Who would pay more for a fragrance-free laundry detergent? How health information affects valuation.

Edina I. Findrik and Ulrich B. Morawetz

Corresponding Author:
Ulrich B. Morawetz
University of Natural Resources and Life Sciences Vienna
Department of Economics and Social Sciences
Feistmantelstrasse 4,
1180 Vienna,
Austria
Phone: + 43/1/47654-73130
Email: Ulrich.Morawetz@boku.ac.at

Abstract

Fragrance allergy is a lifelong condition, and the probability of being affected increases with frequent exposure to fragrance. Currently, fragrance-free laundry detergents are not common in supermarkets. We used a contingent valuation among Austrian consumers in a within-respondent treatment to estimate how willingness to pay is influenced by health information. We found that higher income groups have a higher willingness to pay for fragrance-free detergents. Informing consumers about health impacts substantially increases this difference. Our simulation shows that lower-income groups benefit from health information only if low-priced fragrance-free detergents are available on the market.

Keywords: laundry detergent, fragrance, willingness to pay, contingent valuation, income

1. Introduction

Laundry detergents containing fragrance, deodorants containing aluminum and plastic bottles containing Bisphenol A are examples of consumer products likely to have negative health impacts. Informing consumers about health effects will influence the demand and, eventually, the supply of safe products

(Chrysochou and Grunert 2014). In this article, we explore the case of fragrance in laundry detergents and show which income groups benefit from health information.

Fragrance is used in many consumer products (e.g., laundry, clothes and beauty care), even though it can cause skin irritation and allergic reactions. Contact allergy to fragrances is quite common; according to a literature review from 2009, between 1.1% and 2.3% of the general population in Europe is affected (Thyssen et al. 2009). A test of more than 50,000 Europeans revealed that between 1.7% and 6.9% of the population reacts allergically to fragrances (Frosch et al. 2015). A long-term study found that from 1985 to 1998, the fragrance allergy of the Danish population doubled from 4.1% to 9.9% (Johansen et al. 2000). Data specific to fragrance sensitivity in laundry detergents are available from the US. According to a telephone survey, 10.7% of the general population and 21.2% of respondents with asthma are sensitive to detergent fragrances (Caress and Steinemann 2009). In contrast to exposure on the skin (including through airborne material), inhalation of fragrance sensitizers does not represent a health risk with respect to allergy (Basketter and Kimber 2015).

Due to the complexity of formulations and protections on ingredient disclosure, relatively little is known about the influence of the composition of fragrance on allergic reaction (Caress and Steinemann 2009). Additionally, the use of genetically modified enzymes has accelerated the availability of new fragrance varieties. This increased number of fragrance varieties might increase health issues in the future (Budnik et al. 2017).

Not surprisingly, contact allergy caused by fragrance materials reduces quality of life substantially (Heisterberg, Menné, and Johansen 2014). The more frequent the exposure to fragrance, the more likely a person is to develop an allergy. Based on a sample of 23,824 British patients, Buckley et al. (2003) found support for the hypothesis that allergy to fragrance results from a combination of repeated exposure and age-related susceptibility factors. Women are most susceptible in their 60s, whereas men are most susceptible in their 70s. Once a person has developed an allergy, it is a lifelong condition, and the only

treatment is avoiding contact with fragrance. Reducing exposure to fragrance may be one way of reducing fragrance allergies in the population.

The effort to implement policies to control the presence of fragrance in laundry detergents has been limited in both the EU and the US. In the EU, products do not have to reveal individual fragrance contents; it is enough to mention on the package that 'perfume' is included. A list of 26 ingredients known to cause skin irritation or allergic reactions must be identified by name when used in concentrations of 0.01% or above in 'rinse-off' products such as detergents (European Commission 2004). The rather strict EU chemicals law 'REACH' is rarely applicable to fragrances since it concerns substances used in amounts of more than one ton per year per manufacturer (European Commission 2007). In the US, the safety of consumer products (except for cosmetics) is the responsibility of the Consumer Product Safety Commission (CPSC). For laundry products, which fall under the responsibility of the CPSC, there is currently no requirement to disclose fragrances (Bridges 2002; United States Congress 1972).

Regulating fragrance is controversial because many consumers enjoy fragrance: it is bought as an end in itself in perfumes and used as a product attribute, an agent for promotional efforts and an ambient cue (Nibbe and Orth 2017). It has also been shown that fragrance can lead to stress relief (Warrenburg 2005). Regulating fragrance in laundry detergents means regulating the pleasure consumers obtain from the smell of fresh laundry. Consequently, informing consumers about health risks may be a way of protecting the susceptible without limiting those who benefit from fragrance in detergents.

The objective of the article is 1) to find out how much consumers are willing to pay for fragrance free detergents, 2) how much this changes if additional information about health risks is provided and 3) the welfare effects of different income groups when a fragrance-free detergent is introduced to the market.

We first introduce the economic theory for the WTP for a fragrance-free detergent. Then, we present data analyzed from a contingent valuation method (CVM) survey and use these data in a numerical simulation. This allows us to calculate the consumer surplus (i.e., WTP minus price) as described by Lusk and Marette (2010). To understand the role information plays for each of the income groups, we first

investigated the WTP for fragrance-free laundry detergents based on the current knowledge of respondents. We then informed respondents about the health effects of fragrance in laundry detergents and measured how the WTP changed.

To the best of our knowledge, fragrance-free detergents have not been discussed in the economic literature. One recent study on WTP for green detergents found a significant increase in WTP for detergents with reduced skin irritation potential among Korean consumers (Jo and Shin 2017). In an article on eco-labels for detergents, Siwayanan (2015) found that more than 90% of Malaysian consumers prefer palm oil-based over petrochemical-based detergents. Our article is the first to discuss consumer surplus of health information in relation to consumer income. We consider how different income groups benefit depending on the availability in shops. We discuss this issue for Austria, where only two fragrance-free detergents are available in supermarkets.

2. Theoretical framework

2.1 Supply of fragrance-free detergents

The international laundry detergent market is characterized by a limited number of firms, each offering differentiated laundry detergent products. Among the largest firms worldwide are Procter & Gamble, Unilever and Henkel (European Union 2011). Their detergents differ by format (liquid or powder), purpose (washing temperature, color and material of textiles), packaging, fragrance, health and environment-related characteristics, price and cleanliness of washed laundry.

These characteristics are used for horizontal and vertical product differentiation. Horizontal differentiation occurs if consumers have heterogeneous preferences for a characteristic (e.g., format or packaging). In this case, if two products have the same price and differ only in this one characteristic, both products have a positive demand (Lancaster 1979, chap. 2; Dos Santos Ferreira and Thisse 1996). Vertical differentiation occurs if consumers have homogenous preferences for a characteristic (e.g., cleanliness of washed

laundry). In this case, if two products have the same price and differ only in this one characteristic, one of the products is preferred by all consumers.

In the case of detergents, horizontal differentiation occurs regarding packaging, physical state or fragrance because consumers have heterogeneous preferences with respect to these characteristics. Vertical differentiation occurs regarding cleanliness because almost all consumers want their laundry to be clean after washing. Cleanliness of laundry, however, is not observed by consumers (even after using the detergent, it is not easily assessed). According to economic theory, vertical product differentiation will still occur in the case of imperfect competition and higher production costs for higher-quality products (Daughety and Reinganum 2008).

Information about the production costs of detergents is typically not disclosed, but cleanliness at lower washing temperatures depends on the enzymes used. The production costs of enzymes differ due to differences in the costs of the growth medium (Joo and Chang 2006). Thus, following the theory of Daugherty and Reinganum (2008), for unobservable cleanliness, the price can be expected to be used as a signal for higher-quality products (holding observable characteristics constant).

