Firm Competition and Cooperation with Norm-Based Preferences for Sustainability

Inderst, Roman*   Sartzetakis, Eftichios S.†   Xepapadeas, Anastasios‡

Mai 2022

Abstract

We analyze firms' incentives to coordinate on the introduction of a more sustainable product variant when consumers' preferences for greater sustainability depend on the perceived social norm, which in turn is shaped by average consumption behavior. Such preferences lead to multiple equilibria. If the more sustainable variant allows firms to sufficiently expand their aggregate market share, when a lenient legal regime makes this feasible they will coordinate on the more sustainable outcome. If their aggregate market share however does not expand sufficiently under the more sustainable variant, coordination can forestall a more sustainable outcome. Our analysis thus both confirms and qualifies the notion of a sustainability first-mover disadvantage as a justification for an agreement between competitors, which has gained traction in antitrust. We also provide empirical evidence for norm-based sustainability preferences.

Keywords: Sustainability; Antitrust; Firm Cooperation.

*Goethe University Frankfurt; inderst@finance.uni-frankfurt.de
†University of Macedonia; esartz@uom.edu.gr
‡Athens University of Economics and Business and University of Bolognia; xepapad@aueb.gr

1 Introduction

In March 2022 the European Commission published its draft horizontal guidelines on agreements between competitors.[1] A key novelty is the inclusion of "sustainability agreements" as a new category. Also other jurisdictions have taken steps to recognize potential sustainability benefits when assessing horizontal agreements. For instance, also the Dutch competition authority has issued new guidelines,[2] while Austria recognizes sustainability benefits in its draft competition law reform.[3] Testifying to the rapidly growing importance of sustainability concerns in competition law enforcement also outside Europe, the OECD has dedicated a roundtable to this topic in December 2021.[4]

Recognizable efficiencies, including sustainability benefits, must pass a test of indispensability. To this end, the new sustainability chapter in the Commission's guidelines explicitly mentions a potential *first-mover disadvantage* that would prevent firms from realizing the claimed sustainability benefits individually. As the sharing of fixed costs and infrastructure investments already represent recognizable benefits, e.g., in research and development agreements, prima facie it is not obvious what would be special with respect to sustainability agreements, so that firms have collectively but not individually sufficient incentives to realize the respective benefits.[5] In this contribution we show how such a first-mover disadvantage may materialize when consumers' sustainability preferences are shaped by social norms that in turn depend on the (anticipated) behaviour of others. While this may not be entirely specific to sustainability preferences, social norms should be particularly relevant in this case as preferences are not anchored by some immediate use value and often have a moral dimension, such as altruism with respect to future generations.[6] We provide additional empirical support for such preferences, using the data from

[1] See European Commission (2022a) and the background in the respective expert report European Commission (2022b).

[2] ACM (2021). Also the Hellenic authority has issued a statement of principles (HCC 2020).

[3] According to this, contributions to an ecologically sustainable or climate-neutral economy will be considered alongside with consumer benefits. See for the current draft in German: file:///C:/Users/inder/AppData/Local/Temp/KaWeR%C3%84G_2021_Gesetzestext.pdf.

[4] See https://www.oecd.org/daf/competition/environmental-considerations-in-competition-enforcement.htm.

[5] We acknowledge that the internalization of out-of-market externalities, i.e., on non-consumers, is relatively specific to sustainability agreements. However, such benefits are explicitly not recognized in the draft horizontal guidelines. Moreover, one would need to ask why firms have collectively but not individually incentives to internalize such externalities that can not be monetized in the market.

[6] Non-use value refers to a valuation not based on actual, planned, or possible use by oneself (though possibly by others); cf., Pearce et al. (2006). Such non-use values may still be anthropocentric, motivated by altruism or bequest motives, or extend beyond this, such as in relation to animal welfare.

a conjoint analysis conducted by the Dutch competition authority ("Chicken-of-Tomorrow case"[7]; see below). Precisely, we show there that it is notably the willingness-to-pay for the less sustainable variant that decreases markedly when a consumer anticipates that only few other consumers still choose this option. This is in line with our modelling assumptions of consumer preferences.

