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Explaining Consumer Heterogeneity in Structural State-Dependence

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Abstract: Consumers are heterogeneous in their inertial responses to previous consumptions. Information on consumers' structural state-dependence is valuable for evaluating consumers' habit-forming strength and thus can be used for encouraging more sustainable consumption. Conventional methods of estimating such effects are complex and require repeated purchase data, which is difficult to obtain when consumers are inexperienced in buying sustainable products. In this paper, we utilize consumers' previous switch behaviour data and investigate whether it can explain heterogeneous state-dependence effects. We demonstrate this in consumer-packaged goods markets using scanner datasets. Consumers' normalized brand switches in a different product category several years ago are used to measure inter-temporal preference variations that are stable and are independent of products and markets. Accounting for household characteristics, we find that some variation in switch behaviour is highly stable: it explains a significant portion of consumers' structural state-dependence in the market under investigation. Therefore, consumers' switch tendencies can be structural to their preference. The finding suggests that incorporating consumers' switch behaviour from other choice domains can be a simple and effective method of understanding the heterogeneous effects behind habit formation. Our constructed measure has broad implications in shifting consumer behaviour to be more sustainable.

Keywords: heterogeneity; brand switch; structural state-dependence; habit formation; scanner data

1. Introduction

Now that business values sustainability, encouraging consumers to practice sustainable consumption has become a major goal for marketers and policymakers [1]. In our daily life, many consumption choices are strongly habitual [2]. Habitual decision making prevents consumers from switching towards more sustainable consumption. In the hope of breaking "bad" habits, previous literature has explored various external factors affecting sustainable consumption through habit formation using experimental methods. However, in the process of applying such knowledge to large-scale transaction data, we do not have a simple and direct measure of heterogenous habit-forming strength. The purpose of this work is to recommend and test a methodology for investigating consumers' heterogeneous habit-forming strength in consumer brand choices, and to discuss possible implications in promoting sustainable consumption.

Quantitative marketing and economics literature have both documented rich evidence that consumers are subjected to the habit-forming 'structural state-dependence' effect [3] in choice models. In other words, consumers are more likely to maintain their previous choices, not only because of product characteristics or market environments, but also due to intrinsic changes to consumers' preferences

after making choices. However, unlike external factors, the intrinsic structural state-dependence effect is difficult to identify [4]. Capturing the heterogeneity in structural state-dependence has been a challenge for researchers and business practitioners. The typical method of modelling heterogeneous consumer state-dependence in the discrete choice framework [5] is to allow the coefficients of the lagged choices to follow pre-specified random distributions flexibly. To further rule out other sources of state-dependence, such as market frictions, researchers usually need to carefully select markets in which confounding effects are minimal or can be controlled [3,4,6]. While those studies consistently report positive and robust average structural state-dependence effects, the models usually require restrictive assumptions (for example, search cost and learning effects need to be ruled out first for identifying structural state-dependence [3]) and are relatively complicated to directly apply to a market with new products or a not-well-defined market.

Marketers and policymakers would be more interested in evaluating consumer demand in a market with inexperienced consumers and significant market frictions. For example, with the introduction of (more) sustainable products (e.g., products that provide more environmental, social or economic benefits at the same cost to our society), policymakers hope to break previous 'bad' habits and encourage a shift towards more sustainable products [1]. However, it is difficult, if not impossible, to identify the habit-forming strength in such an environment. In these markets, limited choices cannot provide sufficient variation to distinguish heterogeneous structural state-dependence from other unobserved temporal effects, leading to 'spurious state-dependence' [7]. Without knowing the mechanism behind the formation of sustainable habits, policymakers have to limit their analyses to external environments that only affect habit formation indirectly.