The decision of a multiproduct firm to offer a fragrance-free detergent is driven by strategic considerations (Lancaster 1990). Similarly, the supermarket strategically selects which of the available products are placed on the shelves. Informing consumers about the health effects of fragrance will increase the demand for fragrance-free products and will eventually result in production and availability in the supermarkets. With a differentiated product market, there will be an incentive to produce a fragrance-free variant for many of the differentiated products. Thus, if the average production costs of fragrance-free detergents are sufficiently small, fragrance-free variants will be offered in all price ranges given sufficient consumer demand.

Detergents in Austria are available mainly from supermarkets and drugstore chains. These supermarkets also offer eco-labeled detergents, but none of them is fragrance-free. Among all major shops in Austria, only one drugstore chain currently offers fragrance-free detergents (in addition to some specialized shops).

In this drugstore chain, there were 61 liquid and 25 powder detergents available in October 2017. One of the fragrance-free detergents is liquid for colored laundry, and the other is a powder for white laundry. Figure 1 shows the distribution of the prices per load for colored and white laundry detergents available in the web-shop of the drugstore chain. The fragrance-free detergents are priced in the middle of the price ranges. Neither fragrance-free detergent is primarily advertised as fragrance free but rather as detergent for baby clothes.

We would expect that when information about health effects spreads, more fragrance-free detergents will become available on the market. In the online appendix, we illustrate the case of aluminum-salt free deodorants, for which this seems to have occurred.

[Figure 1 about here]

2.2 Demand for fragrance-free detergents

Doing laundry is embedded in a system of common practices, technologies and conventions (Shove 2003). Selecting a detergent is depending on what is there to launder, the purpose, the knowledge, skills and time constraints of the consumer doing the laundry, the frequency of washing as well as the available devices and appliances (Shove 2003). One way of measuring preferences is by measuring the WTP. To define the WTP, we used a deterministic utility model (Hanemann 1982; Small and Rosen 1981).

In the model, a utility-maximizing consumer buys only one detergent j per time period. All detergents are available only in a fixed quantity, and the price of a fragrance-containing detergent j is noted as p^f_j. To define the change in WTP for a fragrance-free detergent, assume a fragrance-free detergent with price p^{ff}_k is introduced. It is identical to the fragrance-containing detergent j but is fragrance-free. The WTP for a change from the utility-maximizing detergent j to detergent k is noted as d. If $p^f_j = p^{ff}_k$, then d measures only the change in fragrance. For details, see the online appendix.

The fragrance-free detergent will be selected if the WTP for the fragrance-free detergent is non-negative and higher than the price difference between the utility-maximizing, fragrance-free and fragrance-containing detergents. This condition can be formulated as

6

$$d \geq 0 \tag{1}$$

and

$$d \geq p_k^{ff} - p_j^f .$$

The condition in Equation (1) shows that the choice of a fragrance-free detergent depends on 1) the price of the currently used detergent, 2) the price of the fragrance-free detergent, and 3) the WTP for the fragrance-free detergent. Importantly, 1) and 2) are conditional upon the detergents available on the market.

To aggregate the change in consumer surplus as in Lusk and Marette (2010), the consumer surplus for those who buy the fragrance-free detergent is defined as the difference between the WTP for the fragrance-free detergent and its price. The change in the consumer's surplus caused by the availability of K fragrance-free detergents at prices $p^{ff}_1, ..., p^{ff}_K$ is the sum of the WTP of all buyers of the fragrance-free detergents minus the respective price:

$$\Delta\text{Consumer Surplus} = \sum_{i=1}^{P}\sum_{j=1}^{N}\sum_{k=1}^{K}\left[\left(p_{ij}^f + d_i - p_{ik}^{ff}\right)I_j I_k\right], \tag{2}$$

where I_j and I_k are indicator functions. I_j takes the value 1 if for consumer i the detergent j is utility maximizing among the N fragrance-containing detergents and zero otherwise. I_k takes the value 1 if a fragrance-free detergent is selected (i.e., if the condition in Equation (1) is fulfilled) and zero otherwise. For those consumers who do not buy fragrance-free detergents (i.e., where I_k is always zero), the consumer surplus change from the availability of fragrance-free detergents is zero.

The change in consumer surplus measured in Equation (2) is aggregated over all consumers for one detergent choice at the fixed quantity. In our case study, we consider how the change in consumer surplus differs depending on the information given to respondents.

2.3 Health related consumer information

The effect of health related claims has been primarily studied for food products. In a survey of 63 publications Dolgopolova and Teuber (2017) find that the presence of health claims mostly results in an increased WTP for food. No effect or even a negative effect is found if products are not specifically promoted as being healthy. The only two studies on the WTP of detergents support a positive WTP for health related detergent characteristics (Jo and Shin 2017; Siwayanan et al. 2015). In a recent survey Hartmann et al. (2018) found that food with 'free-from' labels (lactose-free, gluten-free, GMO-free, and palm oil-free food) were considered healthier by consumers. Other studies found that 'free-from' labels also increase the WTP: Disdire, Marette and Millet (2013) found that informing consumers about health effects of palm oil reduced the WTP significantly for industrial milk rolls in France. In the Colorado, USA, the WTP increase for 'GMO-free' labeled potatoes has been found to be smaller than for 'locally grown' and 'organic' labels, but still statistically significant (Loureiro and Hine 2002). The authors also found that those consumers categorized as 'upper-class' have a higher WTP for organic and GMO-free potatoes. This is in line with findings from other studies that income and higher education have a positive impact in the WTP for health related claims (Siró et al. 2008; Stranieri, Baldi, and Banterle 2010). The observation that consumers with higher income have a higher WTP for health related product attributes motivated the following discussion.

Following condition (1), consumers who have a higher utility-maximizing price p^f_k for their fragrance-containing detergent and those with a high WTP are more likely to buy fragrance-free detergent. Whether they actually buy a fragrance-free detergent depends on the products available on the market. The intention of informing consumers is to inform the ones susceptible to allergic reactions. Which consumer groups benefit from this additional information also depends on the products available on the market. In the next paragraphs we consider theoretically which income groups benefit from a new fragrance-free product on the market. The analysis is later used to simulate welfare effects based on our empirical data.

Consider two types of detergents, high quality (H) with prices $p^{f,H}$ and $p^{ff,H}$ and low quality (L) with prices $p^{f,L}$ and $p^{ff,L}$. There are also two types of consumers, those who have a positive WTP for fragrance-free detergent ($d^P>0$) and those who have a negative WTP for fragrance-free detergent ($d^N<0$). Moreover, consumers who buy the high-quality detergent do not buy the low-quality detergent and the other way around (because price is a quality signal of vertically differentiated product attributes). Table 1 provides an overview.

For the sake of argument, assume that $p^{f,L} < p^{ff,L}$ and $p^{f,H} < p^{ff,H}$. In addition, the price of the fragrance-free detergents is such that $d^P > (p^{ff,H} - p^{f,H})$ and $d^P > (p^{ff,L} - p^{f,L})$, meaning that those consumers who have a positive WTP for fragrance-free detergent buy it if it is available. Table 1 shows that high-quality fragrance-free detergent is only bought by consumers who buy high-quality detergents and have a positive WTP for fragrance-free detergent (consumer type 1). Low-quality fragrance-free detergent is only bought by consumers who buy low-quality detergents and have a positive WTP for fragrance-free detergent (consumer type 4).

An information campaign about health effects can increase the WTP for fragrance-free detergents. This will increase the likelihood that a fragrance-free detergent is available. If an information campaign leads to the provision of a high-quality fragrance-free detergent, consumer type 1 will benefit. If it leads to the provision of a low-quality fragrance-free detergent, consumer type 4 will benefit.

