



Review Article

Reducing consumption of unhealthy foods and beverages through banning price promotions: what is the evidence and will it work?

Toby LS Watt^{1,2,*}, Walter Beckert³, Richard D Smith⁴ and Laura Cornelsen¹

¹Department of Public Health, Environments and Society, Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine, London WC1E 7HT, UK; ²The Health Foundation, London EC4Y 8AP, UK; ³Department of Economics, Mathematics and Statistics, Birkbeck, University of London, London WC1E 7HX, UK; ⁴College of Medicine and Health, University of Exeter, Exeter EX1 2LU, UK

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Abstract

Objective: Increasing prevalence of overweight and obese people in England has led policymakers to consider regulating the use of price promotions on foods high in fat, sugar and salt content. In January 2019, the government opened a consultation programme for a policy proposal that significantly restricts the use of price promotions that can induce consumers to buy higher volumes of unhealthy foods and beverages. These proposed policies are the first of their kind in public health and are believed to reduce excess purchasing and, therefore, overconsumption of unhealthy products. This study summarises evidence relating price promotions to the purchasing of food and drink for home consumption and places it in the context of the proposed policy.

Design: Non-systematic review of quantitative analyses of price promotions in food and drink published in peer-reviewed journals and sighted by PubMed, ScienceDirect & EBSCOhost between 1980 and January 2018.

Results: While the impact of price promotions on sales has been of interest to marketing academics for a long time with modelling studies showing that its use has increased food and drink sales by 12–43 %, it is only now being picked up in the public health sphere. However, existing evidence does not consider the effects of removing or restricting the use of price promotions across the food sector. In this commentary, we discuss existing evidence, how it deals with the complexity of shoppers' behaviour in reacting to price promotions on foods and, importantly, what can be learned from it in this policy context.

Conclusions: The current evidence base supports the notion that price promotions increase purchasing of unhealthy food, and while the proposed restriction policy is yet to be evaluated for consumption and health effects, there is arguably sufficient evidence to proceed. This evidence is not restricted to volume-based promotions. Close monitoring and proper evaluation should follow to provide empirical evidence of its intended and unintended effects.

Keywords
Public health
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Obesity is considered a global epidemic⁽¹⁾. In England, the issue is particularly acute among children, with 30 % of children aged 2–15 being overweight or obese⁽²⁾. In its recent update of the Childhood Obesity Strategy (Chapter Two), the Department of Health and Social

Care (DHSC) in England has set out a strategy to halve the rate of obesity among children within 12 years. Part of its action plan included a consultation of a policy to ban or considerably restrict volume-based price promotions (PP) and promotional placement of pre-packaged

*Corresponding author: Email toby.watt@lshtm.ac.uk

**Table 1** Share of take-home food and beverage sales volume purchased on price promotion across broad food groups in 2017*

Food group	Share (%) of volume purchased on price promotion
All	32
Milk, eggs and bread	15
Fresh vegetables and salad	24
Starchy foods, e.g. pulses, pasta, rice	27
Fresh fruit	28
Fresh and frozen fish, red meat and white meat	37
Ready meals	42
Savoury snacks	49
Diet soft drinks	50
Biscuits, chocolate and confectionary	52
Regular soft drinks	59

*Data source: Kantar FMCG Panel volume-weighted take-home purchases of foods and non-alcoholic beverages recorded from a nationally representative sample of approximately 30 000 British households annually.

high-fat, high-sugar and high-salt (HFSS) products^(3,4). If passed, such policy would add to the existing measures targeting obesity implemented in England in recent years, including the Soft Drink Industry Levy (2018), Sugar Reduction Programme via voluntary reformulation (2017) and strategies for healthier 'out-of-home' food provision⁽⁵⁻⁶⁾. While the results of the consultation (January–April 2019) are, at the time of writing, yet to be released by DHSC, we argue in this commentary that, while the evidence base on the effects of PP may be sufficient to proceed, it is not sufficiently developed to be conclusive on the effects of restrictive action. Since it is the first policy proposal of its kind, there is need for further evidence on how the proposed restrictions on PP could change consumer behaviour and benefit health.

How frequent are price promotions in food retail?