We consider it of equal importance that with such preferences and the resulting network effect, coordination between firms may however also lead to the less desirable, less sustainable outcome. This is more likely when the considered firms cover most of the relevant market. We show that in this case also such preferences turn firms' product choices into strategic complements, albeit for different reasons. In particular, if firms choose different levels of sustainability, the responsiveness of demand increases, leading to increased competition. Coordination then allows firms to avoid the more sustainable but jointly less profitable outcome.[8]

Our analysis, based on sustainability preferences shaped by social norms, thus both confirms and qualifies a potential first-mover disadvantage that would justify cooperation between competitors. The guidance derived from our formal analysis would call for caution in particular when the involved firms cover much of the market and when they can not expect a sufficient expansion by introducing a more sustainable product variant. A case in place could be the coordination between German premium car manufacturers BMW, Daimler, and Volkswagen, covering also brands like Porsche or Audi, aimed at limiting the development and roll-out of emission cleaning technologies for new diesel and petrol passenger cars sold in the European Economic Area (EEA). At the time this case was examined, together these companies covered more than 80 % of the premium market segment in Europe.[9] Also in terms of formal modelling, such an infringement may be more adequately captured as coordination rather than collusion in an open-ended game (where the respective strategy is chosen repeatedly). In our model, coordination allows firms to select among multiple equilibria, thereby either facilitating joint sustainable strategies or preventing a more sustainable but jointly less profitable outcome.

Generally, our assumption that individual preferences depend on social norms that are shaped by the behaviour of others is not novel also to economists. A well-known exam-

[7]For the decision see https://www.acm.nl/en/publications/publication/13761/Industry-wide-arrangements-for-the-so-called-Chicken-of-Tomorrow-restrict-competition.

[8]We note that such explicit coordination, even in the form of "cheap talk", would clearly be prohibited, that is unless it is treated as an admissible horizontal agreement.

[9]In April 2019 the European Commission sent a Statement of Objections (https://ec.europa.eu/commission/presscorner/detail/en/IP_19_2008).

ple are experimental games of contributions to a public good. Sugden (1984) posits that individuals follow a conditional moral rule of "contributing of what I wish others to contribute, but not needing to contribute more than the person who contributes the least".[10] Such preferences have also been confirmed by various field studies.[11] In environmental economics, Nyborg et al. (2006) invoke social norms, though without modelling market interactions. In this literature, in fact, "green preferences" are typically taken as exogenously given (e.g., Constantatos et al. 2019) or related to the maximum or minimum offered level of sustainability. Thus, while firms have incentives to reduce competition through differentiation,[12] we show that with norm-based preferences for sustainability, differentiation instead leads to more intense competition, so that firms' sustainability strategies become strategic complements. This again ties into the large literature on competition with network effects. Farrell and Saloner (1985) recognize the potential benefits from communication to avoid coordination failure in the presence of network effects, and the subsequent Industrial Organization literature analyzes primarily competing networks (cf. Katz and Shapiro 1985 and notably in a Hotelling framework Griva and Vettas 2011). As we noted above, more generally network effects can constitute appreciable benefits when assessing horizontal cooperations and they may arise from various sources, including the investment in joint infrastructure. In such a framework, Sartzetakis and Tsigaris (2005) analyze optimal environmental policies, such as taxation and subsidies.

We organize our results as follows. Section 2 introduces the main ingredients of our theoretical analysis. Section 3 analyzes a baseline model. Section 4 extends the analysis. We conclude in Section 5. Proofs are collected in a separate Appendix, which contains also the empirical part.

2 Model

To introduce our key ideas, we keep the market environment as simple as possible. The market is populated by the mass one of consumers, each of which purchases (at most) a single unit. We focus on a possible agreement by two firms, $i = A$ and B. Firms can produce either a sustainable (s) or a non-sustainable (ns) variant of the product. The

[10] Cf. more generally Benabou and Tirole (2006) on social norms. Imitation and conformism may also give rise to network effects; cf. Grillo et al. (2001).

