, $unemp$ and $rent$ it can be seen that this is indeed a comparatively poor neighbourhood with more than half of the respondents requiring rental support for their home and 40% not having access to a motor vehicle. Major factors influencing what people buy are the cost/budget and special offers, again signals of low income, but this is tempered by consideration of what the children will eat and the foods liked. Encouragingly just over half report being influenced by the desire to have a balanced diet, opening up the possibility that lower priced supermarkets might increase consumption of healthier foods.

Within the diaries completed either side of the intervention households are required to indicate their consumption of 71 different foodstuffs. Inevitably this is too many to analyse individually, and for many there will be only a limited number of respondents who do partake. Bundling these into groups allows better focus on the key consequences of the supermarket intervention. Only take-away food is left on its' own, as this is subject to study elsewhere, and it is interesting to see what happened to the number of times residents choose to eat outside the home in the study. Based on the literature on nutrition each group is classified as being either healthy or unhealthy, with the exception of the drinks group, which is non calorific but cannot be classified in either group. Following Drescher et al (2007) drinks are not discussed as being good for diet, or otherwise, but are analysed alongside the other groups. Immediately we can see that the major groups consumed are dairy, and the components of a main meal, high fat and processed options dominating the fresh mpf grouping.

Unsurprisingly the largest average consumption is of drinks, with dairy, fruit and vegetables being slightly less likely as the next most popular. Within dairy there is a clear split between high and low fat, the gap in consumption having remained similar either side of the intervention. Necessarily such products require refrigeration and high stock turnover to maintain freshness and so significant

Group Name	Short	Contains	Healthy ?	Pre-Intervention				Post-Intervention				Change
				Mean	S Dev	Min	Max	Mean	S Dev	Min	Max	
Drinks	drk	Water, any hot drink, evaporated milk and other drinks		3.323	1.327	0	9.429	3.531	1.387	0	10.00	0.207***
High Fat Dairy	$daih$	Milk-full fat, ice cream, normal yoghurt, butter, cream, cheese and normal margarine	No	1.492	1.473	0	10.29	1.723	1.548	0	10.86	0.231***
Low Fat Dairy	$dail$	Milk-skimmed, low fat yoghurt and low calorie margarine	Yes	1.759	1.751	0	7.571	1.994	1.736	0	8.286	0.235***
High Sugar Drink	drh	Normal fizzy drinks, squash, beer and wine	No	0.570	0.635	0	4.000	0.538	0.749	0	5.140	-0.032
Low Sugar Drink	drl	Diet fizzy drinks, real fruit juice	Yes	0.332	0.501	0	3.429	0.404	0.582	0	4.000	0.072**
Healthy Cereals	bcl	Muesli, brown bread and soup	Yes	1.028	0.687	0	3.571	1.081	0.720	0	4.140	0.053
Unhealthy Cereals	bch	Cereal and white bread	No	0.786	0.811	0	5.857	0.859	0.802	0	4.857	0.073
Spreads and Oils	spo	Oil, lard, sweet spreads and savoury spreads	No	0.338	0.492	0	4.857	0.345	0.547	0	5.286	0.007
Fruit	frt	Apples, oranges, bananas, peaches and other fruits	Yes	1.034	1.038	0	9.286	1.105	1.001	0	7.000	0.071
Vegetables	veg	Carrot, peas, broccoli, tomatoes, salads and other vegetables	Yes	1.327	0.885	0	6.857	1.437	1.111	0	16.43	0.110*
Other Greens	$oveg$	Dried fruits and baked beans	No	0.184	0.323	0	3.429	0.187	0.310	0	2.857	0.0021
Fresh Meats	mpf	Meat, Poultry, Fish (non-processed)	Yes	0.847	0.561	0	5.571	0.835	0.657	0	11.71	0.012
High Fat Mains	$high$	Processed vegetables, processed poultry, processed meats, processed fish, battered fish, meat pie, vegetable pasties, prepared ready meals, pizzas and chips	No	1.291	0.926	0	12.00	0.981	0.908	0	12.14	-0.398**
Take Away	$take$	Take away	No	0.037	0.157	0	1.429	0.081	0.165	0	2.143	-0.003
Starches	stl	Boiled potatoes, roast potatoes, rice and pasta	Yes	0.747	0.523	0	6.571	0.678	0.454	0	4.714	-0.069**
Deserts	des	Fruit puddings, other puddings, packet mix cakes, cakes, sweet biscuits, other sweets	No	0.585	0.618	0	5.571	0.628	0.765	0	8.714	0.043
Low fat snacks	snl	Crackers /Crisp breads	Yes	0.150	0.328	0	4.000	0.174	0.378	0	3.429	0.024
High fat snacks	snh	Chocolate biscuits, chocolate and crisps	No	0.588	0.687	0	8.143	0.598	0.639	0	5.143	0.010

Table 2: Food groups and two-sample t-tests for equality of post- and pre-intervention means (Source: Own calculations on Wrigley et al, 2004b).
Significance is denoted by *-10%, **-5% and ***-1%

increases following the opening of a new supermarket in which 25%[4] of shoppers did not use a large format retailer beforehand. As with dairy the split in high and low sugar drinks is also worthy of comment, but there is a narrowing of the gap as a significant increase in the healthy alternative is reported. High sugar drinks actually fell post-intervention, but this effect is small and statistically insignificant. Cereals also show a slight reduction in the gap between healthy and unhealthy but here it is the latter increasing to catch the former. Such effects are not statistically significant but many show a worrying trend for policymakers keen to improve diet. Here fruit and vegetables are split; though both show increases it is vegetables for which that is significant rather than fruits that may have been substitutes for snacks. Reductions in high fat mains are reported, a large group which includes all of the danger foods that would commonly make up households main meals. Finally there is also a reduction in starches, such as rice and pasta, but the providence of this lies in personal preference as supermarkets increase availability of these too.

Immediately it is apparent that there are more food groups for which the change is significant amongst non-Tesco shoppers. Whilst this may seem surprising given that it is shoppers at the new outlet who are faced with a changed shopping environment, it is not inconsistent with a change in healthy eating message. Of those changes which are significant for Tesco shoppers only the increase in high fat dairy is notably obtuse to those which are important for non-Tesco users. Reductions in high fat mains and starches of similar magnitudes are noted for both groups. Of interest here is that the changes amongst non-switchers are primarily in a healthful direction, increases in low fat dairy, low sugar drinks and healthy cereals. Policymakers may be immediately concerned that there is not a greater significance to the impact of the intervention on healthy foods.