Due to the above-mentioned data limitations, previous analyses of consumer choices of sustainable products have had to rely more on experimental data. Discrete Choice Experiments [8]—and, more recently, field experiments [9]—can both report consumers' willingness-to-pay for (hypothetical or real) sustainable products. The experimental methods are powerful and valuable in investigating exogenous factors that facilitate habit-formation process [2]. However, without a direct measure, even experimental methods cannot quantify consumers' heterogeneous habit formation and prescribe individual-level treatments accordingly. In making policy suggestions, researchers have to trust average treatment effects over a relatively small sample size and focus more on aggregate effects that drive structural state-dependence.

In this paper, we explore a new and practical way to measure heterogeneous habit-forming strength in choice models. We test whether variations in brand switches in a loosely related market may reveal the habit-forming structural state-dependence effect. If part of consumers' switching tendencies is truly intrinsic, we expect to see a significant interactive effect of consumers' switching behaviour (that cannot be explained by current market environments) on state-dependence effects.

Two market categories, namely yoghurt (in 2001) and carbonated beverages (in 2007), are selected from the IRI's scanner datasets [10]. We construct a measure, 'switch per choice' (SPC), to describe households' switching tendencies in the yoghurt category. The switching information is then used in models of (the same) households' brand choices in the carbonated beverage category five years later. Our estimation result shows that the SPC in yoghurt markets can explain a significant portion of state-dependence on major brand choices in the carbonated beverage market. Such effects are robust when controlling for rich household-level demographic information. We conclude that SPC offers a practical way to capture habit-forming structural state-dependence and discuss how the method can be applied to encourage consumers to shift toward more sustainable consumption.

2. Literature Review and Hypothesis Development

2.1. Sustainable Consumption and Consumer Habit

At the Oslo Symposium in 1994, sustainable consumption was broadly defined as "the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the

use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations." In different occasions, sustainable consumption can be more specific [11]. In general, most people would agree that sustainable consumption is a good thing. However, the favourable attitude does not translate well into action. The "value–action" gap has been reported in various consumption categories [12,13].

Habitual decision making has been viewed as one of the main reasons behind the gap [2]. In contrast to conscious decision making—an effortful and controlled process, habitual decision making is automatic and intuitive [14]. In a repetitive purchase setting, previously established (unsustainable) habits compete with new behavioural intentions of adopting sustainable products [1]. In some markets, encouraging behavioural change can be more challenging. For example, grocery shopping decisions can be highly automatic if shoppers visit the same stores regularly [15,16]. Strong habits can further limit consumers' product searches [17] and their learning of new information [18]. Therefore, Consumption habit has proven to be a significant barrier to the adoption of sustainable products in these markets [12,19–21].

There are potential ways of breaking bad habits and encourage new ones [1]. For example, effective interventions against bad habits usually involve major life changes [22–24] or heavy enough penalties [25,26]. Meanwhile, a more positive approach is to encourage consumers to think more about sustainable options [14], making the adoption as easy as possible [27], and providing necessary information and feedbacks [28,29]. While those approaches are promising at the aggregate level, it is still difficult for researchers and policymakers to quantify the effects of habit formation at the individual level.

An accurate measure of the habit formation effect is helpful because one can assign treatments more precisely and evaluate treatment effects at the individual level. However, obtaining a practical measure of habit strength is not easy. On the one hand, survey-based measures are rare and they are limited in large-scale applications [30,31]; on the other hand, behaviour-based measures are subjected to identification issues, which will be made clear in the next subsection.

2.2. State-Dependence and Heterogeneity

Consumers are more likely to choose the product that they have previously chosen. The inertial effect has been well documented in the marketing literature [32,33]. Heckman [7] offers two conceptually different explanations for such a phenomenon. The first one is based on a habit-forming behavioural effect called the "structural state-dependence". Past experience has a direct causal effect and changes the consumers' preferences or constraints. Broadly speaking, state-dependence is a fundamental behavioural effect not only discovered in product and brand choices, but also in more general domains of choices and responses [34].