[11] For instance, recycling behavior has been found to strongly correlate with beliefs about recycling in the community (see the various studies quoted in Schultz 2002); for related experimental studies on environmental behavior see Alcott and Rogers (2014) or Jakob et al. (2017).

[12] For this literature see, for instance, the references in Ambec and De Donder (2021).

non-sustainable variant can be produced also by a market fringe. Firms' offerings are horizontally differentiated, which allows them to earn a margin above costs. Originally, all firms offer the non-sustainable variant at marginal cost normalized to zero. The two strategic firms can offer the sustainable variant after investing $K \geq 0$, with constant per-unit costs of production $c_s > 0$. K is specific to each firm that switches to the sustainable variant.[13]

The model's timing is as follows. We suppose that firms A and B choose first whether to offer the more or the less sustainable variant. Firms subsequently choose prices. Ultimately consumers make their choices. We first analyze the equilibria of this game. Subsequently we allow firms to possibly coordinate their sustainability investments. Throughout we ask when firms will choose the sustainable variant. We thereby take it as given that societal benefits are highest when both firms choose the sustainable variant. This could be endogenized when production or consumption of the non-sustainable variant generates sufficiently high damages for society that are not internalized by consumers. We next introduce consumer preferences.

Consumer Preferences. A consumer's utility has four separable parts: an immediate use value from the product u_0, with the sustainable variant providing an additional direct value z; the price p; a base part that pertains to the social norm; and a part that pertains to horizontal preferences between firms. To formalize the social norm, we denote by $\widehat{S}$ a consumer's expectation of the fraction of purchases that are sustainable. Then consumers purchasing the sustainable variant receive additional value $\rho_s \widehat{S}$, while those purchasing the non-sustainable variant perceive a reduction equal to $\rho_{ns} \widehat{S}$. Letting u_s be the utility from consuming the sustainable variant and u_{ns} that from the non-sustainable variant, we define

$$\begin{aligned} u_s &= u_0 + z - p + \rho_s \widehat{S} - d\tau, \\ u_{ns} &= u_0 - p - \rho_{ns} \widehat{S} - d\tau. \end{aligned} \tag{1}$$

The last part, $d\tau$, captures horizontal preferences in a standard way, with d denoting the distance of the firm's offer to the consumer's preferred variant. We next discuss in detail the social-norm part, where we make the following key assumption:

Assumption: *Consumers share the same strictly positive social-norm preferences with* $\gamma := \rho_{ns} + \rho_s > 0$.

[13] Otherwise, there is an immediate benefit from an agreement that allows to share such costs.

All that matters in what follows is the size of γ, capturing ceteris paribus the effect of the expected market share of the sustainable variant on the difference between u_s and u_{ns}. When $\rho_{ns} > 0$, this captures a disutility that a consumer experiences from falling behind a perceived social (sustainability) norm, where we suppose that the perceived behavior of other consumers, $\widehat{S}$, constitutes such a norm. When also $\rho_s > 0$, a consumer's willingness-to-pay for the sustainable variant increases when she anticipates that the respective contribution is shared by more consumers. In the Introduction we have discussed foundations and evidence for the feedback effect of other consumers' choices and the working of social norms. In what follows, we briefly introduce additional evidence that is more closely tied to the current setting. This confirms for the specific circumstances of the presented case not only that $\gamma > 0$, but also that the negative feedback through $\rho_{ns} > 0$ can be particularly strong.

Evidence from the "Chicken of Tomorrow" Case. In January 2015, the Netherland's Authority for Consumers and Markets (ACM) decided on a planned agreement between producers, traders, and retailers aimed at introducing a minimum welfare standard for chicken ("Chicken of Tomorrow"). For this the ACM conducted a hypothetical choice experiment (conjoint analysis) with 1,603 panel members so as to thereby assess consumers' willingness-to-pay. Ultimately, the ACM decided that the agreement did not qualify for the exemption from the cartel prohibition as consumers would not value the achieved sustainability improvement sufficiently compared to the price increase that the parties wanted to impose jointly.[14] The ACM shared these data with us for research purposes.