Group	Switch ($n = 354$)			Do Not Switch ($n = 245$)		
	Pre	Post	Change	Pre	Post	Change
Drinks	3.388	3.451	0.063	3.271	3.596	0.325***
High Fat Dairy	1.440	1.806	0.366***	1.535	1.656	0.121
Low Fat Dairy	1.759	1.885	0.125	1.758	2.082	0.324***
High Sugar Drinks	0.558	0.612	0.054	0.579	0.477	-0.102*
Low Sugar Drinks	0.380	0.368	-0.013	0.293	0.434	0.141***
Unhealthy Cereals	1.062	1.131	0.069	1.000	1.040	0.040
Healthy Cereals	0.772	0.795	0.023	0.798	0.911	0.113*
Spreads and Oils	0.318	0.381	0.063	0.354	0.316	-0.039
Fruit	1.100	1.021	-0.080	0.980	1.174	0.194**
Vegetables	1.363	1.481	0.117	1.297	1.401	0.104
Other Greens	0.184	0.206	0.022	0.184	0.171	-0.014
Fresh Meats	0.872	0.809	-0.063	0.826	0.855	0.029
High Fat Mains	1.284	1.045	-0.239***	1.297	0.929	-0.367***
Take Away	0.081	0.090	0.009	0.085	0.073	-0.013
Starches	0.755	0.687	-0.067*	0.741	0.670	-0.071*
Deserts	0.568	0.649	0.081	0.599	0.610	0.012
Low Fat Snacks	0.159	0.163	0.004	0.143	0.183	0.040
High Fat Snacks	0.574	0.646	0.072	0.600	0.559	-0.040

Table 3: Paired Two-Sample t-tests of changes in consumption by switching to Tesco Seacroft (source: own calculations on Wrigley et al, 2004b) Significance Level: * - 10%, ** - 5%, *** - 1%.

[4] Of the 599 observations, 269 shop at Tesco Seacroft and 67 of these shopped at a non-supermarket prior to the intervention. Fill percentage is 24.91%. All based on own calculations from Wrigley et al (2004b)

Group	Car Access ($n = 354$)			No Car Access ($n = 245$)		
	Pre	Post	Change	Pre	Post	Change
Drinks	3.286	3.515	0.247***	3.403	3.553	0.150
High Fat Dairy	1.481	1.674	0.193*	1.508	1.794	0.286**
Low Fat Dairy	1.698	2.025	0.327**	1.846	1.949	0.103
High Sugar Drinks	0.528	0.531	0.003	0.630	0.548	-0.083
Low Sugar Drinks	0.307	0.412	0.105***	0.369	0.393	-0.025
Unhealthy Cereals	0.997	1.087	0.090*	1.072	1.071	-0.001
Healthy Cereals	0.749	0.850	0.101*	0.841	0.873	0.032
Spreads and Oils	0.317	0.322	0.005	0.368	0.378	0.010
Fruit	0.926	1.090	0.164***	1.190	1.127	-0.064
Vegetables	1.244	1.432	0.188***	1.447	1.444	-0.003
Other Greens	0.174	0.175	0.001	0.200	0.204	0.004
Fresh Meats	0.811	0.826	0.015	0.899	0.847	-0.052
High Fat Mains	1.244	0.905	-0.339***	1.358	1.092	-0.267***
Take Away	0.089	0.084	-0.005	0.076	0.076	0.001
Starches	0.698	0.662	-0.036	0.818	0.700	-0.118
Deserts	0.559	0.583	0.023	0.622	0.693	0.071
Low Fat Snacks	0.138	0.136	-0.002	0.168	0.229	0.061
High Fat Snacks	0.595	0.605	0.010	0.578	0.588	0.010

Table 4: Paired Two-Sample t-tests of changes in consumption by car access (source: own calculations on Wrigley et al, 2004b). Significance Level: * - 10%, ** - 5%, *** - 1%

Food deserts are conceived on issues of accessibility to healthy foods, particularly fruit and vegetables, with the view that greater availability will bring increased consumption. Within this dataset access to a motor vehicle and the road network distance from the ITN layer, are the measures available. Tables 4 and 5 explore these with paired two-sample t-tests for those with, and without, car access and by distance quartile. Immediately there are differences with the aggregate picture. By quick inspection those with access to cars change their diet much more significantly than those who lack such options. Indeed the only changes of note amongst households reliant on walking or public transport are an increase in high fat dairy and a reduction in high fat mains. Both changes are in a less healthful direction than is seen for car available shoppers, being a larger rise in high fat dairy and a smaller reduction in high fat mains than those with cars. Otherwise all of the significant changes for those who do have motor vehicle access improve the health of their diet. In this table an early concern about who exactly is being helped is raised, it is suggested that those with the ability to search benefit but the poorer residents who could not reach out-of-town stores can still not benefit from an outlet on their doorstep.

Breaking the impact down by distance quartile also produces some interesting insights, with not all benefits coming close to the store as might be hypothesised. With the nearest distance quartile what significant effects there are are positive, large rises in low fat dairy, healthy cereals and fruit as well as a reduction in high fat mains. Given that high fat dairy was also shown to increase it is encouraging that this does not happen in the nearest region. Moving away from Seacroft the picture becomes less encouraging as many of the changes in the second and third quartile are in a less healthful direction. Reduction in fresh meats in both, and increases in high fat dairy in quartile 2 are concerning enough, but moving to quartile 3 is where much deeper issues are observed. Statistically