If there is a positive correlation between income and the WTP d^P, as the literature cited above suggests (Loureiro and Hine 2002; Stranieri, Baldi, and Banterle 2010; Siró et al. 2008), then the quality of fragrance-free detergents available on the market determines which income groups benefit from an information campaign. High-income groups will benefit if a high-quality fragrance-free detergent is provided; low-income groups will benefit if a low-quality fragrance-free detergent is provided.

[Table 1 about here]

3. Methodology

3.1 Empirical method

Our survey is designed to reveal how much the respondents would pay if the detergents usually bought were fragrance-free (i.e., eliciting d when there is only one fragrance-free detergent that is otherwise identical to the utility-maximizing, fragrance-containing detergent). The applied CVM originates from the valuation of public goods but has also been applied to value products not yet available on the market and to health benefits (Dolgopolova and Teuber 2017). Many variants of the CVM have been applied in the literature (Johnston et al. 2017). One key difference between the CVM variants is the way of asking the WTP question. According to recent literature, incentive-compatible response formats (such as the 'single dichotomous choice' format) are preferred (Johnston et al. 2017). However, single dichotomous choice formats (where the respondents only state if they would buy a product at a suggested price) come at the price of being less informative than directly asking respondents for their maximum WTP. There is a trade-off between unbiasedness and precision (compared to a similar issue stressed by Deaton and Cartwright (2016)).

In our CVM survey, we therefore applied the payment card elicitation format: the respondent is asked to choose the maximum agreeable price from a range of possible values. The payment card approach has long been used in CVM applications (Hu et al. 2011; Morawetz and Koemle 2017; Cameron and Huppert 1989; Maynard and Franklin 2003). The main advantage over the single dichotomous choice format is that the WTP is directly retrieved.

A recent comprehensive meta-analysis finds a hypothetical bias to be pervasive in the revealed preference methods (Penn and Hu 2018). Comparing different methods, the authors find that payment card based contingent valuation studies, have a lower hypothetical bias than auctions, there is no significant difference to choice experiments and only dichotomous choice formats have statistically significant lower hypothetical bias. Also, private goods have a significantly lower hypothetical bias than public goods. On the other hand, there are several effective hypothetical bias mitigation techniques (cheap talk, certainty

follow-up or consequentiality design) which we did not apply. Based on this meta-analysis it is possible that our elicited values are biased upwards. We discuss our conclusions in the light of potentially over-estimated WTP in the conclusions.

3.2 Questionnaire design and sampling strategy

We collected data on the preferences of laundry detergent shoppers in Vienna, Austria. We limited the analysis to liquid laundry detergents because the majority of offered detergents are of this format (70% in the drugstore described above). We developed a CVM questionnaire and tested the wording and clarity using focus groups and a pilot study. The interviews were conducted in July and August 2016 in Vienna, Austria, covering five public squares in various parts of town. To select respondents randomly, every 5th pedestrian was approached to participate in a short survey on their laundry detergent purchasing behavior. The self-completion questionnaire was handed over to those who were willing to participate in the survey. The questionnaire consists of four sections: (1) filter for the target group; (2) awareness of the health impact of fragrance and attitudes toward fragrance-free products; (3) assessment of willingness to pay for fragrance-free detergent using payment cards; and (4) assessment of socio-demographic status.

The first section identified for participation only people using liquid detergent who had been living in Vienna for at least 6 months, those over 18 years of age, and those without asthma. In the second section, questions about awareness of the impacts of fragrance (including asking for an example of potential health impacts to confirm knowledge) and attitudes toward fragrance-free products (e.g., whether they had tried any fragrance-free products) were asked. It also included a question about whether the respondent checked the ingredients of household products (if yes, they had to mention at least one of them for confirmation).

In the third section, respondents were asked which detergent they usually bought and their WTP for a fragrance-free detergent of the same type. This included the following steps: first, respondents were asked to select the most frequently purchased liquid detergent type from a card showing all available detergents

on the market. This was followed by a question about the WTP for a fragrance-free laundry detergent (otherwise identical to their most frequently bought brand). Specifically, the respondents were asked: 'Which of these prices describe your maximum willingness to pay for 1 Liter fragrance-free detergent for colored laundry best? All other characteristics are identical to your most frequently purchased detergent selected before' (translated from German). The respondent could select from prices between 0 € and 5.5 € in 0.5 € steps and above 0.5 €. The range of prices was determined by a survey of prices in the shops, in the focus groups and tested in the pilot study. Next, a card showing the following information from the webpage of the EU commission (Fernandez 2016) was given to the respondent:

> 'The most common problems observed with fragrance ingredients, either through use of a perfume or a fragranced consumer product, are skin allergies and skin irritations. Many people complain about intolerance or rashes to perfumes or perfumed products. However, the majority of complaints commonly described as "skin rash" are believed to be irritant reactions and not skin allergies. A key difference is that allergic reactions typically occur with a delay of about one day after using the perfume or cosmetic product, while irritant reactions develop immediately after use.'

Respondents were then asked again to state their WTP for a fragrance-free detergent. In the last section of the questionnaire, the demographic characteristics of the respondents were recorded, including age, sex, education, income and household size.

3.3 Econometric model

The survey data were analyzed using regression analysis. Based on condition (1), the dependent variables of interest are the current price paid (p_i^f), the WTP before the health information is provided (d_i^{before}), the WTP after health information is provided (d_i^{after}), and the WTP after health information minus the WTP

before health information ($d_i^{after} - d_i^{before}$). The vector of each of these four dependent variables, noted as Y, is measured in €/Liter.

The first set of models is used to calculate the correlation of the explained variable with income groups:

$$Y = 1 + Inc\ \beta + e \ , \tag{3}$$

where 1 is a vector of ones, Inc is a matrix of dummies for income groups, β is a vector of coefficients, and e is an error term.

In a second set of models, additional explanatory variables are added:

$$Y = 1 + Inc\ \beta + X\ \gamma + e, \tag{4}$$

where X is the matrix of additional explanatory variables and γ is a vector of the respective coefficients. X contains the current expenditures for detergents p_f (except for the regression where p_f is the dependent variable), whether the current detergent carries an eco-label, and respondent-specific characteristics (gender, age, education, household size, and knowledge about health effects). The error term is noted by e and, for ceteris paribus interpretation of β, needs to be uncorrelated with income. This does not hold for the simple ordinary least square Equation (3). For the multiple ordinary least square Equation (4), we include all relevant variables, at least in the three regressions where the dependent variable is the WTP. However, we do not have a way of proving exogeneity.

An issue related to exogeneity of the error term is a non-representative sample, which limits inference about population means and reduces them to sample statistics. If exogeneity holds, however, for ceteris paribus interpretation of a non-representative sample, we only need to assume that sampling is independent of the dependent variable conditional on explaining variables (Solon, Haider, and Wooldridge 2015). Given our sampling strategy, we consider this to be the case. However, if exogeneity of the error term fails, estimated population average effects (i.e., the estimated coefficients) are influenced by a non-representative sample.

The interval regression model has been suggested as an alternative to the linear regression model (Cameron and Huppert 1989). It takes into account that in payment card CVM applications, only the

interval of the maximum WTP is known, not the point value. We applied this model to assess sensitivity. All calculations were performed using the software R (R Development Core Team 2015), and data and coding are available from the journal's webpage.