In Appendix C we report results from a conditional logit analysis of these data. Importantly, next to the specific sustainability attributes (outdoor access, living space, lifespan, and anaesthetized slaughtering), the choice options contained information on whether the particular alternative was chosen either by a "large" or by a "small" number of consumers. In our analysis we both include this as an additional attribute and we examine its interaction with the various sustainability attributes. In terms of our previous notation, we could thus conceive of two values $\widehat{S} = S_l$ or $\widehat{S} = S_h$ with $S_l < S_h$, so that when $\widehat{S} = S_h$, the more sustainable variant is supposed to be chosen by a large number S_h and the less sustainable by a small number S_l (and vice versa). Holding all else constant, when first only few consumers (S_l) choose the sustainable variant but then more consumers (S_h), this

[14] See the Dutch case document Mulder et al (2014).

increases the incremental willingness-to-pay, $u_s - u_{ns}$, by $\gamma\Delta_S$.

In our empirical analysis, the inclusion of the interaction between the reported number of consumers choosing the particular option and sustainability attributes allows us also to identify separately the two different components that make up $\gamma\Delta_S$, that is $\rho_{ns}\Delta_S$ and $\rho_s\Delta_S$. Our key finding, leaving now out the multiplicant Δ_S, is that $\rho_{ns} > \rho_s > 0$ (implying $\gamma > 0$). In fact, it is in particular the part ρ_{ns} that is both economically important and statistically significant:[15] Panelists' willingness-to-pay for a less sustainable variant markedly decrease when this is supposedly no longer chosen by a large number of consumers.

Horizontal Differentiation. We turn next to horizontal differentiation. We achieve tractability by invoking an extended Hotelling model, which gives rise to linear demand. A key element of our comparative analysis is the extent to which the introduction of the sustainable variant allows firms to expand their (joint) market, rather than only shifting market shares between them. To analyze this in a tractable way, we introduce three market segments: In market segment A the respective firm A competes with a fringe, firm B competes with a fringe in market segment B, and in market segment C firms A and B compete against each other. The respective market sizes (mass of consumers) are denoted by M for the market segment C, on which firms A and B compete, and, assuming symmetry, by m for each of the two fringe market segments A and B, with $2m + M = 1$. In terms of consumer preferences, in the two fringe markets consumers experience zero differentiation between the respective firm (A or B) and the fringe firms (so that $d_i = 0$). Consumers in market segment C have horizontal preferences between the two firms that are uniformly distributed over an interval of size one: A consumer with respective distance parameter x derives disutility $x\tau$ when purchasing from A (thus $d_A = x$) and disutility $(1 - x)\tau$ when purchasing from B (thus $d_B = 1 - x$). In our baseline model, we allow firms A and B to set different prices in the respective market segments (p_A and p_B in the respective fringe market segments and p_a and p_b in segment C), which greatly simplifies the analysis. In the subsequent section we show that results are robust when there is uniform pricing across all market segments.[16]

[15] In our empirical analysis this holds for all separate interactions with the four sustainability attributes and thus not only when comparing the least with the most sustainable variant (where all four attributes are flipped).

[16] There, we also represent the three market segments as three intervals on a single Hotelling line of length three, with firms A located at 1, firm B located at 2, and fringe market competitors located at 0 and 3, respectively.

To restrict attention to interior pricing solutions, we require that horizontal differentiation in market C is sufficiently important. To state the respective assumption we note that, as is standard in a Hotelling context, the direct utility benefit of the sustainable product z affects profits in the same way as the higher marginal costs c_s, albeit with different sign. Capturing the net effect of these two parameters by the variable $v = z - c_s$, we require that:

$$\tau > \gamma + \max(0, v/3). \tag{2}$$

3 Analysis

Before we conduct the analysis for the case where consumers exhibit the hypothesized social-norm preferences, as a benchmark it is informative to report on the outcome when $\gamma = 0$.

Benchmark ($\gamma = 0$): *With standard preferences, there is generically a unique equilibrium in firms' product choices, so that there is no scope for firms to coordinate their strategies.*

This observation stresses the importance of $\gamma > 0$ for the subsequent analysis. Presently, we choose to report this result without a proof, which however will follow immediately, as a corner case, from the subsequent derivations (and, for ease of reference, is separately treated at the end of Appendix A). In what follows we will also return to this benchmark when we discuss details of firms' pricing and product choice strategies.