Group	Nearest Distance Quartile $d < 1.2$ $(n = 145)$			Second Distance Quartile $1.2 \leq d < 1.6$ $(n = 145)$			Third Distance Quartile $1.6 \leq d < 2.0$ $(n = 145)$			Furthest Distance Quartile $2.0 \leq d$ $(n = 145)$		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Drinks	3.345	3.448	0.103	3.443	3.481	0.048	3.339	3.316	-0.022***	3.160	3.875	-0.714***
High Fat Dairy	1.676	1.848	0.173	1.397	1.676	0.279**	1.541	1.797	0.256	1.375	1.584	0.209
Low Fat Dairy	1.616	2.201	0.585**	1.770	1.812	0.042	1.950	1.701	-0.249	1.703	2.279	0.576***
High Sugar Drinks	0.629	0.597	-0.032	0.501	0.581	0.079	0.602	0.508	-0.094	0.560	0.457	-0.103
Low Sugar Drinks	0.373	0.439	0.065	0.296	0.374	0.078	0.394	0.424	0.030	0.275	0.388	-0.113**
Unhealthy Cereals	1.122	1.113	-0.009	1.079	1.100	0.021	0.954	1.072	0.118	0.946	1.034	0.088
Healthy Cereals	0.734	0.951	0.217**	0.689	0.816	0.127	0.996	0.691	-0.305***	0.750	0.980	0.230**
Spreads and Oils	0.377	0.384	0.007	0.331	0.325	-0.006	0.357	0.299	-0.058	0.289	0.373	0.084
Fruit	1.033	1.292	0.259**	0.950	0.948	-0.002	1.186	0.905	-0.281**	0.987	1.295	0.391
Vegetables	1.428	1.533	0.125	1.243	1.354	0.112	1.461	1.260	-0.201**	1.196	1.581	0.391***
Other Greens	0.205	0.201	-0.004	0.185	0.154	-0.031	0.170	0.183	0.013	0.176	0.213	0.037
Fresh Meats	0.832	0.940	0.107	0.867	0.772	-0.096*	0.912	0.750	-0.162***	0.774	0.885	0.111*
High Fat Mains	1.355	1.082	-0.273**	1.298	0.888	-0.410***	1.273	1.080	-0.194**	1.236	0.895	-0.341***
Takeaway	0.075	0.080	0.005	0.089	0.099	0.010	0.062	0.085	0.022	0.107	0.058	-0.050**
Starches	0.780	0.0735	-0.045	0.746	0.644	-0.102*	0.769	0.616	-0.153***	0.694	0.719	0.0254
Deserts	0.653	0.748	0.015	0.506	0.516	0.010	0.610	0.582	-0.029	0.585	0.683	0.098
Low Fat Snacks	0.193	0.234	0.042	0.123	0.115	-0.008	0.138	0.144	0.006	0.153	0.211	0.059
High Fat Snacks	0.648	0.639	-0.009	0.582	0.566	-0.016	0.539	0.592	0.053	0.583	0.603	0.020

Table 5: Paired Two-Sample t-tests of changes in consumption by distance quartile from Tesco Seacroft (Source: Own Calculations on Wrigley et al, 2004b).
Significance Level: * - 10%, ** - 5%, *** - 1%

Group	Rental Support ($n = 340$)			No Rental Support($n = 259$)		
	Pre	Post	Change	Pre	Post	Change
Drinks	3.395	3.473	0.028	3.229	3.672	0.442***
High Fat Dairy	1.548	1.815	0.267**	1.419	1.603	0.184
Low Fat Dairy	1.827	1.833	0.006	1.669	2.204	0.536***
High Sugar Drinks	0.584	0.570	-0.014	0.551	0.495	-0.056
Low Sugar Drinks	0.361	0.385	0.024	0.295	0.430	0.136***
Unhealthy Cereals	1.072	1.092	0.020	0.969	1.066	0.097
Healthy Cereals	0.817	0.785	-0.032	0.746	0.956	0.210***
Spreads and Oils	0.395	0.344	-0.051	0.264	0.346	0.083**
Fruit	2.265	1.033	-0.132	0.863	1.200	0.338***
Vegetables	1.452	1.400	-0.052	1.163	1.485	0.323***
Other Greens	0.205	0.193	-0.012	0.157	0.178	0.020
Fresh Meats	0.894	0.824	-0.070	0.785	0.849	0.064*
High Fat Mains	1.333	1.130	-0.203	1.236	0.786	-0.450***
Take Away	0.083	0.1025	0.019	0.084	0.052	-0.032***
Starches	0.807	0.677	-0.131***	0.668	0.680	0.012
Deserts	0.613	0.606	-0.008	0.547	0.657	0.110**
Low Fat Snacks	0.165	0.180	0.015	0.131	0.166	0.035
High Fat Snacks	0.597	0.645	0.049	0.577	0.537	-0.040

Table 6: Paired Two-Sample t-tests of changes in consumption by requirement for rental support (source: own calculations on Wrigley et al, 2004b) Significance Level: * - 10%, ** - 5%, *** - 1%.

significant falls in healthy cereals, fruit and vegetables are of note and the change in high fat mains is much smaller than in other areas. Where quartile 3 engenders worries, the furthest reaches of the study area show more encouraging results. In this area there are more significant changes than any other, and the vast majority are diet improving. Low fat dairy, healthy cereals, vegetables and fresh meats all increase, while high fat mains and takeaways decrease. There is a further fall in low sugar drinks, but a rise in non-calorific drinks so it is unclear whether this is a substitution which would be no cause for alarm.

From the accessibility discussion there is some indication that it is the poorest who continue to suffer from poor diets. Tables 6 and 7 now consider whether households receiving rental support, or having the head of household being unemployed, as measures of income and show again that it is the deprived who see the least change in diet, especially in terms of the healthfulness of what is consumed. Only two changes are significant in the rent supported subset, and increase in high fat dairy and a reduction in the healthiest starches. Interestingly neither of these are significant in the subsample who do not receive rental support. For those households there are significant increases in low fat dairy, low sugar drinks, healthy cereals, fruit, vegetables and fresh meats, combined with falls in high fat mains and takeaways. By no means are all the changes healthy, upward movement in spreads and deserts are seen, but the overall picture is one of improved diet. Again taking the aggregate figures has masked a concerning split in who benefits and who does not.

Unemployment is another good proxy for income, as although low paid workers will receive broadly comparable incomes, being without a wage will leave households with less to spend on food

Group	Unemployed ($n = 354$)			Not Unemployment ($n = 245$)		
	Pre	Post	Change	Pre	Post	Change
Drinks	3.365	3.189	-0.176	3.317	3.581	0.264***
High Fat Dairy	1.226	1.783	0.557**	1.531	1.715	0.183**
Low Fat Dairy	2.032	1.536	-0.495	1.718	2.061	0.343***
High Sugar Drinks	0.557	0.672	0.115	0.572	0.518	-0.054
Low Sugar Drinks	0.371	0.245	-0.126*	0.327	0.428	0.101***
Unhealthy Cereals	1.035	1.071	0.035	1.027	1.082	0.056
Healthy Cereals	0.948	0.592	-0.356***	0.763	0.899	0.136***
Spreads and Oils	0.388	0.388	0	0.331	0.339	0.008
Fruit	1.312	0.902	-0.410**	0.993	1.135	0.142**
Vegetables	1.497	1.262	-0.236	1.302	1.463	0.161***
Other Greens	0.219	0.182	-0.037	0.179	0.187	0.008
Fresh Meats	0.939	0.740	-0.199*	0.833	0.848	0.015
High Fat Mains	1.443	1.208	-0.236	1.268	0.948	-0.320***
Take Away	0.080	0.156	0.076*	0.084	0.070	-0.015*
Starches	0.753	0.659	-0.095	0.746	0.681	-0.065**
Deserts	0.618	0.601	-0.017	0.580	0.632	0.052
Low Fat Snacks	0.191	0.202	0.011	0.144	0.170	0.025
High Fat Snacks	0.490	0.688	0.199*	0.603	0.585	-0.018

Table 7: Paired Two-Sample t-tests of changes in consumption by Unemployment (source: own calculations on Wrigley et al, 2004b). Significance Level: * - 10%, ** - 5%, *** - 1%

shopping. High fat dairy, takeaways and high fat snacks are all shown to increase significantly for residents who are unemployed. Coupled with significant reductions in low fat dairy, low sugar drinks, healthy breakfast cereals, fresh meats and fruit, the combined impact for diet is incredibly negative. Contrasting against the healthful increases to low fat dairy, low sugar drinks, healthy cereals, fruit and vegetables reported by those who are not unemployed and an inequality is being expanded. Reductions in take away and high fat main courses compound the situation. From these statistics it is unclear whether all can be laid at the door of the intervention supermarket, but whether directly, or indirectly, there are opposing signs on so many of the important measures that leave the unemployed facing greater problems. From Table 7 the policy aim of the intervention as a means to help the poorest looks increasingly difficult to support.