PP incentivises customers to purchase through reductions below the recommended retail price. In the UK food retail sector, there are predominantly either total price reductions, or volume-based PP that encourage greater quantities to be purchased for the same cost (e.g. buy-one-get-one-free). Data on consumer expenditures (Table 1) show that, in 2017, a third of take-home purchases were made on PP, and products typically considered HFSS (e.g. regular soft drinks) were twice as likely to be bought on promotion in comparison to fruits and vegetables or starchy foods.

The public health rationale for the DHSC policy proposal follows from this frequent, on-promotion purchasing of unhealthy HFSS products. Even if the policy could be seen as anti-competitive in limiting this frequently used method of competition, regulation might be the only way to proceed as retailers are unlikely to reduce PP unilaterally on voluntary basis.

What evidence exists on price promotions and food buying behaviour?

PP has been studied by researchers in public health, focusing on the nutritional impact of 'point of sale' health policies, and marketing, focussing on the sales and revenue impact of PP. The challenge is that existing research is conducted in a retail industry filled with promotions, where high variability in prices boosts purchasing through different consumer behavioural responses.

Public health

Seven reviews of public health literature considering the impact of price interventions on food consumption or nutrition have been published between 2014 and 2018⁽⁷⁻¹³⁾. These reviews find evidence, based on demand modelling, experimental methods and RCT, that financial incentives can result in changes in food purchasing behaviour. For example, Hartmann-Boyce *et al.*⁽⁹⁾ focussed on RCT of in-store interventions to improve population health, finding discounts and subsidies to be effective in encouraging healthier food consumption. Policies to discourage less-healthy food consumption typically involve taxation (e.g. taxes on sugary drinks⁽¹⁴⁾ or junk food⁽¹⁵⁾), which is increasingly implemented given the successful use of fiscal measures in other areas of public health such as tobacco and alcohol control^(16,17).

The systematic reviews on PP, however, do not cite any literature that discusses the removal of PP on unhealthy foods as a possible strategy, and while similarities exist with taxation as both increase prices, the two policies are different in their mechanisms for eliciting consumer and retailer responses and require further research from public health perspective.

Marketing

Marketing studies use highly disaggregated data from retailers or household expenditure panels to understand how PP influences consumer behaviour. This literature takes the perspective of 'managers' and explores ways to increase sales. The food or beverage categories used in these analyses do not distinguish between healthier or less healthy as this is not their purpose. The analysis relied upon by DHSC – finding that promotions that are more common on unhealthy products increase purchases by up to 22% – is in fact one of the very few to make use of the link between nutrition and sales data⁽¹⁸⁾ to analyse the effect of PP.

Five relevant reviews⁽¹⁹⁻²³⁾ exist in the marketing literature on the impact of PP on food and drink sales. Van Heerde and Neslin^(21,22) provided a thorough overview of the literature on the impact of PP on brand and category sales. Hawkes⁽¹⁹⁾ review is the only discussion of the marketing literature from a nutrition perspective. Two meta-analyses have found that PP leads to significantly increased

sales for individual products^(20,23). Santini *et al.*⁽²⁰⁾ looked at both the short- and long-run effects of PP on sales volume and purchase incidence, and their meta-analysis of seventy-five studies concluded that PP increases purchase incidence and sales volume (with no average effect size provided). Bijmolt *et al.*⁽²³⁾ concluded from 198 elasticities that a 20% PP leads to a 73% increase in purchasing, on average.

Do increased sales as a result of price promotions lead to increased consumption?

Considerable effort has gone into identifying how PP increases sales, or the ‘promotion bump’ as often referred to in the marketing literature. Generally, this is attributed to three forms of consumer reactions⁽¹⁹⁾:

1. Consumer switching: purchasing the same quantity but of a different brand. This has little effect on total nutritional consumption.
2. Increased purchasing: promotions causing purchases that otherwise would not have occurred, creating a potential increase in consumption quantity.
3. Stockpiling: increasing purchase quantity to take advantage of a promotion and avoid higher spending on off-promotion purchases in the future. This does not necessarily increase overall consumption, but there is a possibility that it does, notably if it induces a change in consumption habits. When stockpiling is effective, purchases that would otherwise have occurred at a later date are brought forward. This is referred to as ‘purchase acceleration’.