The second one is based on "spurious state-dependence" mainly caused by unobserved heterogeneity. Consumers differ in certain unobserved factors that influence their probability of experiencing an event. Because the structural state-dependence effect and consumer heterogeneity have different implications, econometricians and statisticians in the related fields have developed various choice models to distinguish structural state-dependence effects [6,35–37]. The general idea of this literature is to use various statistical methods to control for unobserved heterogeneity and report the residual state-dependence effect as structural to consumers. These studies documented strong structural state-dependence effects after flexibly controlling for market heterogeneity.

Seetharaman [4] considers more detailed sources of serial correlations across time including different habit persistence effects and carry-over effects. He also considers variety seeking as a potential negative structural state-dependence. However, transaction datasets usually witness more aggregate effects of inertia, instead of variety seeking effects. Dubé, Hitsch, and Rossi [3] show that structural state-dependence effects are also heterogeneous: some products or brands can be more habit-forming. Moreover, the authors point out that other behavioural effects due to learning and search cost can bring structural changes to consumers' preferences as well. Therefore, a model of structural state-dependence

needs to further rule out these possibilities. Thomadsen and Seetharaman [38] work on the implications of state-dependence on marketing strategies and concludes that variety seeking and state-dependence have similar impacts on pricing strategies.

Due to the dominating inertial effects, brand switches are less explored in transaction-based data. In contrast, brand switches are more linked to consumers' variety seeking tendencies. Using experimental and survey approaches, consumer behaviour studies document clear evidence that consumers switch in search of variety [39–42]. In a recent working paper, Wang and Shankar [43] also show that some realized brand switches cannot be explained by the changes in product characteristics and marketing strategies in transaction datasets. The variety seeking effect is simply a negative form of structural state-dependence [4]. Brand switches can provide crucial information on the heterogeneity in the structural state-dependence.

2.3. Methodology Notes

One popular approach to studying the adoption of sustainable products is the Discrete Choice Experiment [44–46]. For example, in an experimental setting, consumers are asked to make hypothesized product choices between a product with a sustainability label and a regular product. The information provided in the experimental settings is usually more salient than what we experience in everyday life. Therefore, consumers' habitual decision making is not fully accounted for. Meanwhile, field experiments have provided alternative and more credible estimates of consumer choices in relation to sustainable products [9]. Evaluating consumers' real purchase behaviour becomes a clear trend in sustainability studies. Yet, in contrast to discrete choice experiments, field evaluation reports very weak results for sustainability labels.

Researchers need to find a way to control and evaluate the effect of habitual decision making more directly. In large-scale applications, existing measures based on consumers' structural state-dependence needs to be estimated using high quality repeated purchase data [3]. Statistical models that identify structural state-dependence from heterogeneity is usually complex. For example, Hierarchy Bayesian models provide the most flexible ways of controlling consumers' heterogeneous and unobserved tastes [5]. However, the models need to be built from scratch and be customized for each different case.

For the purpose of evaluating sustainable consumption policies, research designers and practitioners would benefit most from a measure of habit-forming strength that is intuitive and easy to obtain. Because consumers' switches that are unrelated to a specific market or product reflect (negative) structural state-dependence [4], such information can be readily used in evaluating consumers' habit-forming strength.

2.4. Hypothesis

We hope to understand how heterogeneous habit-forming strength affects consumers adopting sustainable products. Drawing from the literature on structural state-dependence, we propose to use consumers' switches in a different choice category to explain the heterogeneous habit-forming strength (in choices). Therefore, our hypothesis is straightforward: an individual consumer or household's brand switch information that is not related to the market or products being investigated should explain the consumer's structural state-dependence in her choices. In the test carried out below, we construct a normalized switch rate in a different product category at a much earlier time, and then test this hypothesis in the carbonated beverage market—a market with clear evidence of habitual effects [47].