Attention now turns to the variables that link directly to the issues of price and income. Shoppers who report their purchasing decisions as being affected by the cost, or their budget, are clearly the more price sensitive of the residents in the area. Should Tesco indeed offer cheaper prices then it would be reasonable to suggest that there would be increases in consumption as budgets begin to stretch further. Table 8 presents cost influences, first for all shoppers and then separating that into first the switchers subset, and second the non-switchers. Within each there is a set who are influenced by costs and a second subset who are not. In the first comparison the early indications are supportive of intervention, positive and significant effects on low fat dairy, healthy cereals and fruit, and vegetables sit alongside a reduction in high fat mains in giving those who do care about costs a healthier diet. There are also negatives, increases in high fat dairy and deserts, which would not be viewed as positive by promoters. Those who report not being affected by their budget only see consumption move in a less healthful direction. Less starches, processed vegetables and high fat dairy are the notable effects on shoppers who are not concerned overly by cost.

Group	All Shoppers						Tesco Seacroft Green Shoppers						Others					
	Cost Affects ($n = 438$)			Cost Not Affect ($n = 161$)			Cost Affects ($n = 201$)			Cost Not Affect ($n = 68$)			Cost Affects ($n = 237$)			Cost Not Affect ($n = 93$)		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Drinks	3.252	3.513	0.261***	3.517	3.579	0.061	3.357	3.430	0.072	3.477	3.513	0.036	3.163	3.583	0.421***	3.547	3.627	0.080
High Fat Dairy	1.505	1.743	0.238**	1.457	1.670	0.213	1.348	1.817	0.470***	1.712	1.771	0.059	1.639	1.680	0.041	1.270	1.596	0.326
Low Fat Dairy	1.711	2.071	0.360***	1.888	1.783	-0.106	1.771	1.979	0.208	1.725	1.605	-0.120	1.660	2.149	0.489***	2.008	1.912	-0.096
High Sugar Drinks	0.568	0.557	-0.011	0.574	0.485	0.089	0.589	0.655	0.065	0.466	0.485	0.019	0.550	0.474	-0.077	0.653	0.485	-0.167*
Low Sugar Drinks	0.314	0.419	0.106***	0.382	0.363	-0.020	0.353	0.385	0.033	0.462	0.315	-0.147*	0.281	0.449	0.168***	0.324	0.398	0.074
Unhealthy Cereals	0.994	1.095	0.100**	1.119	1.043	-0.076	1.004	1.150	0.146**	1.231	1.074	-0.158	0.986	1.048	0.062	1.037	1.020	-0.017
Healthy Cereals	0.791	0.847	0.056	0.773	0.892	0.119	0.768	0.797	0.028	0.784	0.790	0.006	0.811	0.890	0.079	0.765	0.966	0.201
Spreads and Oils	0.337	0.357	0.020	0.341	0.313	-0.028	0.289	0.399	0.109**	0.403	0.328	-0.076	0.377	0.321	-0.057	0.295	0.303	0.008
Fruit	1.005	1.112	0.107[a]	1.113	1.086	-0.027	1.040	1.013	-0.027	1.279	1.044	-0.235	0.976	1.197	0.221**	0.991	1.117	0.126
Vegetables	1.311	1.455	0.145**	1.371	1.386	0.015	1.337	1.502	0.166	1.441	1.415	-0.025	1.288	1.415	0.127	1.320	1.364	0.045
Other Greens	0.178	0.203	0.025	0.201	0.141	-0.060*	0.168	0.220	0.052*	0.231	0.164	-0.067	0.187	0.189	0.002	0.178	0.124	-0.054
Fresh Meats	0.830	0.857	0.026	0.891	0.775	-0.116*	0.839	0.827	-0.012	0.971	0.758	-0.212*	0.823	0.882	0.056	0.833	0.787	-0.046
High Fat Mains	1.279	1.032	-0.247***	1.322	0.843	-0.479***	1.249	1.092	-0.158*	1.384	0.906	-0.479	1.304	0.981	-0.323***	1.276	0.797	-0.479***
Takeaway	0.082	0.082	0	0.088	0.077	-0.011	0.076	0.097	0.021	0.097	0.071	-0.025	0.087	0.070	-0.018	0.081	0.081	0
Starches	0.731	0.686	-0.044	0.792	0.655	-0.137**	0.723	0.696	-0.027	0.849	0.662	-0.187**	0.737	0.678	-0.059	0.750	0.650	-0.100
Deserts	0.570	0.652	0.082*	0.626	0.563	-0.063	0.528	0.652	0.124**	0.685	0.641	-0.044	0.605	0.652	0.046	0.582	0.505	-0.077
Low Fat Snacks	0.146	0.183	0.038	0.182	0.148	-0.014	0.156	0.163	0.007	0.168	0.162	-0.006	0.137	0.201	0.063*	0.158	0.138	-0.020
High Fat Snacks	0.590	0.616	0.026	0.583	0.551	-0.032	0.557	0.686	0.129**	0.624	0.529	-0.095	0.618	0.556	-0.061	0.553	0.567	0.014

Table 8: Paired Two-Sample t-tests of changes in consumption by affect of cost and use of Tesco Seacroft (source: own calculations on Wrigley et al, 2004b). Significance Level: * - 10%, ** - 5%, *** - 1%. [a] this has a p-value of 0.1028.

Amongst those who switch to using the new Tesco store the effects are much more skewed against healthful consumption. Where households care about their budgets and use the intervention store there are significant increases in high fat dairy, less healthy breakfast cereals, spreads, processed vegetables, deserts and high fat snacks. Only the lowering of high fat mains would be seen as a step in the right direction, but this is not of the magnitude of the decreases in other groups. Tesco also receives customers who are not so constrained, but they too emerge post-intervention with lower levels of healthy food being consumed. Reductions in the intake of low sugar drinks, fresh meats and starches are all unexpected impacts of switching to Tesco. Households who did not switch to using Tesco display a very different story, with caring about the cost producing positive changes in low fat dairy, fruit and healthy snacks. Not having such budgetary concerns means that there are fewer changes amongst non-switchers, only a reduction in high sugar drinks and a larger than normal reduction of high fat mains are noted.