From a health perspective, understanding the relative effects of the last two categories is crucial, particularly whether the ‘additional’ purchases are stockpiled for later use or consumed.

For households, the frequency with which goods are purchased is important: infrequent ‘impulse’ purchases are likely for immediate consumption, but for frequently purchased goods, stockpiling can make the effects less straightforward. Stockpiling creates the opportunity to save the customer money, but it may also lead to unintended consumption. For example, a repeat customer of cola may buy one bottle per week, but with a two-for-one promotion, they might buy two, intending to save money by avoiding future purchases. Once the extra bottle is in the house, it is drunk at a faster rate. If next week the potentially avoided purchase is still made, overall consumption has increased. The increased purchase can, therefore, be decomposed into ‘purchase acceleration’ – a successful use of stockpiling in which future purchases are avoided – and ‘increased consumption’.

Table 2 presents the decomposition of the ‘promotion bump’ into primary demand increases (i.e. increased consumption and purchase acceleration) and secondary

demand (i.e. switching brands). It is clear that the ‘promotion bump’ varies a great deal depending on the product: 33–87% of these increases using the unit sales decomposition approach are increases of category sales, of which 10–56% are consumption increases (i.e. buying more altogether), and 9–69% purchase acceleration due to stockpiling. The key evidence, however, comes from two counterfactual analyses^(24,25) that are most appropriate from a methodological point of view. These studies conclude that consumption increases of 12–43% occur as a result of promotions.

The product range studied is clearly restricted, which makes generalisation of these estimates difficult, although Nijs *et al.*⁽²⁶⁾, who used a large range (n 560) of products, found (without a decomposition analysis) that promotions lead to an increase in primary demand for more than half (58%) of these products. Importantly, these results are not restricted to volume-based promotions, but include simple price reductions as well. At present the DHSC’s proposal mentions volume-based promotion only which is a small part of PP as a marketing strategy.

While increases in primary demand due to promotions appear prominent, we must question whether increased purchasing necessarily leads to increased consumption – which is what leads to detrimental effects on public health⁽¹⁹⁾. There is some evidence in behavioural and economics research that actual consumption rates can be affected by stockpiled food (or inventory)⁽²⁷⁾. This is through a number of mechanisms, including uncertainty about future prices^(28–30), scarcity – concerns of running out before the next shop would reduce consumption rates^(31,32), increased storage costs – stockpiling leads to crowded kitchens and pantries, increasing holding costs and the desire to consume⁽³³⁾, replacement costs – when prices fluctuate, stockpiled goods are replaced only when on promotion⁽³³⁾ and convenience – the presence of food in the kitchen, in the fridge or on counter tops^(27,34,35).

What is the evidence relating to a restrictive policy on price promotions?

This evidence, together with Public Health England’s estimated ‘effect’ from PP of up to 22% increase in purchases, presents a rationale for intervening to reduce PP on unhealthy foods⁽¹⁷⁾. However, these methods still do not answer the question at hand: ‘what if PP on unhealthy foods was restricted or banned altogether?’ Without a direct evidence, it is difficult, *ex ante*, to quantify the potential benefits, as well as identify the potential risks from unknown consumer and retailer response, because:

- Existing evidence largely ignores a crucial aspect of PP: their efficacy relies on their repeated use (i.e. consumers may expect PP and factor this into their purchasing decisions). In the current retail markets, PP

Table 2 Product-level sales increases associated with price promotions: decomposition into primary (purchase acceleration and increased consumption) and secondary effects*