3.4 Numerical simulation

We ran a numerical simulation based on the data from the CVM survey to illustrate who in the population of respondents benefits from the availability of one fragrance-free detergent on the market at the price p^{ff}. Our data do not allow us to predict how many consumers will switch to a particular fragrance-free detergent. This would require cross-price elasticities. Instead, we use a particularity of the detergent market to make an assumption about consumer behavior: cleanliness of washed clothes cannot be easily observed. Given vertical product differentiation, consumers can rely on price as a quality signal. This implies that consumers can consider detergents with equal prices to be of equal quality.

This leads to the following assumption used for the numerical simulation: a consumer i currently buying a fragrance-containing detergent j for price p^f_{ij} will switch to the one fragrance-free detergent at the price p^{ff} (not necessarily identical in all other attributes) if the following two conditions apply. First, the consumer will not choose a detergent of lower quality than the currently bought quality. Given that price is the quality signal, $p^{ff} \geq p^f_{ij}$ is required for the fragrance-free detergent to be chosen. Second, consumers will buy the fragrance-free detergent only if the price is lower than or equal to the maximum price they are willing to pay (which is the sum of what they currently pay plus the surplus/discount for not containing fragrance): $p^{ff} \leq p^f_{ij} + d_i$.

This leads to the following behavioral decision rule: consumer i will prefer a fragrance-free detergent over the fragrance-containing detergent j if the following condition applies:

$$p^f_{ij} \leq p^{ff} \leq p^f_{ij} + d_i \ . \tag{5}$$

4. Results

Our WTP estimates for fragrance-free detergents were based on the CVM survey. In total, the response rate was 87.97% (139 out of 158 people contacted). However, only 77.70% (122 respondents) of the questionnaires could be used because some interviews were stopped after the initial filtering questions.

[Table 2 about here]

The population relevant to the survey is the people buying laundry detergent. Because women still perform the majority of housework, it is likely that the sample share of 57% women is lower than representative for the population of laundry detergent buyers (see Table 2). Compared to the Vienna average, the sample over-represents those younger than 40 years of age. More than 47% of respondents hold a university degree or higher. This is substantially above the 27% Viennese average. One quarter of the respondents live in one-person households, and 40% live in two-person households. The average net income of employees in Vienna is 1,762 €/month (Vienna City Administration 2016), which falls in the second highest income group of our survey. Our sample is most likely not representative of the population of detergent buyers (and not representative for the population of Vienna).

Table 2 shows that approximately 73% of the sample knows that laundry detergents contain fragrance, approximately 40% know about the health effects of fragrance, and 52% know about fragrance-free products (see Table 2). These sample values are likely higher than the population values given the share of respondents with higher education. Approximately 55% of the respondents never check the ingredients of products, and approximately 72% have never purchased a fragrance-free product.

[Table 3 about here]

The price per liter (Ltr) of detergent currently paid by respondents is, on average, 3.24 € and ranges between 1.30 and 5.30 €/Ltr (row (a) in Table 3). When asked for the maximum price for a detergent that is just like the usually bought detergent but without fragrance (row (b)), the maximum price they are willing to pay is reduced by 0.51 to 2.70 €/Ltr and ranges between 0 and 6 €/Ltr. Nine respondents (7%) stated a maximum price of zero for a fragrance-free detergent. The median of the difference between (b)

and (a) is reduced by 0.50 €/Lit (this is not equal (b)−(a) due to re-sorting). For 67%, there was a negative WTP for the fragrance-free detergent (not shown in the table). This is encouragingly close to the 72% who stated that they had never or almost never bought a fragrance-free detergent (Table 2). These figures suggest that for the majority of respondents, the maximum price they are willing to pay reduces, on average, if fragrance is removed.

This finding changed after respondents were informed about the health effects of fragrance. The maximum price for the fragrance-free detergent is only 0.03 €/Ltr lower than the price of the usually bought detergent, and the median is 0.30 €/Ltr higher. These results suggest that the maximum price increases with health information but does so differently for different respondents.

[Table 4 about here]

In Table 4, we analyze the correlation of income with the currently paid price, the WTP with and without information, and the influence of information. The first column shows that the higher the income, the higher the price paid for the detergent. The difference between the lowest income group (less than 1,501 €/month) and the highest income group (above 4,500 €/month) is 1.06 €/Ltr (40%). The second column shows that those who earn above 1,501 €/month have a higher WTP for fragrance-free detergents than do those with lower income (between 0.54 and 0.73 €/Ltr higher). Column 3 reveals that those with higher income have an even higher WTP than do those with lower income once health information is given. The difference in the WTP between those with an income below 1,501 €/month and those above 4,501€/month increases to 1.20 €/Ltr. This is confirmed by the last row, which shows that those with higher income are more susceptible to health information.

[Table 5 about here]

In Table 5, the influence of income is tested conditionally on several other respondents' characteristics. For the first column, which has price as a dependent variable, income is no longer significant once it is conditional on other characteristics. A higher price for the currently bought detergent correlates with buying eco-labeled detergents, higher education and knowing about the health effects of fragrance. From

the second column, we see that higher income is (jointly) significant in explaining higher WTP for fragrance-free detergents. From column 3, we see that the difference between lower-income households and higher-income households increases with health information; the difference in the WTP of households in the lowest income group and those in the highest income group is 1.87 €/Ltr.

From column 2 and column 3, we also see that those who already spend more on detergents have, on average, a lower conditional WTP for fragrance-free detergents. Those who currently buy eco-labeled detergents have, on average, a higher conditional WTP for fragrance-free detergents. Households with more members have a lower WTP for fragrance-free detergents.

Column 4 confirms that households with higher income are more susceptible to health information than lower-income households are. It also shows that the WTP of women increases by 0.29 €/Ltr more than that of men. Households with more members and those who already know about health effects are less influenced. Like all other regression results, these results are strictly valid only for the sample; we cannot test whether correlations of variables in the population are different from correlations in the sample, and exogeneity cannot be tested. We do not see why correlations between variables in the sample should differ from those in the population. Finally, Table C.1 in the online appendix shows that the results based on the interval regression are very similar to those from the linear regression.

To investigate which income groups benefit from the introduction of a fragrance-fee detergent, we run a simulation. Based on the data collected in the CVM survey and the behavioral assumptions from Equation (5), we simulated which income groups benefit without and with information at various prices for one fragrance-free detergent becoming available on the market. In Table 6 and Figure 3, the results for the situation without health information are shown. We see that the mean welfare gain is, on average, between 0.04 and 0.08 €/Ltr. For each price level, the mean is based on the change in welfare for those who buy the fragrance-free detergent at that particular price and those who do not buy it (and therefore do not have a gain in welfare). Looking at rows 2 through 5 in Table 6, we learn that at different prices,

different income groups benefit. In particular, the lowest income group does not benefit if fragrance-free detergents are only offered at prices 4 €/Ltr and above.

[Table 6 about here]

After health information has been provided, the conclusion that the lower-income groups do not benefit from higher-priced fragrance-free detergents is confirmed. However, benefits for higher-income groups increase substantially and are up to three times higher (Table 6 middle panel and Figure 3).

Currently in Austria, there is one liquid fragrance-free detergent available in major stores. It costs 2.55 €/Ltr (October 2017). This is 0.95 €/Ltr more than the same brand with fragrance. From Figures 2 and 3, we see that at this price for the fragrance-free detergent, the higher two income groups (green and blue lines) will benefit more than average, and the lower two income groups (blue and pink lines) will benefit less than average (black line).

[Figure 2 about here]

[Figure 3 about here]

5 . Conclusions

Some consumer goods for daily use contain ingredients suspected of having negative health impacts. Informing consumers about potential negative health effects will increase demand for products that are free of controversial ingredients, and supply will eventually increase. Fragrance is one example of a controversial ingredient found in many consumer goods. For laundry detergents, the number of fragrance-free variants is still very limited.