Table 8 thus points to price variations within store that are designed to let the Seacroft store extract the most surplus from that outlet. This is logical practice as highlighted by Martin-Biggers et al (2013) and discussed in the economic theory literature by Dobson and Waterson (2008) and others. Taking differences for those affected by special offers is then a logical next step, the corresponding two-sample t-tests being reported in Table 9. Immediately it is clear that offers can change the way that households shop, changes being reported in ten of the eighteen groups. No particular result on health can be seen as where high fat dairy consumption rises amongst those influenced by offers, so does low fat dairy. Only high fat mains and starches see falls from households who are affected by promotions. Interest lies not in the main comparison but actually in the way that shoppers reporting special offers as important behave in the new Tesco. Increases in high fat dairy, deserts and high fat snacks only adds to the worry that the new outlet is actually targeting shoppers preferred product range and stocking such less healthy foodstuffs with discounts. There is an increase in vegetables to balance some of the negatives, but also a reduction in the consumption of fresh meats of just under 1 portion a week is revealed. Other users of Tesco report reductions in low sugar drinks. Meanwhile among the non-switchers a totally different tale sits to be told, with better for you items seeing significant increases. Fruit, low fat dairy and low sugar drinks all show increases amongst non-switchers who care about special offers, while for those who do not reductions in high sugar drinks by 0.2 portions per day is the only change seen.

From the two price discussions it is very clear that there is indeed cause for concern about the impact that a large intervention store with the ability to vary promotions to local characteristics may have. Neither comparison is definitive as the actual price data is missing, but it is telling that so much of the significant impact of the new outlet comes in increasing consumption of unhealthy foodstuffs. Policies to encourage discounts on the foods that dieticians would recommend are thus suggested, aiming at the results seen for non-switchers being extended to those who do switch.

By way of a final look at the factors which households report as being of importance the role of the child is an important variable to explore. In this case it is the respondent indicating that they are influenced in their food shopping by what their children will eat. This is different to having the child present on the shopping trip, but it is still easy to infer a great deal from this variable as caregivers will be very aware of what it is that is wanted. Wingert et al (2014) showed that many start to abandon their commitment to healthy diet in order to better cope with the kinds of unhealthy snacks that those in their care would like. Interestingly within the Seacroft study the influence of

Group	All Shoppers						Tesco Seacroft Green Shoppers						Others					
	Offers Affect ($n = 381$)			Offers Not Affect ($n = 218$)			Offers Affect ($n = 176$)			Offers Not Affect ($n = 93$)			Offers Affect ($n = 205$)			Offers Not Affect ($n = 125$)		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Drinks	3.326	3.369	0.243**	3.318	3.464	0.145	3.375	3.532	0.157	3.412	3.296	-0.115	3.284	3.600	0.316**	3.249	3.589	0.339*
High Fat Dairy	1.503	1.762	0.259**	1.473	1.655	0.182	1.409	1.800	0.390***	1.498	1.817	0.310	1.584	1.730	0.146	1.455	1.535	0.080
Low Fat Dairy	1.727	2.031	0.304**	1.814	1.929	0.115	1.756	1.961	0.205	1.765	1.740	-0.025	1.702	2.091	0.389**	1.850	2.069	0.218
High Sugar Drinks	0.562	0.569	0.007	0.583	0.482	-0.101	0.575	0.637	0.063	0.527	0.564	0.037	0.551	0.511	-0.040	0.625	0.422	-0.203**
Low Sugar Drinks	0.307	0.448	0.142***	0.377	0.327	-0.050	0.358	0.435	0.077	0.422	0.240	-0.183**	0.263	0.460	0.197***	0.343	0.392	0.049
Unhealthy Cereals	1.008	1.093	0.085*	1.062	1.058	-0.003	1.067	1.168	0.101	1.052	1.060	0.008	0.958	1.029	0.071	1.069	1.057	-0.011
Healthy Cereals	0.762	0.861	0.099*	0.829	0.857	0.028	0.761	0.789	0.028	0.793	0.807	0.014	0.72	0.922	0.159*	0.894	0.856	0.038
Spreads and Oils	0.335	0.346	0.011	0.343	0.343	0	0.299	0.377	0.079	0.355	0.387	0.032	0.367	0.319	-0.047	0.334	0.310	-0.024
Fruit	0.998	1.098	0.100	1.097	1.117	0.020	1.050	1.022	-0.028	1.195	1.018	-0.177	0.953	1.164	0.210**	1.024	1.191	0.167
Vegetables	1.320	1.444	0.123*	1.338	1.425	0.087	1.336	1.506	0.169*	1.415	1.433	0.018	1.307	1.390	0.084	1.281	1.418	0.137
Other Greens	0.177	0.188	0.012	0.198	0.184	-0.014	0.172	0.205	0.033	0.207	0.207	0	0.181	0.174	-0.007	0.191	0.166	-0.025
Fresh Meats	0.844	0.829	-0.014	0.852	0.843	-0.009	0.876	0.772	-0.103**	0.865	0.880	0.015	0.816	0.879	0.063	0.842	0.816	-0.026
High Fat Mains	1.253	0.951	-0.302***	1.356	1.034	-0.322***	1.220	1.009	-0.213***	1.399	1.112	-0.287*	1.279	0.901	-0.378**	1.325	0.976	-0.479***
Takeaway	0.085	0.072	-0.013	0.082	0.097	0.015	0.080	0.087	0.007	0.084	0.097	0.012	0.089	0.059	-0.031**	0.080	0.097	0.017
Starches	0.735	0.673	-0.061*	0.769	0.686	-0.083*	0.749	0.681	-0.068	0.765	0.699	-0.066	0.722	0.667	-0.055	0.771	0.675	-0.096
Deserts	0.565	0.663	0.097**	0.619	0.567	-0.052	0.535	0.685	0.150**	0.630	0.581	-0.049	0.592	0.643	0.052	0.610	0.557	-0.054
Low Fat Snacks	0.127	0.154	0.027	0.191	0.208	0.017	0.149	0.155	0.006	0.177	0.177	0	0.107	0.153	0.046*	0.202	0.232	0.030
High Fat Snacks	0.579	0.653	0.074	0.605	0.503	-0.102*	0.540	0.723	0.183***	0.639	0.501	-0.138	0.612	0.592	-0.020	0.579	0.505	-0.074