Author	Date	Product category	Increased consumption (%)	Purchase acceleration (%)	Combined (primary) (%)	Switching (secondary) (%)
Unit sales decomposition approach						
Teunter ⁽⁴⁰⁾	2002	Soft drinks	27	38	65	34
		Fruit juice	17	58	75	25
		Ground coffee	14	48	62	39
		Potato chips	46	41	87	13
		Candy bars	10	63	73	27
		Pasta	14	47	61	39
		Average	21	46	67	33
Van Heerde <i>et al.</i> ⁽⁴¹⁾	2003	Eleven products (as in Bell <i>et al.</i>)			33	67
Sun <i>et al.</i> ⁽⁴²⁾	2003	Ketchup			44	56
Van Heerde <i>et al.</i> ⁽⁴³⁾	2004	Tuna	31	38	69	31
		Peanut butter	33	24	57	43
		Average	35	32	67	33
Nair <i>et al.</i> ⁽⁴⁴⁾	2005	Orange juice			92	8
Ailawadi <i>et al.</i> ⁽⁴⁵⁾	2007	Yoghurt (average across brands)	56	9	65	35
		Ketchup (average across brands)	39	18	57	44
		Tuna	29	43	72	28
Chan <i>et al.</i> ⁽³⁸⁾	2008	Beverage			52	48
Ebling and Klapper ⁽⁴⁶⁾	2010	Spread			50	50
		Dessert			74	26
		Average				
Counterfactual analysis						
Ailawadi and Neslin ⁽²⁴⁾	1998	Yoghurt	35			
Sun ⁽²⁵⁾	2005	Ketchup	12			
		Yoghurt	43	18	61	39
		Tuna	33	25	58	42

Combined (primary) values are the sum of increased consumption and purchase acceleration where they are separately reported in bold. *With the exception of Nijs *et al.*⁽²⁶⁾ and Teunter (2002)⁽⁴⁰⁾, which were conducted in the Netherlands, all studies used US consumer scanner data.

is frequent and shoppers are likely to stockpile during sales and delay purchases when they are not on⁽²¹⁾.

- Consumers respond asymmetrically to price changes⁽³⁶⁾ meaning that the effect of price increase is not necessarily the opposite of the effect of a discount.
- Few studies have looked at what happens to the demand for a product once a promotion is withdrawn (rather than added)⁽²⁵⁾. But removing all promotions on similar products with no promoted substitutes available altogether has never been addressed.
- The effects of this policy depend on the response from retailers who will act to maintain profitability. Will the new pricing strategy be a switch to pre-regulation non-promotional prices? Or a regular low price? It could be that if retailers reduce their regular, everyday prices enough, the policy will have little effect.

There are techniques that allow researchers to deal with these dynamic difficulties. Structural demand estimation^(25,37-39) can identify the effect of price expectations on current purchasing and consumption decisions. These are difficult to implement but workable. Without their use, the analysis will overestimate the consumption effects of PP. In simplest terms, this is because there is

no incentive to stockpile if shoppers know the price will be the same in a week's time; people can better plan their purchasing, allowing them to take control of their diets. The extent to which this occurs, as well as retailer response, could be estimated through dynamic structural modelling.

What can we conclude for current policy?

Existing evidence suggests that PP might lead to significant increases in purchases that, in turn, can lead to greater consumption and likely overconsumption, but the evidence is not sufficient to know the extent to which banning or significantly restricting promotions would reduce consumption. This requires more studies to simulate the effects of promotions removal. On the other hand, this is not new in public health policies, especially major government initiatives that are often based on a combination of evidence related to the problem and its solutions (e.g. public indoor smoking ban). It is rare to have *a priori* direct evidence on policy impact, especially if the scope for an experimental investigation is limited.

Given the seriousness of adult and childhood obesity, it is clear that the usual playbook of individual-focused

interventions and policies has not worked. More radical and structural policy initiatives that rely less on consumer agency might, therefore, be exactly what we need, even if the evidence is less-than-perfect. In this instance, the rationale and logic for the policy of restricting PP is clear. The evidence of intended and unintended consequences is of utmost importance and should be carefully monitored and evaluated when a policy is implemented. However, the lack of direct evidence now should not cause a missed opportunity.