A CVM survey among 122 Austrian consumers in Vienna revealed that the average maximum price respondents are willing to pay for a fragrance-free detergent is 0.51 €/Ltr lower than the current average price (3.24€/Ltr). The median is 0.50 €/Ltr lower. After respondents were informed about the health effects of fragrance in detergents, the average maximum price for fragrance-free detergents was only 0.03 €/Ltr below the currently paid price average. The median was 0.30 €/Ltr higher. The surplus respondents are willing to pay ranges between −4.60 and 2.90 €/Ltr. Thus, holding prices constant but

banning fragrance from laundry detergents would generate winners and losers. If no health information is provided, the average and majority of respondents would be worse off in the case of a fragrance ban. If health information is provided, the average of respondents would be almost as well off as before, and the majority of respondents would be better off. Given that the survey is not representative, these average values are not necessarily valid for the population.

Our empirical results are based on a revealed preference elicitation method which can lead to biased WTP estimates. Additionally, better educated respondents are over-represented in our data likely leading to an upward bias in the estimated WTP. Never the less, the core results of our work would also hold if the actual WTP estimates are lower: without additional information, the average would still be worse off if fragrances were banned, but there would still be winners and losers (given constant prices). Information on the health effects of fragrance would still increase the WTP, but probably the average would be lower.

In our theoretical considerations, we derive a condition necessary for a consumer to benefit from a fragrance-free detergent: the currently paid price p_f plus the surplus respondents are willing to pay for the fragrance-free detergent, d, needs to be more than the price of the fragrance-free detergent p^{ff}. With our CVM survey, we tested whether p^f and d are higher for higher-income groups.

We found that in our sample, higher-*income* respondents buy detergents with higher prices p_f. This correlation disappears after controlling for *education*, *knowledge about health effects* of fragrance and whether *eco-labeled* detergent*s* are usually purchased. We consequently cannot claim that higher income is causal for buying detergents with higher prices. However, our results also show that the surplus respondents are willing to pay, d, is positively correlated with *income*. This relationship is robust to conditioning on other household characteristics. We also found that respondents with higher income are more susceptible to health information (i.e., their WTP increases by more). Because we controlled for relevant variables, we suspect that these correlations hold not only for the sample but also for the population of detergent buyers.

Which consumers benefit from health information depends not only on the currently paid price p^f and the willingness to pay d but also on the availability of fragrance-free detergents. We simulated the consumer surplus using the CVM data and a behavioral decision rule. We simulated consumer surplus by income group for the case of only a single fragrance-free detergent on the market. We found that lower-income groups benefit only if a fragrance-free detergent with a low price is available. This also holds after informing respondents about health effects. The consumer surplus increases up to three times for the highest income class after health information is provided. We conclude that if the higher WTP for fragrance-free detergents of high-income groups results in only expensive, safe products being offered, then the benefits of health information go to those with higher income.

Our analysis is based on a one-time detergent choice. When aggregating the consumer surplus over time, those who wash their laundry more frequently might benefit more from fragrance-free detergents. Thus, if laundry detergents have an income elasticity above one, then higher income groups benefit even more within a year than in a one-time detergent choice. In this case, our results need to be interpreted with lower limits.

There is currently one fragrance-free liquid detergent available in Austria. Its price lies in the middle of the price range. Our simulation suggests that the availability of this product changes the consumer surplus of the two lower income groups of our respondents below average and the consumer surplus of the two upper income groups above average. A systematic description of the availability and prices of fragrance-free detergents in the years to come could shed light on the question of which price ranges the fragrance-free detergents will be provided. Another relevant extension would be to test whether our empirical results also hold for other samples. We suspect that consumers elsewhere, at least in other high-income countries, would have similar preferences.

Oure empirical analysis reveals that preferences for fragrance in detergents are heterogeneous, at least for the sample from Vienna. Banning fragrance would generate winners and losers. Informing consumers makes no one worse off, but some would benefit more: due to being more amenable to health information,

20

higher-income groups benefit more. Information targeted to susceptible low-income groups could be used for a more balanced effect. This is likely to also foster the supply of low-priced, safe products.

6. Literature

Basketter, David, and Ian Kimber. 2015. 'Fragrance Sensitisers: Is Inhalation an Allergy Risk?' *Regulatory Toxicology and Pharmacology* 73 (3): 897–902. https://doi.org/10.1016/j.yrtph.2015.09.031.

Bridges, Betty. 2002. 'Fragrance: Emerging Health and Environmental Concerns'. *Flavour and Fragrance Journal* 17 (5): 361–71. https://doi.org/10.1002/ffj.1106.

Buckley, D.A., R.J.G. Rycroft, I.R. White, and J.P. Mcfadden. 2003. 'The Frequency of Fragrance Allergy in Patch-Tested Patients Increases with Their Age'. *British Journal of Dermatology* 149 (5): 986–89. https://doi.org/10.1111/j.1365-2133.2003.05491.x.

Budnik, Lygia T., Edwin Scheer, P. Sherwood Burge, and Xaver Baur. 2017. 'Sensitising Effects of Genetically Modified Enzymes Used in Flavour, Fragrance, Detergence and Pharmaceutical Production: Cross-Sectional Study'. *Occup Environ Med* 74 (1): 39–45. https://doi.org/10.1136/oemed-2015-103442.

Cameron, Trudy Ann, and Daniel D Huppert. 1989. 'OLS versus ML Estimation of Non-Market Resource Values with Payment Card Interval Data'. *Journal of Environmental Economics and Management* 17 (3): 230–46. https://doi.org/10.1016/0095-0696(89)90018-1.

Caress, Stanley M., and Anne C. Steinemann. 2009. 'Prevalence of Fragrance Sensitivity in the American Population'. *Journal of Environmental Health; Denver* 71 (7): 46–50.

Chrysochou, Polymeros, and Klaus G. Grunert. 2014. 'Health-Related Ad Information and Health Motivation Effects on Product Evaluations'. *Journal of Business Research* 67 (6): 1209–17. https://doi.org/10.1016/j.jbusres.2013.05.001.

Daughety, Andrew F., and Jennifer F. Reinganum. 2008. 'Imperfect Competition and Quality Signalling'. *The RAND Journal of Economics* 39 (1): 163–83. https://doi.org/10.1111/j.1756-2171.2008.00008.x.

Deaton, Angus, and Nancy Cartwright. 2016. 'Understanding and Misunderstanding Randomized Controlled Trials'. *NBER Working Paper* w22595.

Disdier, Anne-Célia, Stéphan Marette, and Guy Millet. 2013. 'Are Consumers Concerned about Palm Oil? Evidence from a Lab Experiment'. *Food Policy* 43 (December): 180–89. https://doi.org/10.1016/j.foodpol.2013.09.003.

Dolgopolova, Irina, and Ramona Teuber. 2017. 'Consumers' Willingness to Pay for Health Benefits in Food Products: A Meta-Analysis'. *Applied Economic Perspectives and Policy*. https://doi.org/10.1093/aepp/ppx036.

Dos Santos Ferreira, Rodolphe, and Jacques-François Thisse. 1996. 'Horizontal and Vertical Differentiation: The Launhardt Model'. *International Journal of Industrial Organization* 14 (4): 485–506. https://doi.org/10.1016/0167-7187(95)00486-6.

European Commission. 2004. 'Regulation (EC) No 648/2004 of the European Parliament and the Council of 31 March 2004 on Detergents'. *Official Journal of the European Union* 104.

———. 2007. 'Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 Concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), Establishing a European Chemicals Agency.'