Table 9: Paired Two-Sample t-tests of changes in consumption by effect of special offers (source: own calculations on Wrigley et al, 2004b). Significance Level: * - 10%, ** - 5%, *** - 1%

Group	Pre-Intervention Supermarket Shopper ($n = 354$)			Pre-Intervention Other Shopper ($n = 245$)		
	Pre	Post	Change	Pre	Post	Change
Drinks	3.339	3.300	-0.039	3.311	3.713	0.401***
High Fat Dairy	1.509	1.640	0.131	1.479	1.789	0.310***
Low Fat Dairy	1.858	1.694	-0.163	1.681	2.229	0.549***
High Sugar Drinks	0.535	0.595	0.060	0.597	0.492	-0.105*
Low Sugar Drinks	0.317	0.402	0.086*	0.345	0.406	0.061
Unhealthy Cereals	1.074	1.045	-0.029	0.991	1.109	0.118**
Healthy Cereals	0.844	0.634	-0.210***	0.741	1.037	0.296***
Spreads and Oils	0.366	0.281	-0.085*	0.316	0.395	0.079**
Fruit	1.080	0.884	-0.195**	0.998	1.279	0.281***
Vegetables	1.344	1.267	-0.077	1.313	1.570	0.257***
Other Greens	0.204	0.161	-0.042	0.169	0.206	0.037*
Fresh Meats	0.891	0.732	-0.159***	0.812	0.916	0.104**
High Fat Mains	1.344	0.964	-0.380***	1.249	0.995	-0.254***
Take Away	0.090	0.101	0.010	0.078	0.065	-0.013
Starches	0.796	0.607	-0.189***	0.708	0.734	0.025
Deserts	0.583	0.455	-0.128**	0.586	0.764	0.177***
Low Fat Snacks	0.149	0.112	-0.038	0.151	0.223	0.072**
High Fat Snacks	0.612	0.693	0.081	0.570	0.524	-0.048

Table 10: Paired Two-Sample t-tests of changes in consumption by influence of Children (source: own calculations on Wrigley et al, 2004b). Significance Level: * - 10%, ** - 5%, *** - 1%.

children is to reduce the intake of some items, rather than to increase anything. Dairy, both low fat and full fat, go up for those who do not have any child thoughts. This pattern continues for a large proportion of the food groups, including vegetables and healthy snacks. Effects of the eating patterns of children are seen in reducing healthy cereals, fruit, fresh meats and starches, all of which would concern policy makers. There is some hope in the significant reductions of deserts, but generally there is a need to push towards a more healthful response, and away from the "foods liked" approach. Evidence from adults own data shows that increases in healthy intake are very possible, and there is a desire for a better diet there.

Finally thought is given to the type of outlet used before the intervention. Significant changes are seen amongst those who used supermarkets pre-intervention and those who did not. Former supermarket shoppers did reduce their intake of high fat mains more than others, and there were significant increases for these households in low fat dairy and low sugar drinks. Such results confirm that all do indeed reappraise their diet in light of the new opening, not just those facing new store types. Where non supermarkets had been used in the pre-intervention wave the changes come in vegetables and other greens on the positive side. It was feared though that those who liked high fat main courses purchased the same amount, or more, after the intervention, in Table 11 it can be readily noted that less healthful options are often fitting this fear. Increases in high fat snacks and high fat dairy will be of concern to policymakers. It is apparent from the behaviour of non-supermarket shoppers that post-intervention a lot more of what they like is made available to them. Encouraging these households to consider the healthier options that the supermarket can offer them, but their convenience stores could not, is a key step for policy to take.

Group	Pre-Intervention Supermarket Shopper ($n = 354$)			Pre-Intervention Other Shopper ($n = 245$)		
	Pre	Post	Change	Pre	Post	Change
Drinks	3.331	3.503	0.172*	3.299	3.625	0.325*
High Fat Dairy	1.511	1.698	0.187**	1.431	1.810	0.380**
Low Fat Dairy	1.760	1.978	0.218*	1.753	2.045	0.292
High Sugar Drinks	0.580	0.541	-0.039	0.535	0.526	-0.009
Low Sugar Drinks	0.330	0.421	0.091***	0.340	0.349	0.009
Unhealthy Cereals	1.046	1.083	0.037	0.965	1.073	0.108
Healthy Cereals	0.776	0.861	0.085	0.823	0.853	0.030
Spreads and Oils	0.349	0.322	-0.027	0.302	0.422	0.120
Fruit	1.025	1.079	0.054	1.065	1.192	0.127
Vegetables	1.330	1.398	0.068	1.317	1.567	0.250**
Other Greens	0.192	0.174	-0.018	0.160	0.229	0.070**
Fresh Meats	0.856	0.847	-0.010	0.814	0.794	-0.021
High Fat Mains	1.279	0.945	-0.336***	1.330	1.107	-0.022*
Take Away	0.087	0.076	-0.011	0.073	0.096	0.023
Starches	0.743	0.653	-0.090***	0.760	0.760	0
Deserts	0.575	0.609	0.034	0.618	0.692	0.074
Low Fat Snacks	0.142	0.163	0.021	0.177	0.212	0.034
High Fat Snacks	0.609	0.573	-0.036	0.518	0.684	0.166**

Table 11: Paired Two-Sample t-tests of changes in consumption by pre-intervention store type (source: own calculations on Wrigley et al, 2004b). Significance Level: * - 10%, ** - 5%, *** - 1%.

Across this large set of paired two-sample t-tests there has been one common feature, the data does not support the simple view that supermarkets will improve health for everyone. Indeed there is some suggestion that the health of many will actually be reduced because large format stores can, and do, tailor their stock and promotions to local market conditions and tastes. Hence going into an area like Seacroft where the consumption of items which are considered good for them is not a common activity, it is perhaps inevitable that existing habits become amplified. In the focus groups it was suggested that Tesco was awash with temptation and so it has proved. The lesson for policymakers from this section is very clear, it will take a lot more than simply opening a supermarket for the dietary situation to improve. Focus now turns to the multivariate linear regressions for explaining post-intervention consumption of each food group.