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References

1. Ulijaszek SJ (2003) *Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation. WHO Technical Report Series 894.*
2. Health and Social Care Information Centre (2017) Summary of key findings. In *Health Survey for England* (version 2), pp. 1–33 [Department of Health and Social Care, editor]. UK: NHS Digital. <https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/2017> (accessed June 2019).
3. Department of Health and Social Care: Global Public Health Directorate: Obesity, Food and Nutrition (2018) Chapter 2. In *Childhood Obesity: A Plan for Action*, pp. 1–33 [Department of Health and Social Care, editor]. UK: Department of Health and Social Care. <https://www.gov.uk/government/publications/childhood-obesity-a-plan-for-action-chapter-2> (accessed June 2019).
4. Department of Health and Social Care (2019) Closed consultation: Restricting promotions of food and drink that is high in fat, sugar and salt. In *Consultations*, pp. 1–36. UK: Department of Health and Social Care, Global and Public Health Directorate / Population Health Division / Obesity Food and Nutrition Branch. <https://www.gov.uk/government/consultations/restricting-promotions-of-food-and-drink-that-is-high-in-fat-sugar-and-salt> (accessed October 2019).
5. Tedstone A, Coulton V, Targett V *et al.* (2017) Sugar reduction and wider reformulation programme: Report on progress towards the first 5% reduction and next steps. In *Sugar Reduction: Report on First Year Progress*, pp. 1–101 [Department of Health and Social Care, editor]. UK: Department of Health and Social Care. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/709008/Sugar_reduction_progress_report.pdf (accessed June 2019).
6. Public Health England (2017) Health Matters: Obesity and the food environment. In *Public Health England: Guidance* [Department of Health and Social Care, editor]. UK: Department of Health and Social Care. <https://www.gov.uk/government/publications/health-matters-obesity-and-the-food-environment/health-matters-obesity-and-the-food-environment-2> (accessed May 2019).
7. McGill R, Anwar E, Orton L *et al.* (2015) Are interventions to promote healthy eating equally effective for all? Systematic review of socioeconomic inequalities in impact. *BMC Public Health* **15**, 457–457.
8. Hyseni L, Atkinson M, Bromley H *et al.* (2016) The effects of policy actions to improve population dietary patterns and prevent diet-related non-communicable diseases: scoping review. *Eur J Clin Nutr* **71**, 694–711.
9. Hartmann-Boyce J, Bianchi F, Piernas C *et al.* (2018) Grocery store interventions to change food purchasing behaviors: a systematic review of randomized controlled trials. *Am J Clin Nutr* **107**, 1004–1016.
10. Liberato SC, Bailie R & Brimblecombe J (2014) Nutrition interventions at point-of-sale to encourage healthier food purchasing: a systematic review. *BMC Public Health* **14**, E919.
11. Adam A & Jensen JD (2016) What is the effectiveness of obesity related interventions at retail grocery stores and supermarkets? A systematic review. *BMC Public Health* **16**, E1247.
12. Escaron AL, Meinen A, Nitzke SA *et al.* (2013) Supermarket and grocery store based interventions to promote healthful food choices and eating practices: a systematic review. *Prev Chronic Dis* **10**, E50.
13. Cameron AJ, Charlton E, Ngan WW *et al.* (2016) A systematic review of the effectiveness of supermarket-based interventions involving product, promotion, or place on the healthiness of consumer purchases. *Curr Nutr Rep* **5**, 129–138.
14. Teng AM, Jones AC, Mizdrak A *et al.* (2019) Impact of sugar-sweetened beverage taxes on purchases and dietary intake: systematic review and meta-analysis. *Obes Rev* **20**, 1187–1204.
15. Taillie LS, Rivera JA, Popkin BM *et al.* (2017) Do high vs. low purchasers respond differently to a nonessential energy-dense food tax? Two-year evaluation of Mexico's 8% non-essential food tax. *Prev Med* **105S**, S37–S42.
16. Chaloupka FJ, Straif K & Leon ME (2011) Effectiveness of tax and price policies in tobacco control. *Tob Control* **20**, 235–238.
17. Chisholm D, Moro D, Bertram M *et al.* (2018) Are the “best buys” for alcohol control still valid? An update on the comparative cost-effectiveness of alcohol control strategies at the global level. *J Stud Alcohol Drugs* **79**, 514–522.
18. Smithson MK, James K & Capelin C (2015) Sugar Reduction: The evidence for action Annex 4: An analysis of the role of price promotions. In *Sugar Reduction: From Evidence into Action*, pp. 1–43. [Public Health England, editor]. United Kingdom: Department of Health and Social Care. <https://www.gov.uk/government/publications/sugar-reduction-from-evidence-into-action> (accessed May 2019).
19. Hawkes C (2009) Sales promotions and food consumption. *Nutr Rev* **67**, 333–342.
20. Santini FdO, Vieira VA, Sampaio CH *et al.* (2016) Meta-analysis of the long- and short-term effects of sales promotions on consumer behavior. *J Promot Manag* **22**, 425–442.
21. Neslin SA & van Heerde HJ (2009) Promotion dynamics. *Found Trends Mark* **3**, 177–268.
22. van Heerde HJ & Neslin SA (2008) Sales promotion models. In *Handbook of Marketing Decision Models*, pp. 107–162 [B Wierenga, editor]. Boston, MA: Springer US.
23. Bijmolt THA, van Heerde HJ & Pieters RGM (2005) New empirical generalizations on the determinants of price elasticity. *J Mark Res* **42**, 141–156.
24. Ailawadi KL & Neslin SA (1998) The effect of promotion on consumption: buying more and consuming it faster. *J Mark Res* **35**, 390–398.