European Union. 2011. 'Final Report of the Hearing Officer (1) COMP/39.579 - Consumer Detergents (2011/C 193/05)'. *Official Journal of the European Union* 193: 12–13.

Fernandez, Marisa. 2016. 'Perfume Allergies - European Commission'. European Commission. 2016. https://ec.europa.eu/health/scientific_committees/opinions_layman/perfume-allergies/en/index.htm#il1.

Frosch, Peter J., Jeanne Duus Johansen, Marie-Louise A. Schuttelaar, Juan F. Silvestre, Javier Sánchez-Pérez, Elke Weisshaar, and Wolfgang Uter. 2015. 'Patch Test Results with Fragrance Markers of the Baseline Series – Analysis of the European Surveillance System on Contact Allergies (ESSCA) Network 2009–2012'. *Contact Dermatitis* 73 (3): 163–71. https://doi.org/10.1111/cod.12420.

Hanemann, W. Michael. 1982. 'Applied Welfare Analysis with Qualitative Response Models'. Departemtn of Agricultural & Resource Economics, UCB, CUDARE Working Papers. Berkley, USA.

Hartmann, Christina, Sophie Hieke, Camille Taper, and Michael Siegrist. 2018. 'European Consumer Healthiness Evaluation of "Free-from" Labelled Food Products'. *Food Quality and Preference* 68 (September): 377–88. https://doi.org/10.1016/j.foodqual.2017.12.009.

Heisterberg, Maria V., Torkil Menné, and Jeanne D. Johansen. 2014. 'Fragrance Allergy and Quality of Life – Development and Validation of a Disease-Specific Quality of Life Instrument'. *Contact Dermatitis* 70 (2): 69–80. https://doi.org/10.1111/cod.12153.

Hu, Wuyang, Timothy Woods, Sandra Bastin, Linda J. Cox, and Wen You. 2011. 'Assessing Consumer Willingness to Pay for Value-Added Blueberry Products Using a Payment Card Survey'. *Journal of Agricultural and Applied Economics* 43 (02). https://doi.org/10.1017/S1074070800004193.

Jo, Manseok, and Jungwoo Shin. 2017. 'Market Strategy for Promoting Green Consumption: Consumer Preference and Policy Implications for Laundry Detergent'. *International Journal of Consumer Studies* 41 (3): 283–90. https://doi.org/10.1111/ijcs.12339.

Johansen, J.duus, T. Menné, J. Christophersen, K. Kaaber, and N. Veien. 2000. 'Changes in the Pattern of Sensitization to Common Contact Allergens in Denmark between 1985–86 and 1997–98, with a Special View to the Effect of Preventive Strategies'. *British Journal of Dermatology* 142 (3): 490–95. https://doi.org/10.1046/j.1365-2133.2000.03362.x.

Johnston, Robert J., Kevin J. Boyle, Wiktor (Vic) Adamowicz, Jeff Bennett, Roy Brouwer, Trudy Ann Cameron, W. Michael Hanemann, et al. 2017. 'Contemporary Guidance for Stated Preference Studies'. *Journal of the Association of Environmental and Resource Economists* 4 (2): 319–405. https://doi.org/10.1086/691697.

Joo, Han-Seung, and Chung-Soon Chang. 2006. 'Production of an Oxidant and SDS-Stable Alkaline Protease from an Alkaophilic Bacillus Clausii I-52 by Submerged Fermentation: Feasibility as a Laundry Detergent Additive'. *Enzyme and Microbial Technology* 38 (1): 176–83. https://doi.org/10.1016/j.enzmictec.2005.05.008.

Lancaster, Kelvin. 1979. *Variety, Equity and Efficiency: Product Variety in an Industrial Society*. S.l.: Columbia University Press.

———. 1990. 'The Economics of Product Variety: A Survey'. *Marketing Science* 9 (3): 189–206.

Loureiro, Maria L., and Susan Hine. 2002. 'Discovering Niche Markets: A Comparison of Consumer Willingness to Pay for Local (Colorado Grown), Organic, and GMO-Free Products'. *Journal of Agricultural and Applied Economics* 34 (3): 477–87. https://doi.org/10.1017/S1074070800009251.

Lusk, Jayson L., and Stéphan Marette. 2010. 'Welfare Effects of Food Labels and Bans with Alternative Willingness to Pay Measures'. *Applied Economic Perspectives and Policy* 32 (2): 319–37. https://doi.org/10.1093/aepp/ppp013.

Maynard, Leigh J., and Sharon T. Franklin. 2003. 'Functional Foods as a Value-Added Strategy: The Commercial Potential of "Cancer-Fighting" Dairy Products'. *Applied Economic Perspectives and Policy* 25 (2): 316–31. https://doi.org/10.1111/1467-9353.00141.

Morawetz, Ulrich B., and Dieter B. A. Koemle. 2017. 'Contingent Valuation of Measures against Urban Heat: Limitations of a Frequently Used Method'. *Journal of Urban Planning and Development* 143 (3): 04017005. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000384.

Nibbe, Nathalie, and Ulrich R. Orth. 2017. 'Odor in Marketing'. In *Springer Handbook of Odor*, 141–42. Springer Handbooks. Springer, Cham. https://doi.org/10.1007/978-3-319-26932-0_56.

Penn, Jerrod M., and Wuyang Hu. 2018. 'Understanding Hypothetical Bias: An Enhanced Meta-Analysis'. *American Journal of Agricultural Economics* 100 (4): 1186–1206. https://doi.org/10.1093/ajae/aay021.

R Development Core Team. 2015. *R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing*. Vienna, Austria. http://www.R-project.org.

Shove, Elizabeth. 2003. 'Converging Conventions of Comfort, Cleanliness and Convenience'. *Journal of Consumer Policy* 26 (4): 395–418. https://doi.org/10.1023/A:1026362829781.

Siró, István, Emese Kápolna, Beáta Kápolna, and Andrea Lugasi. 2008. 'Functional Food. Product Development, Marketing and Consumer Acceptance—A Review'. *Appetite* 51 (3): 456–67. https://doi.org/10.1016/j.appet.2008.05.060.

Siwayanan, Parthiban, Nooh Abu Bakar, Ramlan Aziz, and Shreeshivadasan Chelliapan. 2015. 'Exploring Malaysian Household Consumers Acceptance towards Eco-Friendly Laundry Detergent Powders'. *Asian Social Science* 11 (9): 125. https://doi.org/10.5539/ass.v11n9p125.

Small, Kenneth A., and Harvey S. Rosen. 1981. 'Applied Welfare Economics with Discrete Choice Models'. *Econometrica* 49 (1): 105–30. https://doi.org/10.2307/1911129.

Solon, Gary, Steven J. Haider, and Jeffrey M. Wooldridge. 2015. 'What Are We Weighting For?' *Journal of Human Resources* 50 (2): 301–16. https://doi.org/10.3368/jhr.50.2.301.

Statistik Austria. 2018. 'Statistik Austria'. 2018. https://www.statistik.at/.

Stranieri, Stefanella, Lucia Baldi, and Alessandro Banterle. 2010. 'Do Nutrition Claims Matter to Consumers? An Empirical Analysis Considering European Requirements'. *Journal of Agricultural Economics* 61 (1): 15–33. https://doi.org/10.1111/j.1477-9552.2009.00223.x.

Thyssen, J.p., T. Menné, A. Linneberg, and J.d. Johansen. 2009. 'Contact Sensitization to Fragrances in the General Population: A Koch's Approach May Reveal the Burden of Disease'. *British Journal of Dermatology* 160 (4): 729–35. https://doi.org/10.1111/j.1365-2133.2008.09022.x.