4 Multivariate Regressions

Factors which either individually, or combined with use of the new Tesco intervention store, influence the levels of consumption of each food group were identified in the previous section. However, each was identified in comparative isolation and designed to assess narrow questions on the role that one, or two, factors play alone. Bringing together the full dataset from Table 1 allows the development of standard multivariate regression models for each of the groups outlined in Table 2. Variable inclusion is now evaluated on an equation by equation basis, with variables removed in a stepwise fashion until all that remain are significant at the 10% level. Rather like the OLS work of Wrigley et al (2003) on fruit and vegetables, there are inevitable concerns as to how much change might actually be explained by other factors not included in the initial list. Through consideration, and rejection, of various interactions it is felt that making the explanatory variable that of table 2 is optimal. It is these which are used in the regressions of Tables 12 and 13.

	drk	$daih$	$dail$	drh	drl	bch	bcl	spo	stl
Intercept	3.129*** (0.137)	1.366*** (0.163)	2.026*** (0.204)	0.385*** (0.065)	0.278*** (0.048)	0.984*** (0.057)	1.002*** (0.079)	0.397*** (0.061)	0.757*** (0.051)
$nc1$	-0.465* (0.272)								
$nc2$	-0.326* (0.178)		-0.329** (0.158)	0.128* (0.066)					-0.101** (0.049)
$nc3$	-0.235* (0.139)		-0.264** (0.124)		0.109*** (0.041)				-0.067* (0.038)
$nc4$		-0.234** (0.113)							
$ca1$				0.263*** (0.292)					
$ca2$			-0.274* (0.143)						
$ca3$			-0.200* (0.121)						
$ca4$	0.165** (0.067)								
pre		0.114*** (0.041)							
$switch$							-0.208*** (0.078)		
$aasda$		-0.306** (0.132)					-0.236*** (0.083)		
$asmkt$									
$bsmkt$								-0.111** (0.053)	-0.108** (0.043)
$nocar$	0.517** (0.212)								0.108** (0.050)
$unemp$					-0.158** (0.071)		-0.174* (0.091)		
$rent$		0.250** (0.126)							
$cost$			0.349** (0.154)						
$health$		-0.391* (0.170)	0.479** (0.195)			-0.139* (0.081)	0.328*** (0.086)	0.162*** (0.061)	
$seat$									
$ceat$	-0.232* (0.123)	-0.230* (0.126)	-0.466*** (0.139)				-0.307*** (0.062)	-0.098** (0.045)	-0.116** (0.037)
bal	0.496*** (0.111)		0.503*** (0.144)	-0.151** (0.060)	0.106** (0.048)	-0.106* (0.060)	0.326*** (0.063)		0.078* (0.037)
$like$	0.271** (0.114)	0.516*** (0.128)	-0.337** (0.142)	0.169*** (0.063)		0.277** (0.060)		0.080* (0.046)	
$conv$							-0.115* (0.063)		
$spouse$									
$child$	-0.382** (0.163)			0.217*** (0.081)					
$hunger$				0.127* (0.068)					
$offer$					0.107* (0.049)				
R^2	0.0937	0.0707	0.0986	0.0664	0.0385	0.0474	0.1689	0.0328	0.0486
$Adj\ R^2$	0.0798	0.0597	0.0848	0.0570	0.0320	0.0426	0.1591	0.0273	0.0390

Table 12: Regression Results First Set (Source: Own calculations on Wrigley et al, 2004b). Significance Level: * - 10%, ** - 5%, *** - 1%.

	frt	veg	$oveg$	mpf	$high$	$take$	des	snl	snh
Intercept	1.005*** (0.118)	1.4674*** (0.115)	-0.124 (0.124)	0.776*** (0.071)	0.639*** (0.082)	0.054*** (0.016)	0.623*** (0.090)	0.213*** (0.049)	0.427*** (0.067)
$nc1$								0.068*** (0.028)	
$nc2$	-0.188** (0.094)			-0.239** (0.078)	-0.251*** (0.090)		-0.164** (0.077)		
$nc3$				-0.159*** (0.061)					
$nc4$		0.103** (0.051)		-0.131** (0.059)	-0.201*** (0.073)		-0.115* (0.061)	0.068** (0.028)	
$ca1$	0.395*** (0.132)		0.279** (0.125)				0.251** (0.104)		
$ca2$			0.169* (0.089)						
$ca3$			0.131* (0.068)						
$ca4$	0.160*** (0.051)		0.141** (0.053)				0.124*** (0.040)		
pre									0.067* (0.037)
$switch$	-0.145* (0.078)							-0.077** (0.039)	
$aasda$		-0.177* (0.098)						-0.097* (0.041)	-0.118** (0.054)
$asmkt$								-0.027* (0.016)	
$bsmkt$	-0.177* (0.093)								
$nocar$	0.304*** (0.102)		0.303*** (0.121)	0.255*** (0.089)	0.274*** (0.093)	-0.026* (0.014)	0.333*** (0.086)		
$unemp$						0.073*** (0.020)			
$rent$					0.307*** (0.077)	0.044*** (0.014)			
$cost$			0.062* (0.028)	0.111* (0.059)	0.175*** (0.082)			0.067* (0.035)	
$health$	0.247** (0.110)	0.287** (0.126)		0.181** (0.073)				0.134*** (0.042)	
$seat$				0.110* (0.056)					
$ceat$	-0.329*** (0.079)	-0.254*** (0.090)		-0.175** (0.055)		0.024* (0.014)		-0.066** (0.031)	0.103* (0.056)
bal	0.379*** (0.081)	0.314*** (0.092)	0.057** (0.025)					0.061** (0.031)	-0.171*** (0.051)
$like$									0.135** (0.054)
$conv$				0.102* (0.055)		0.024* (0.014)			0.095* (0.054)
$spouse$									
$child$									0.131* (0.076)
$hunger$									
$offer$						-0.026** (0.014)	0.129** (0.063)	-0.062* (0.032)	0.114** (0.054)
R^2	0.1351	0.0734	0.0430	0.0638	0.0630	0.0658	0.0812	0.0951	0.0849
$Adj\ R^2$	0.1219	0.0640	0.0300	0.0495	0.0551	0.0564	0.0687	0.0797	0.0725

Table 13: Regression Results Second Set (Source: Own calculations on Wrigley et al, 2004b).
Significance Level: * - 10%, ** - 5%, *** - 1%.

A lack of access to a motor vehicle interacting with the distance from Seacroft reduces consumption of all of the food groups for which it is significant, with the exception of high sugar drinks. This is to be expected since carrying products from the store will be difficult and get harder the further the respondents have to travel. By contrast distance interacted with car access causes increases in consumption, but there are notably fewer occasions on which it does. Low fat dairy products are the only exception to the car rule, where further residents do reduce their consumption. As well as differentiating for the effect of travel mode the car access variable is included as a simple dummy and broadly speaking those without cars consume more than those with. Only take-away reduces as a result of not having a car, linked to the fact that cars are useful for collecting the food. From this it is clear that there are not the large effects near to the store that the intervention would have set out to achieve. In the nearest distance quartile the only significant effects are increases in fruits, processed vegetables, low fat snacks, high sugar drinks and desserts. While the first four would be welcomed by policymakers the latter two would be causes for concern.