3. Data

We use two market categories—namely yoghurt (in 2001) and carbonated beverage (in 2007), selected from the IRI's scanner datasets [11]—to demonstrate the effect of consumer brand switches. The IRI data consists of households' purchasing records in two mid-sized cities (Eau Claire, Wisconsin and Pittsfield, Massachusetts) of the United States. In both selected product categories, habitual decisions are likely to affect consumers. Regular consumption of yoghurt products is probably viewed

as a good habit [48], which is also costly to form. Meanwhile, carbonated beverage is viewed as addictive and brings limited health benefits. Manufacturers have incentives to make the products healthier and the production and packaging more environmental-friendly. We have used the most recent year we have (2007) in the IRI datasets for our targeted market. Moreover, our analysis requires households' complete choice history, which can be covered by the scanner data in 2007. In contrast, when online shopping behaviour becomes more popular, shopping records cannot be fully tracked using scanner data alone. Because consumers' structural state-dependence effects are fundamental to their intrinsic preferences, the effect is likely to remain stable for long periods of time. Finally, to make sure that products in the two markets are not related, we also calculate households' brand switches at a much earlier time (2001). The long gap reflects the fact that consumer inertia is a stable phenomenon over time.

We model consumers' binary brand choices in the IRI carbonated beverage category; 4189 households have more than five shopping trips within this year (In the IRI scanner data sets, choices and switches are defined at the household level. For expositional ease, we use 'household' and 'consumer' interchangeably). Together, the market records purchases of about 43 vendor brands and 146 sub-brands. We consider the choices of the two main vendor brands: Coca-Cola and Pepsi, as well as all private-label brands. Those three choices took approximately 80% of the total market share during 2007. The IRI yoghurt market contains about 23 vendor brands and 89 sub-brands. Brand switches are defined similarly at the vendor-brand level in the yoghurt category: 10 major vendors (The vendor brands include COLOMBO, BREYERS, DANNON, KEMPS, OLD HOME, STONYFIELD FARM, WELLS DAIRY, YOFARM, and YOPLAIT) and private label brands receive 96.5% of the total yoghurt market share. Households in the sample are assumed to make vendor choices at each shopping trip (For multiple vendor brands on a shopping trip, we use the most frequently chosen vendor). Both markets witness frequent vendor-level switches. For an average household in either the yoghurt market or the carbonated beverage market, about 50% of shopping trips involve a vendor-brand switch. The summary statistics of vendor switches (for both the yoghurt and the carbonated beverage markets) are provided in Table 1. Detailed variables and meanings are further reported in Table 2.

Table 1. Summary Statistics: Households' Switch Behavior.

	Yoghurt MKT Year 2001		Beverage MKT Year 2007	
	Mean	Std. Dev.	Mean	Std. Dev.
No. of Households	3160	-	4189	-
Avg Choices: Total	19.1	10	15.3	8.6
Avg Switches: Total	8.9	6.6	7.7	8.6

Table 2. Variables and Meanings.

Variable	Meaning
SPC	the constructed variable, switch per choice in the yoghurt market
total	total shopping trips in the yoghurt market
lagchoice	state-dependence variable: 0–1
price0	the normalized price index for other brands
price1	the normalized price index for the targeting brand
hh_size	household size: 1 to 6
hh_age	age intervals: 1 = 18–24, 2 = 25–34 . . . 6 = 65+
hh_edu	1 = some grade school or less, 2 = completed grade school . . . 5 = Technical school . . . 8 = postgraduate work
hh_income	combined pretax income of household heads: 1 = USD 0–USD 9999, 2 = USD 10,000–USD 11,999, 3 = USD 12,000–USD 14,999 . . . 7 = USD 35,000–USD 44,999 . . . 12 = USD 100,000 and greater