United States Congress. 1972. *Consumer Product Safety Act, Pubic Law 92-573, 86 Stat. 1972.*

Vienna City Administration. 2016. *Statistisches Jahrbuch Der Stadt Wien 2016*. Vienna: Vienna City Administration MA 23.

Warrenburg, Stephen. 2005. 'Effects of Fragrance on Emotions: Moods and Physiology'. *Chemical Senses* 30 (suppl_1): i248–49. https://doi.org/10.1093/chemse/bjh208.

Tables:

	Current price	WTP for fragrance-free detergent	Buy fragrance-free detergent:	
			If market price: $p^{ff,H}$	**If market price: $p^{ff,L}$**
Consumer type 1	$p^{f,H}$	$d^P>0$	Yes, because $(p^{ff,H}-p_f^{H}) < d^P$	No, because fragrance-free is L.
Consumer type 2	$p^{f,L}$	$d^N<0$	No, because fragrance-free is H	No, because $(p_{ff}^{L}-p_f^{L}) > d^N$
Consumer type 3	$p^{f,H}$	$d^N<0$	No, because $(p^{ff,H}-p^{f,H}) > d^N$	No, because fragrance-free is L.
Consumer type 4	$p^{f,L}$	$d^P>0$	No, because fragrance-free is H.	Yes, because $(p^{ff,L}-p^{f,L}) < d^P$

Notes: $p^{f,H}$ stands for the price of a high quality (H) fragrance (f) containing detergent. The superscript ff is for 'fragrance free' and the superscript L for low quality. d^P stands for a positive WTP while d^N stands for a negative WTP.

Table 1: Schematic table showing which consumer types buy which fragrance-free detergent.

Gender		Male	Female			
	Sample	43%	57%			
	Vienna	49%	51%			
Age group		**18- 24**	**25-40**	**41-60**	**61+**	
	Sample	11%	58%	24%	7%	
	Vienna	9%	26%	28%	20%	
Education		**<High school**	**High school**	**Uni-versity**	**>Uni-versity**	
	Sample	12%	40%	45%	2%	
	Vienna	55%	18%	27%	--	
Household size (persons)		**1**	**2**	**3**	**4**	**>4**
	Sample	25%	40%	12%	16%	7%
	Vienna	44%	29%	13%	9%	5%
Income of respondent (€/month)		**<1500**	**1501-3000**	**3001-4500**	**> 4501**	**no reply**
	Sample	27%	25%	16%	29%	4%
Respondent knows						
detergents contain fragrance		**No**	**Yes**			
	Sample	27%	73%			
health effects of fragrance		**No**	**Yes**			
	Sample	60%	40%			
about fragrance-free products		**No**	**Yes**			
	Sample	48%	52%			
Check ingredients of products		**Never**	**Almost never**	**Some-times**	**Often**	**Always**
	Sample	30%	25%	25%	14%	5%
Bought fragrance-free products (including other than detergents)		**Never**	**Almost never**	**Some-times**	**Often**	**Always**
	Sample	56%	16%	20%	7%	1%

Table 2: Household characteristics, knowledge and attitudes of 122 respondents and for Vienna in 2017. Source for data from Vienna: Statistik Austria (Statistik Austria 2018).

	Mean	Median	St. Dev.	Min	Max
Current price paid (a)	3.24	3.30	1.19	1.30	5.30
Maximum price for fragrance-free detergent					
before information (b)	2.73	2.50	1.50	0.00	6.00
after information (c)	3.20	3.50	1.62	0.00	6.00
(b)-(a): difference without health information	-0.51	-0.50	1.14	-4.60	2.00
(c)-(a): difference with health information	-0.03	0.30	1.22	-4.60	2.90
(c)-(b): effect of health information	0.47	0.50	0.59	0.00	3.00

Table 3: Distribution of current price paid and stated WTP of 122 respondents.

Dependent variable	Current price		WTP without information		WTP with information		WTP with info. – WTP without info.	
	Coef	St. Err	Coef	St. Err	Coef	St. Err	Coef	St. Err
Intercept	2.61	(0.19) **	-0.99	(0.21) **	-0.78	(0.22) **	0.21	(0.06) **
Income (€/month)								
1501-3000	0.64	(0.29) **	0.54	(0.27) *	0.89	(0.27) **	0.35	(0.12) **
3001-4500	0.67	(0.33) **	0.73	(0.39) *	0.97	(0.42) **	0.24	(0.11) **
> 4501	1.06	(0.27) **	0.73	(0.28) **	1.20	(0.29) **	0.47	(0.15) **
no reply	1.37	(0.50) **	0.71	(0.36) *	0.70	(0.32) **	-0.01	(0.15)
No. of obs.	122		122		122		122	
R^2	0.13		0.07		0.15		0.11	

Note: WTP is the willingness to pay for a change from the currently used detergent to fragrance-free detergent

Table 4: Linear regression results showing correlation between income and dependent variables.

Dep. Variable	Current price			WTP without information			WTP with information			WTP with info. – WTP without info.		
	Coef	St. Err		Coef	St. Err		Coef.	St. Err		Coef.	St. Err	
Intercept	1.35	(0.41)	**	-0.27	(0.39)		-0.02	(0.46)		0.25	(0.23)	
Current price (€/Ltr)				-0.49	(0.11)	**	-0.39	(0.12)	**	0.10	(0.06)	
Usually buy ecolabel	0.44	(0.26)	*	1.18	(0.27)	**	0.96	(0.28)	**	-0.22	(0.17)	
Female	0.05	(0.22)		0.14	(0.20)		0.43	(0.21)	**	0.29	(0.16)	*
Age (years):												
25-40	0.52	(0.32)		0.12	(0.30)		0.01	(0.36)		-0.11	(0.17)	
41-60	0.52	(0.36)		0.30	(0.35)		0.08	(0.40)		-0.22	(0.20)	
>61	0.78	(0.49)		-0.19	(0.62)		-0.33	(0.65)		-0.13	(0.23)	
Education:												
High school	0.52	(0.32)		0.35	(0.29)		0.26	(0.32)		-0.09	(0.18)	
University	1.12	(0.36)	**	0.53	(0.37)		0.14	(0.39)		-0.39	(0.25)	
> University	2.15	(0.81)	**	0.96	(0.67)		0.63	(0.55)		-0.32	(0.37)	
Household												
2 persons	-0.13	(0.28)		-0.33	(0.30)		-0.53	(0.28)	*	-0.21	(0.19)	
3 persons	0.42	(0.36)		-0.24	(0.40)		-0.51	(0.42)		-0.27	(0.21)	
4 persons	0.08	(0.34)		-0.44	(0.33)		-0.91	(0.33)	**	-0.47	(0.24)	*
> 4 persons	-0.03	(0.62)		-1.05	(0.56)	**	-1.39	(0.60)	**	-0.34	(0.29)	
Income (€/month)												
1501-3000	0.44	(0.30)		0.77	(0.29)	**	1.21	(0.29)	**	0.44	(0.15)	**
3001-4500	-0.18	(0.36)		0.68	(0.47)		1.37	(0.48)	**	0.68	(0.25)	**
>4501	0.33	(0.37)		0.99	(0.39)	**	1.87	(0.40)	**	0.89	(0.29)	**
no reply	0.68	(0.48)		1.17	(0.48)	**	1.43	(0.53)	**	0.26	(0.26)	
Know health effects	0.76	(0.22)	**	0.37	(0.23)		0.04	(0.22)		-0.33	(0.13)	**
No. of obs.	122			122			122			122		
R²	0.37			0.42			0.44			0.26		

Note: WTP is the willingness to pay for a change from the currently used detergent to fragrance-free

Table 5: Linear regression results for conditional estimates of the influence of income.