3.1 Prices and Profits

Recall that in our baseline model, firms can set separate prices in the market segments they participate. These are now considered in turn, always taking as given firms' sustainability choices. Recall also that in the fringe segments there is competition by at least one firm that is undifferentiated and sells the non-sustainable variant. We denote consumers' expectation of the fraction of market segment C that is served by firm A by (the threshold type) $\widehat{x}_C$.

Lemma 1 *(Prices on the Fringe Segments) When firm A offers the nonsustainable variant, in the respective market segment A it can only set a price equal to costs (of zero), and this applies symmetrically to firm B. When both firms offer the sustainable variant,* *they both set* $p_A = p_B = z + \gamma$. *When only firm* A *chooses the sustainable variant, its price in market segment* A *is* $p_A = z + \gamma(m + M\widehat{x}_C)$, *while when only firm* B *chooses the sustainable variant, its price is* $p_B = z + \gamma(m + M(1 - \widehat{x}_C))$.

When both firms offer the sustainable variant, in equilibrium all consumers will make a sustainable purchase, which for $\widehat{S} = 1$ pushes up their willingness-to-pay by γ. When only one firm offers the sustainable variant, total market penetration depends on how the mutually contested segment C is shared (and the relative importance of this segment, as captured by M). The overall lower market penetration reduces consumers' incremental willingness-to-pay for the more sustainable variant.

Turning next to market segment C, we deal first with the symmetric case, for which we can recoup the standard result that in a symmetric Hotelling setting prices are equal to marginal costs plus a margin equal to the differentiation parameter, τ.

Lemma 2 *(Prices on the Contested Segment with Symmetric Product Choices) When both firms offer the nonsustainable variant, in market segment* C *they set the price* $p_a = p_b = \tau$. *When both offer the sustainable variant, they set* $p_a = p_b = c_s + \tau$.

We turn next to the asymmetric case, where we derive results in more detail. Suppose for specificity that only firm A introduces the sustainable variant. Now, using expressions (1), the offer of firm A yields to a consumer with preference parameter x the utility $u_0 + \rho_s\widehat{S} - p_a - x\tau$ and that of firm B the utility $u_0 - \rho_{ns}\widehat{S} - p_b - (1-x)\tau$, which, from indifference, yields the threshold (when interior)

$$x_C = \frac{\tau + z - p_a + p_b + \gamma\widehat{S}}{2\tau}. \tag{3}$$

Importantly, in this expression $\widehat{S}$ depends also on the expected cutoff $\widehat{x}_C$: With asymmetric product choices and only firm A offering the sustainable variant, $\widehat{S} = m + M\widehat{x}_C$. Substituting this into (3) and using, from rational expectations, that $\widehat{x}_C = x_C$, we have finally

$$x_C = \frac{\tau + z + \gamma m - p_a + p_b}{2\tau - \gamma M}. \tag{4}$$

This derivation makes transparent two effects of the modified (norm-based) preferences of consumers. If firm A reduces its price, this has both a direct effect on the utility of a consumer and an indirect effect as it will expand overall purchases of the sustainable product and thus changes the norm and with it consumer preferences. This shows up in the (absolute value of the) slope of the cutoff-type in (4): When the price p_a is marginally decreased, ceteris paribus, through a change in x_C the marginal effect on demand in the market segment C (of size M) is $M/(2\tau - \gamma M)$ and thus strictly larger than without norm-based preferences (or likewise in the symmetric case where both firms choose the same alternative).[17] Hence, when only one firm chooses the sustainable variant and $\gamma > 0$, demand becomes more responsive to price changes, given the feedback effect that a change in the market share has on consumers' preferences. This intensifies competition. Furthermore, again only for $\gamma > 0$ there is an interaction between the two segments of the market that firm A serves, A and C, which shows up in the term γm in the numerator of expression (4). As the mass m of consumers in market segment A choose also the sustainable variant, A's product becomes more attractive to all consumers and pushes up x_C. Solving for equilibrium prices, it is straightforward to obtain:

Lemma 3 *(Prices on the Contested Segment with Asymmetric Product Choices) When only firm A chooses the sustainable variant, equilibrium prices in market segment C are*

$$\begin{aligned} p_a &= \tau + \frac{1}{3}\left[2c_s + z + \gamma(m - M)\right], \\ p_b &= \tau + \frac{1}{3}\left[c_s - z - 2\gamma(m + M)\right]. \end{aligned} \tag{5}$$

This gives rise to the cutoff type (A's share of segment C)

$$x_C = \frac{3\tau + z + \gamma(m - M) - c_s}{3\,(2\tau - \gamma M)}. \tag{6}$$

The case where only firm B chooses the sustainable variant is symmetric.

We note that $x_C < 1$ holds if $3\tau - \gamma(2M + m) > z - c_s$, which is implied by assumption (2).[18] We briefly comment on the role of γ (as the dependency of prices and market shares on all other parameters is standard). The aforementioned increase in the responsiveness of demand to prices unambiguously reduces the price for the nonsustainable product. When market segment C is sufficiently important with $M > m$, also the price of the sustainable product decreases in γ. This follows again from the increased responsiveness of demand. However, when $M < m$, instead, p_a increases in γ. Then the immediate effect of the increased valuation for the sustainable product, which firm A captures by setting a higher

[17] Note that our parameter assumptions imply that $\gamma M < 2\tau$.

[18] While also $x_C > 0$ requires parameter restrictions, we suppress these as they are not required for the equilibrium characterization (where product variants are chosen optimally).

price, dominates. When $\gamma = 0$, firm A has a larger share only when $z > c_s$. When however $\gamma = 0$, the market share of A is still larger even when $z < c_s$, for $\gamma > 2(c_s - z)$.

We can next utilize these characterizations to determine profits for the different strategy choices. Given symmetry of the two fringe market segments, we can conveniently define profits as $\pi_{ns,s}$ for the case where the considered firm chooses the nonsustainable variant and the other firm the sustainable variant, and likewise for all other combinations. These profits are gross of investment costs K in case of choosing the sustainable variant. Summing up over all market segments and making use of the characterized equilibrium prices, from Lemmas 1 and 2 we obtain first for the symmetric choices the following result:

Lemma 4 *(Profits for Symmetric Choices) Suppose both firms choose the same product variant. If they choose the nonsustainable variant, their gross profits are* $\pi_{ns,ns} = M\frac{\tau}{2}$. *If they choose the sustainable variant, their gross profits are* $\pi_{s,s} = M\frac{\tau}{2} + m(\gamma + z - c_S)$.

From Lemma 4 we have immediately that

$$\pi_{s,s} - \pi_{ns,ns} = m(\gamma + z - c_s).$$

Since, as in market segment C the higher utility of consumers is fully competed away, when both firms switch to the sustainable variant, they only make additional profits from market segments A and B, where they compete against the nonsustainable fringe (and only when $\gamma + z > c_s$). For competition on the fringe the fact that also the rival switches to the sustainable variant is beneficial, as the overall greater market penetration of sustainable products raises the social norm and with it the relative willingness-to-pay for the more sustainable product. Using next Lemma 3 and substituting into firms' profit functions, we have:

Lemma 5 *(Profits for Asymmetric Choices) Suppose only firm A offers the sustainable product variant. Then firms' gross profits are given by*

$$\pi_{s,ns} = m\left[\gamma(m + Mx_C) + z - c_s\right] + Mx_C\left[\tau + \frac{1}{3}\left[\gamma(m - M) + z - c_s\right]\right], \qquad (7)$$

$$\pi_{ns,s} = M(1 - x_C)\left[\tau + \frac{1}{3}\left[c_s - z - 2\gamma(m + M)\right]\right],$$

with x_C obtained from (6). When only firm B offers the sustainable variant, expressions are symmetric (with x_C replaced by $1 - x_C$).