We measure households' tendency to switch using the IRI yoghurt category from 2001. For each household in the yoghurt market, a switch-per-choice (or SPC) measure is defined by dividing the number of total switches over the year by the household's total number of choices. For example, the unit value of SPC suggests the household switches brands after every single visit; in contrast, the most persistent households have an SPC equal to 0. In Figure 1, the histogram of SPC shows that the SPC measure is widely spread between 0 and 1. In addition to brand switches caused by market-related factors, such as price cuts or advertisements, we hypothesize that SPC-driven choice variations reflect heterogeneity in structural state-dependence. If our hypothesis is true, the SPC variable can be used to drive choice variations in an unrelated market and year, and it can moderate the state-dependence effect in the market.
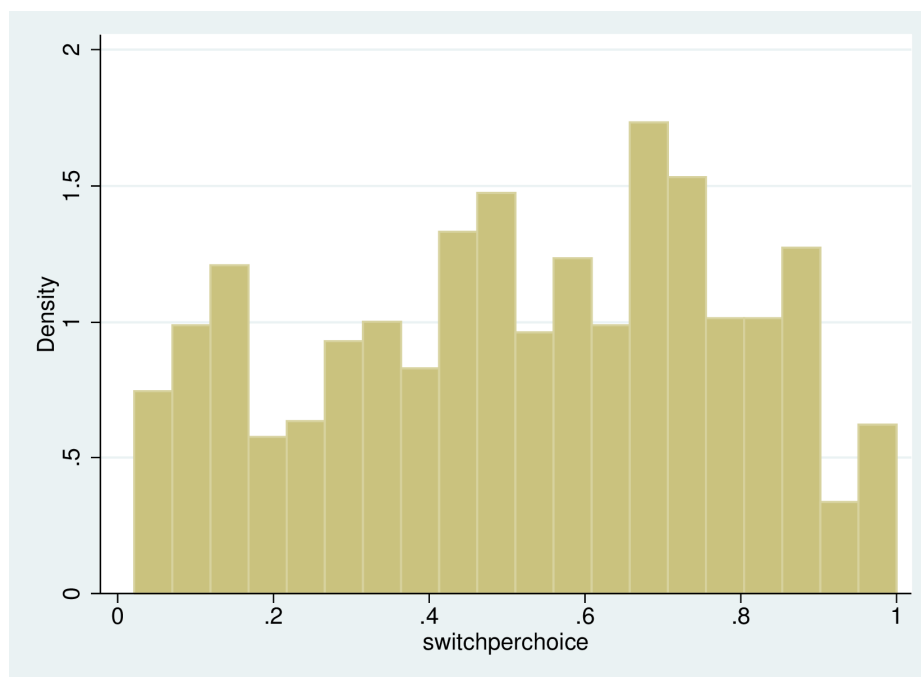

Figure 1. Histogram—Switch Per Choice (2001).

4. Model and Estimation

Based on the previous descriptive evidence, we construct unbalanced panel data sets of binary choices for each major vendor in the IRI carbonated beverage market in 2007 and match the households with switch information using the IRI yoghurt data sets (2001). Denote $Y_{it} = 1$ if household i chooses the targeted brand j in shopping trip t. Then, the household's choice can be modelled as follows:

$$Y_{ijt} = \begin{cases} 1, & \Delta U_{ijt} > 0 \\ 0, & \Delta U_{ijt} \leq 0 \end{cases},$$

where

$$\Delta U_{ijt} = \alpha_0 + \beta_0 \text{Price}_{-j,t} + \beta_1 \text{Price}_{jt} + \left[I\left(Y_{ijt-1} = 1\right) \right] \# [\text{SPC}_I, \text{Total}_I, \mathbf{Demo}_i] \beta_2 + \mathbf{z}_{jt} + v_{ij} + \epsilon_{ijt}$$

In the model, ΔU_{it} can be interpreted as a measure of consumers' preference of the targeted brand over other alternatives, and is assumed to be affected by several factors. The key variables we focus on include the indicator variable, $I\left(Y_{ijt-1} = 1\right)$, representing the structural state-dependence effect, and its interaction with our constructed measure, SPC. $I\left(Y_{ijt-1} = 1\right) = 1$ suggests that the household i has chosen the brand in her most recent shopping trip. Total_i is the total number of visits in the reference category, and Demo_i consists of a vector of household characteristics, including household

size, age, income, and education. $Price_{j,t}$ is the normalized transaction price index (USD per 144 oz of the relevant products) of the targeted vendor brand, and $Price_{-j,t}$ indicates the price index for the remaining products excluding brand j. The operator '#' represents a full interaction between the left and right-side variables, along with their main effects. The random effect logit model has included both a vector of time fixed effects, $\mathbf{z}_{jt}$, and a household level random effect, v_{ij}; therefore, it can reasonably account for consumers' unobserved heterogeneity across both individual households and time.