Mean consumer welfare per detergent bought given only one detergent on the market	Without information					With health information					Obs
	$p^{ff}=2$	$p^{ff}=3$	$p^{ff}=4$	$p^{ff}=5$	$p^{ff}=6$	$p^{ff}=2$	$p^{ff}=3$	$p^{ff}=4$	$p^{ff}=5$	$p^{ff}=6$	
All incomes	0.06	0.07	0.08	0.07	0.04	0.12	0.13	0.22	0.15	0.07	122
< 1500 €/month	0.09	0.02	0.00	0.00	0.00	0.12	0.02	0.00	0.01	0.00	33
1501-2900 €/month	0.00	0.06	0.16	0.09	0.00	0.05	0.07	0.18	0.17	0.02	30
3001-4500 €/month	0.12	0.10	0.08	0.12	0.07	0.22	0.20	0.39	0.20	0.14	19
> 4500 €/month	0.07	0.11	0.09	0.11	0.09	0.12	0.28	0.42	0.25	0.13	35

Table 6: Numerical simulation based on CVM data and behavioral decision rule assumptions. p^{ff} is the price of the fragrance-free detergent offered on the market.
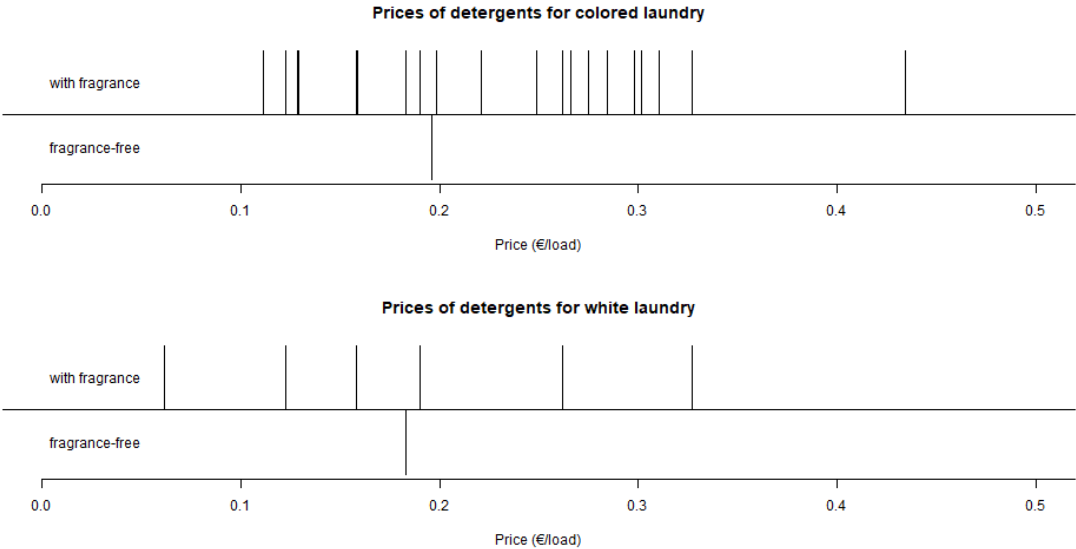
Figures:

Fig. 1: Prices of detergents in Euros per washing load in a leading central European drugstore in October 2017.

Before health information

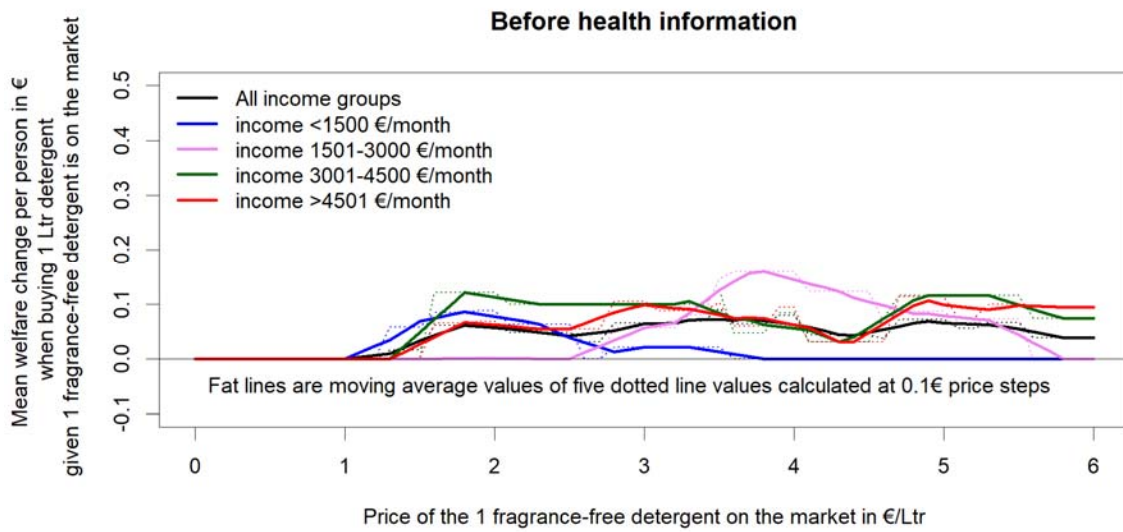Fat lines are moving average values of five dotted line values calculated at 0.1€ price steps

Fig. 2: Mean welfare change per liter of detergent for respondents by income group before health information was provided as a consequence of one fragrance-free detergent being offered on the market.

After health information

Fat lines are moving average values of five dotted line values calculated at 0.1€ price steps
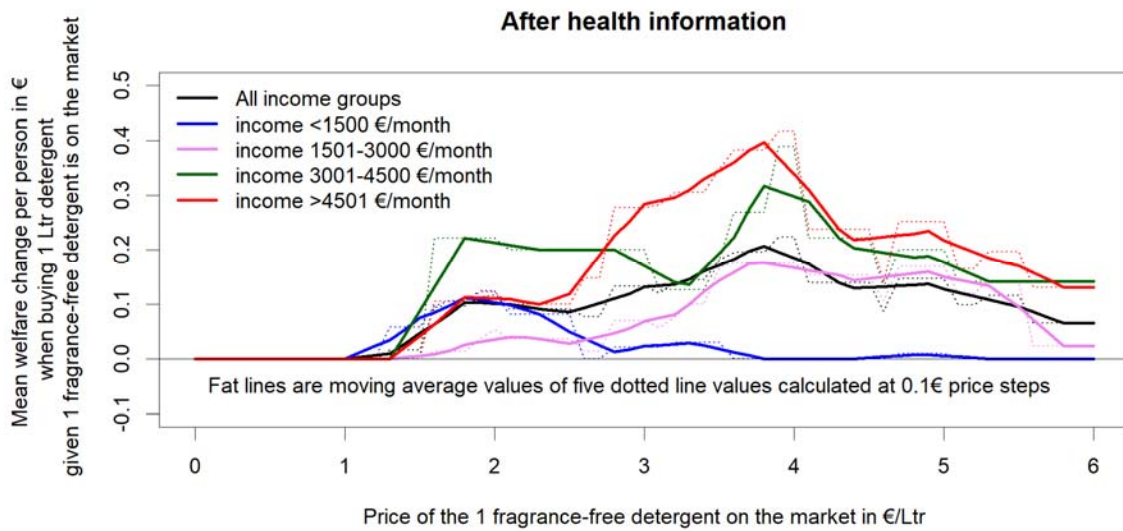
Fig. 3: Mean welfare change per liter of detergent for respondents by income group after health information was provided as a consequence of one fragrance-free detergent being offered on the market.