One of the most interesting features of these regressions is that the pre-intervention consumption levels are so rarely significant. Indeed only high fat dairy and high fat snacks show any link. Value in moving beyond the paired two-sample t-tests is clearly illustrated by this. Equally insignificant is the $switch$ variable, with Tesco Seacroft only shown to reduce low fat breakfast cereals, fruit and low fat snacks, all of which would be seen as undesirable consequences of an intervention. Contrasting this with Asda Killingbeck shoppers, who have reductions in high fat dairy, high fat snacks, low fat breakfast cereals, vegetables and low fat snacks, shows that the impact of the latter large format retailer is much more mixed. Amongst those who also use another supermarket the only significant effect is a reduction in low fat snacks. For shoppers at a supermarket before the intervention the general effects are also loosely negative, reductions in fruit, starches and spreads and oils. Although this means that the impact of store format is quite insignificant the role of large format here is a concern. Policymakers looking at these results would then be rightly dubious about the benefits of supermarket shopping to the healthfulness of household's diet.

Income will reduce consumption, necessarily, but the question is what food groups see the biggest changes. Unemployment causes a reduction in low sugar drinks, low fat breakfast cereals and increases in take-away consumption. While the first two might be in line with lower income the latter result seems at odds and is more in keeping with earlier links to ability to cook and work with fresh alternatives. Needing rental support causes increases in high fat dairy, processed mains and take-away consumption, again this is at odds with income reducing consumption, but may be indicative of less healthy items being cheaper than their better for you alternative. Bringing in the impact of being influenced by special offers supports this conjecture, with low fat snacks reducing and high fat snacks increasing due to promotions. Additionally desserts and low sugar drink consumption is raised by discounts, and households are drawn away from take-away food. Targeting diet with price reductions would appear to be a fruitful policy from this study of deprivation variables.

Turning to the factors that influence the main shopper it is immediately apparent that cost/budget can cause increases in the consumption of certain foods, namely low fat dairy, processed vegetables, non-processed meats and low fat snacks. These are all good from a governmental perspective, but this positivity is tempered by the increase in high fat mains that is also noted. Respondents are also active in following the advice given to them on healthy eating by their doctors and peers. Health

advice being an influence leads to increases in low fat dairy, low fat cereals, spreads and oils, fruit, vegetables, low fat snacks, non-processed meats and fish. There are also reductions on health advice in high fat dairy and unhealthy cereals, but otherwise no significant changes in any of the other groups that policymakers might like to see reductions in.

Interestingly the foods that the respondents spouse would eat do not feature very strongly at all, only causing a significant increase of just under one portion per week of non-processed meat, poultry and fish. Having their spouse present on the shopping trip does not cause any change in any of the variables, suggesting there is no pester power on that side. However, this may simply be indicative of similar tastes rather than anything else. Where there are marked differences are when responding to what children eat is reported, the variable $ceat$ is significant in almost every equation across the two tables. There are only two significant increase attributable to this variable, high fat snacks and take-away, both are not surprising given that children do have preferences for sweets and chocolate and are likely to want foods like McDonald's etc. Reductions are seen in many of the healthy categories, including low fat dairy, low fat cereals, starches, fruit, vegetables, fresh meats and low fat snacks. There are also reductions in spreads and oils, and general non-calorific drinks. Having children present on the shopping trip causes increases in high sugar drinks, and high fat snacks, clear evidence of the pester power that they possess. Dietary interventions may wish to look at the role children play, as there is no indication that adults within households have significantly different food habits.

At the time of the study there was already a concerted effort to improve education about the importance of having a balanced diet. The effectiveness of this can be seen in the number of regressions in which it has a significant impact in improving the healthfulness of the diet. Increases are seen for low fat dairy, low sugar drinks, healthy breakfast cereals, starches, fresh fruits, fresh vegetables and low fat snacks. From many of these there are reductions in the corresponding unhealthy alternative, seen for high sugar drinks, less healthy cereals and high fat snacks. An increase in non-calorific drinks is also noted, so there is a bigger switch away from high sugar than the low sugar coefficient would suggest. Countering this education effort is the importance of the foods that people like, and in many cases the effect is in the opposite direction. Opposing effects are seen for low fat dairy, high sugar drinks, unhealthy cereals and high fat snacks. There is also an increase in high fat dairy as well as spreads and oils. From the analysis it is apparent that households like food which is inconsistent with a healthy diet.

In the literature a lot is made of the importance of having convenient access to healthy food, and it is felt that there will be improvements in diet should that be addressed. However when looking at those who report convenience as a major influencing factor only a few regressions show any meaningful role for access. A reduction in healthy breakfast cereals is seen, alongside increases in fresh meats, take-away and high fat snacks. The latter two may be a result of nearby outlets which sell such things, but the increase in meats is more surprising. Of note here will be the fact that a large number of the important food groups, including fruit and vegetables, show no impact in these OLS models. Equally insignificant is the role of hunger, which might have been expected to fuel more impulse buys and convenience store use. In this case only an increase in high sugar drinks is noted, a surprising result in many ways.

Across all of these regressions we can see that there are many different factors at play which influence the diet of respondents after the opening of the new Tesco Seacroft store. Evidence points to a real need to question the benefits of the intervention store, especially when special offers are moving customers towards less healthy options. Theory tells us that new large format stores can make people healthier, but the coefficients found here disprove this for the study at hand. Great care should be taken when introducing low price, large product range, outlets to improve diet as often there are many negative consequences that should be factored in. Policymakers viewing these results should tread carefully as the dangers of accepting aggregate, or average, conclusions have been well highlighted.

5 Conclusions

Large format retail interventions have been a major part of the changing face of the food retail landscape in many nations around the world. A key premise for this expansion has been the health benefits that low prices and large product ranges bring. However, little work has been done to study the bigger picture, and few opportunities exist to really delve into what happens when such stores open. In this study it is seen that the picture is far more complex and that certainly there is no significant evidence of the dietary improvements that theory dictates should occur. Health advice, the desire for a balanced diet and income are far greater drivers than any of the supermarkets that are included in the dataset. Indeed the major impact of the new Tesco store is found to amplify existing habits and consumption patterns.

Policy has long focused on getting fruit and vegetables to those whose access was previously limited, and been premised on the idea reduced price and convenience would have the desired consumption increasing effect. Results like those presented here give credence to that position but highlight the inevitable flaw that if cheap prices and greater accessibility can improve intake of greens, they can also increase intake of processed foods and less healthy options. Strategies have thus been falsely directed and far more attention needs to be paid to increasing demand for foods that are better for those who eat them, through education and through price interventions. Key to success will be ensuring that the prices of unhealthy foods do not also fall simultaneously as happens with new supermarket openings. In essence a large amount of micromanagement is suggested, and a lot more hands on investigation of likely effect should be undertaken on each change.

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