To estimate the model, we assume that the idiosyncratic shock ϵ_{ijt} follows the standard logistic distribution, and the random effect, v_{ij}, follows a normal distribution, $N(0, \sigma_{v_j}^2)$. Then, we can calculate household i's probability of choosing brand j at the individual shopping trip t as follows:

$$\Pr(y_{ijt} = 1) = \frac{1}{1 + \exp(-\Delta U_{ijt})}$$

Household i's probability of choosing the choice sequence $\{y_{ij1}, \ldots, y_{ijT}\}$ is calculated by aggregating per-period likelihood, $\Pr(y_{ijt} = 1)$, and integrating out the random effect.

$$\Pr(y_{ij1}, \ldots, y_{ijT}) = \int_{-\infty}^{\infty} \frac{e^{-\frac{v_i^2}{2\sigma_{v_j}^2}}}{\sqrt{2\pi}\sigma_{v_j}} \left\{ \prod_t \Pr(y_{ijt} = 1) \right\} dv_{ij}$$

The corresponding log-likelihood for the whole sample is calculated by summing over all households for each major brand, i.e., $L_j = \sum_i^N \log(\Pr(y_{ij1}, \ldots, y_{ijT}))$, and then maximized using simulation methods (in practice, we use Stata's built-in statistical package to estimate this model).

5. Results and Discussions

5.1. Results

Table 3 reports the estimation results for two major vendor brands and private brands. The first column lists the related variables for each estimated coefficient. Our key variables include the state-dependence variable ("lagc") and its interactive effect with SPC. Column 2 to Column 4 correspond to the estimation results for different brands. According to the results, first, the main effects of past choices are positive for all brands. Evaluating at $SPC = 0.5$, all brands witness significantly positive state-dependence effects (see also Table 4). Therefore, after flexibly controlling for demographic variables and the random effect, all regressions confirm structural state-dependence.

Second, the interactive effects with SPC remain negative. The magnitude of the interactive effect is much stronger compared to other demographic variables. The interactive effect is comparable to the corresponding main effect in each regression, yet the standard error of the interactive effect is relatively smaller, compared with that of the main effect of the lagged choice.

To better understand the economic impact of SPC, we calculate the marginal effects in Table 3. On average, past choices increase the repurchase probability by 1.5–3%, based on different vendor brands. Global brands tend to have stronger state-dependence effects. In addition, SPC has significant impacts on the past choices of all major vendor brands. For example, a persistent household in the yoghurt market is subjected to a 6% increase in the repurchase probability with the Coca-Cola brand, while a frequent switcher does not reveal any systematic bias in state-dependence.

The marginal effects show that for the major brands in the carbonated beverage market, most of the heterogeneity in consumers' state-dependence is not market- or product-dependent. Nor can it be captured by household characteristics. Therefore, those explained variations in state-dependence reflect a preference difference that is intrinsic to consumers.

Third, household age and household total visit frequency have consistent yet weaker interactive effects on state-dependence across all regressions. The total number of shopping trips in the yoghurt market is positively correlated with the state-dependence effect. Households who used to make purchases frequently are more likely to maintain their choices on consecutive shopping trips. Household age is also positively correlated with state-dependence. Elderly households are more state-dependent, while the effect is quite weak. Other interactive effects seem to have undetermined signs across brands.

Finally, control variables report reasonable estimates. In particular, the price index of own brand products negatively affects the choice probability of the brand, while the price index of outside brands positively affects the choice probability. These two variables have the strongest effects, indicating that monetary incentives play a major role. Besides, households with a large household size, younger members, and lower education levels have a higher probability of choosing the carbonated beverage brands.