25. Baohong S (2005) Promotion effect on endogenous consumption. *Mark Sci* **24**, 430–443.
26. Nijs VR, Dekimpe MG, Steenkamp J-BEM *et al.* (2001) The category-demand effects of price promotions. *Mark Sci* **20**, 1–22.
27. Wansink B & Deshpande R (1994) 'Out of sight, out of mind': pantry stockpiling and brand-usage frequency. *Mark Lett* **5**, 91–100.
28. Assunção JL & Meyer RJ (1993) The rational effect of price promotions on sales and consumption. *Manag Sci* **39**, 517–535.
29. Gourville JT & Soman D (1998) Payment depreciation: the behavioral effects of temporally separating payments from consumption. *J Consum Res* **25**, 160–174.
30. Soman D & John T. (2001) Transaction decoupling: how price bundling affects the decision to consume. *J Mark Res* **38**, 30–44.
31. Folkes V & Wheat RD (1995) Consumers' price perceptions of promoted products. *J Retail* **71**, 317–328.
32. Wansink B (1996) Can package size accelerate usage volume? *J Mark* **60**, 1–14.
33. Chandon P & Wansink B (2002) When are stockpiled products consumed faster? A convenience-salience framework of postpurchase consumption incidence and quantity. *J Mark Res* **39**, 321–335.
34. Wansink B, Brasel SA & Amjad S (2000) The mystery of the cabinet castaway: why we buy products we never use. *J Fam Consum Sci* **92**, 104–108.
35. Raghubir P & Krishna A (1999) Vital dimensions in volume perception: can the eye fool the stomach? *J Mark Res* **36**, 313–326.
36. Cornelsen L, Mazzocchi M & Smith R (2018) Between preferences and references: Evidence from Great Britain on asymmetric price elasticities. *Quaderni di Dipartimento* **1**, 1–34.
37. Hendel I & Nevo A (2006) Measuring the implications of sales and consumer inventory behavior. *Econometrica* **74**, 1637–1673.
38. Chan T, Narasimhan C & Zhang Q (2008) Decomposing promotional effects with a dynamic structural model of flexible consumption. *J Mark Res* **45**, 487–498.
39. Liu Y & Balachander S (2014) How long has it been since the last deal? Consumer promotion timing expectations and promotional response. *Quant Mark Econ* **12**, 85–126.
40. Teunter LH (2002) Analysis of sales promotion effects on household purchasing behavior. ERIM PhD Research Series in Management, Erasmus University Rotterdam, 262 p.
41. Van Heerde HJ, Gupta S & Wittink DR (2003) Is 75% of the sales promotion bump due to brand switching? No, only 33% is. *J Mark Res* **40**, 481–491.
42. Sun B, Neslin SA & Srinivasan K (2003) Measuring the impact of promotions on brand switching when consumers are forward looking. *J Mark Res* **40**, 389–405.
43. Van Heerde JH, Leeflang PSH & Wittink DR (2004) Decomposing the sales promotion bump with store data. *Mark Sci* **23**, 317–334.
44. Nair H, Dubé J-P & Chintagunta P (2005) Accounting for primary and secondary demand effects with aggregate data. *Mark Sci* **24**, 444–460.
45. Ailawadi K, Gedenk K, Lutzky C *et al.* (2007) Decomposition of the sales impact of promotion-induced stockpiling. *J Mark Res* **44**, 450–467.
46. Ebling C & Klapper D (2010) Modeling whether, what and how much to buy the right way: how important is the selectivity bias in purchase quantity outcomes? *Rev Manag Sci* **4**, 171–199.