Table 3. Estimation Results.

| | Random Effect Model | | |
	Coca-Cola	Pepsi	Private
lagc	0.391	0.286	0.429
	(0.247)	(0.257)	(0.397)
lagc*SPC	−0.281	−0.302 *	−0.779 **
	(0.145)	(0.151)	(0.258)
lagc*total	0.00205	0.0137 **	0.00614
	(0.00419)	(0.00442)	(0.00730)
lagc*hh_size	0.0101	−0.0324	−0.179 ***
	(0.0302)	(0.0317)	(0.0518)
lagc*hh_age	0.0245	0.000503	0.0201
	(0.0326)	(0.0351)	(0.0548)
lagc*hh_edu	0.0000897	−0.0345	0.0708
	(0.0254)	(0.0271)	(0.0439)
lagc*hh_inc	−0.0337 *	0.00517	0.0520 *
	(0.0144)	(0.0150)	(0.0264)
price1	−1.094 ***	−1.107 ***	−0.283 **
	(0.0581)	(0.0606)	(0.106)
price0	0.667 ***	1.208 ***	1.304 ***
	(0.0805)	(0.0956)	(0.161)
SPC	−0.0448	0.0308	1.263 ***
	(0.188)	(0.209)	(0.289)
total	−0.0103	−0.0167 **	0.0235 **
	(0.00554)	(0.00620)	(0.00821)
hh_size	0.124 **	0.114 *	0.303 ***
	(0.0407)	(0.0453)	(0.0599)
hh_age	−0.0528	−0.207 ***	−0.0715
	(0.0415)	(0.0464)	(0.0620)
hh_edu	−0.0283	−0.0490	−0.0321
	(0.0329)	(0.0368)	(0.0494)
hh_income	0.0853 ***	−0.0172	−0.0961 ***
	(0.0191)	(0.0212)	(0.0286)
constant	−0.100	0.615	−6.591 ***
	(0.381)	(0.415)	(0.610)
week dummies	Yes	Yes	Yes
Cluster	1610	1859	1859
N	25,371	28,951	28,951

Standard errors in parentheses.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Note: Estimation results of three binary logit models with random effects are reported. "lagc" denotes the state-dependence variable, "SPC" is consumers' switch-per-choice measure in the 2001 yoghurt market, and "Total" represents consumers' total shopping frequency in the yoghurt market.

Table 4. Marginal Effects of SPC on State-dependence.

	Coca-Cola	Pepsi	Private
2001 Yoghurt			
SPC = 0	0.0623 **	0.0546 **	0.0193 **
	(0.0196)	(0.0192)	(0.00593)
SPC = 0.5	0.0300 ***	0.0227 **	0.0150 ***
	(0.00848)	(0.00832)	(0.00326)
SPC = 1	−0.00118	−0.00812	0.00257
	(0.0165)	(0.0160)	(0.00707)

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

5.2. Discussions

We have demonstrated that SPC in the yoghurt data negatively explains structural state-dependence in a loosely related carbonated beverage market. The magnitude of such interactive effects is strong enough to remove most of the state-dependence effects in major brands. The results are robust when we use different years to construct the SPC measure. In Appendix A Table A1, we provide the same marginal effects based on a different year's switch data. The results are qualitatively similar across the two major vendor brands. Households who frequently switched within yoghurt brands five years ago illustrate little state-dependence. The magnitude of the effect and the long gap of years suggest that the effect captured by SPC is stable.

Our results have direct implications in improving sustainability in carbonated beverage markets or similar markets of food and beverages. In those markets, repeated purchases make households rely more on habitual decision making. Inertial households can be stuck in bad habits and (over) consume less healthy products, even when manufacturers provide options with more health benefits or with less sugar and calories. Inertial households are also more likely to overlook manufacturers' efforts in sustainable production, such as the adoption of environmental-friendly packaging technologies and the reduction in energy and water used. Therefore, they should be offered additional incentives to switch or search for alternative options. Our results provide researchers with a practical measure of evaluating heterogeneous habit-forming strength and can be used for identifying households who can benefit from additional "nudges" [49] for sustainable consumption.

Beyond direct applications in the carbonated beverage market or similar markets, our approach has broader implications in sustainability research. On the one hand, SPC can help researchers evaluate the heterogeneous treatment effects of sustainability policies at the individual level. The lack of evaluation tools has become a major barrier to policy-making [50]. For example, field experiments have questioned the credibility of the effects of sustainability labels [9]. However, the field environment is also much noisier, and habitual decision making is not fully accounted for in previous implementations. With consumers' data on past switches, our approach helps researchers to focus on specific types of households. For households with higher SPC, sustainability labelling can be more effective; for those with lower SPC, policymakers need to apply stronger interventions to break previous habits. On the other hand, researchers can design new questionnaires to investigate individual-level habit-forming effects [31]. One simple way is to directly ask survey/experiment participants to recall their product or brand switches previously in a different choice domain. The switch information can then be used as a moderator of the treatment effect under investigation. More research is required for evaluating the effectiveness of such questionnaires based on consumers' past brand or product switches.

Managerial practices may also benefit from consumers' switch behavior. Marketers and policymakers can use SPC to segment inertial buyers and focus more resources on helping inertial consumers switch for more sustainable products [51]. Because our method imposes less requirements on data quality, it can be applied to more decision scenarios than current methods. For example, SPC in other markets is robust to confounding factors from the targeted market, such as market frictions and products' learning curves, both of which significantly increase the state-dependence effects and are not easy to control under conventional methods.

6. Conclusions, Limitations and Future Research

In this paper, we demonstrate that switching information from SPC in the yoghurt data years ago negatively explains structural state-dependence in a loosely related carbonated beverage market. Those variations in state-dependence reflect preferences that are intrinsic to consumers and should be interpreted as structural. Compared with other demographic variables commonly used for segmenting a market, SPC has a stronger and more consistent impact on consumers' structural state-dependence effects.

SPC is a useful measure in sustainability research because it provides a practical way to evaluate the heterogenous effects of sustainability policies, when the effects rely on people's habitual decision making. It also helps researchers and practitioners focus on specific types of consumers and personalize sustainability policies more efficiently.

The study also displays some limitations. First, we do not have more recent data with which to carry out the test. Consumer behaviour has changed a lot as online business have become more popular. Therefore, it would be helpful if more recent data on consumers' complete shopping history could be collected. However, we believe that state-dependence caused by habitual decision making is a stable phenomenon, not only in consumer purchases and consumptions but in other choice domains as well. Habitual decision making may play an even more important role when consumers face an excessive amount of information and more difficult tasks from the internet. Second, our analysis currently focuses on two specific market categories. Therefore, our results need to be extended to other categories where habitual decision making is a dominating phenomenon. Similarly, the current SPC is based on households' brand choices in the yoghurt category. In future research, we can extend this by considering households' switching behaviour in a basket of different products and brands. We leave a more systematic evaluation of SPC for future research.

Appendix A

Below we use brand switch data from a different year (Year 2002) to construct SPC and interact it with the state-dependence effect in the same carbonated beverage market. The marginal effects are qualitatively similar across different SPC values for major vendors.

Table A1. Marginal Effects of SPC on State-dependence: Year 2002 yoghurt data.

	Coca-Cola	Pepsi	Private
2002 Yoghurt			
SPC = 0	0.0771 ***	0.0319	0.00991 **
	(0.0187)	(0.0197)	(0.00384)
SPC = 0.5	0.0315 ***	0.0188 *	0.0127 ***
	(0.00801)	(0.00802)	(0.00274)
SPC = 1	−0.0135	0.00694	0.0141 *
	(0.0158)	(0.0143)	(0.00712)

Standard errors in parentheses. $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$.

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