For $\pi_{s,ns}$ the first term in rectangular brackets in (7), multiplied by m, refers to the profits realized in the fringe market (of firm A), while the second term, multiplied by M, refers to the contested market C. The firm choosing the non-sustainable variant only makes positive profits in market C, which is why there is only a single term in $\pi_{ns,s}$ (multiplied by M). It is now instructive to briefly focus on firm A's profit from segment C. Moreover, we also suppose that $M = 1$ and only for now that the sustainable product has no direct advantage or disadvantage as $z = c_s$. In this case firm A's profits simplify to

$$\pi_{s,ns} = \frac{1}{9}\frac{(3\tau - \gamma)^2}{(2\tau - \gamma)},$$

which is strictly decreasing in γ.[19] Recall now the two identified effects that γ has on pricing and profits. From the direct effect, which pushes up the willingness-to-pay for the sustainable product relative to that of the non-sustainable product, firm A should gain when the norm effect is stronger (higher γ). But in the presently analyzed case ($M = 1$, $z = c_s$) this is more than compensated for by the increase in competition, which results from the increased responsiveness of demand. As we now add the fringe with $m > 0$, intuitively the positive direct effect becomes larger and the countervailing negative effect through an increase in competition becomes smaller, where both changes follow from the same logic: There is now a fraction of the market on which the two firms do not compete directly but which affects the overall penetration of the sustainable product and thus the shift in valuation due to the norm effect. Indeed, we can show that, as a consequence, $\pi_{s,ns}$ increases in γ if and only if the fringe segments become sufficiently important. This property will also feature in the subsequent discussion of equilibrium product choice.

3.2 Sustainability and Cooperation

It is instructive to first consider two corner cases, with either only market segment C ($M = 1$) or only the two fringe market segments ($M = 0$). This will allow us to isolate the key economic forces, both for sustainable investments and for the scope of coordination. Subsequently, we analyze the interplay of these forces when we consider interior values of M. Throughout we focus on pure-strategy equilibria for product choice. At the core of our analysis is a multiplicity of such equilibria over a wide range of parameter values.

[19] In fact, we have

$$\frac{d\frac{(3\tau-\gamma)^2}{(2\tau-\gamma)}}{d\gamma} = -\frac{(3\tau - \gamma)(\tau - \gamma)}{(2\tau - \gamma)^2},$$

which together with (2), securing $\tau > \gamma$, is negative.

Coordination then allows firms to choose their jointly preferred outcome, and our main interest lies in analyzing when this leads to less or to more sustainability.

Competitive Choices when $M = 0$. Take first the corner case with $M = 0$, so that only the fringe market segments exist. Recall now the notation $v = z - c_s$, capturing the net direct advantage (when positive) or disadvantage (when negative) of the sustainable product.

Proposition 1 *(Competitive Product Choices When $M = 0$) When there is no contested market segment C ($M = 0$), equilibrium product choices are characterized as follows: There exist two cutoff levels for the investment costs K, $K'_{M=0} = \frac{1}{2}(\frac{1}{2}\gamma + v)$ and $K''_{M=0} = \frac{1}{2}(\gamma + v)$, so that for $K < K'_{M=0}$ both firms choose the sustainable variant, for $K > K''_{M=1}$ both firms choose the nonsustainable variant, while for $K'_{M=0} \leq K \leq K''_{M=0}$ there exists both an equilibrium where both firms choose the sustainable variant and one where no firm does so.*

When sustainability investment costs are low, it is immediate that both firms choose the more sustainable variant, and likewise both firms choose the non-sustainable variant when investment costs are sufficiently high. According to Proposition 1, for intermediate values of investment costs there exist two equilibria, where either none or both firms make the respective choice. This parameter region only exists due to the social norms effect, as we have for the difference of the respective boundaries $K''_{M=0} - K'_{M=0} = \frac{1}{4}\gamma$. With $\gamma > 0$, the (anticipated) choice of the sustainable product by one firm and the respective purchases by its (fringe) customers exert a positive externality on the respective willingness-to-pay of customers in the other firm's fringe market, increasing also the latter firm's incentives to become sustainable.

While we consider a simultaneous-moves game, in what follows it is often convenient to refer to a given firm that expects the other to choose the sustainable variant as a "second mover". Instead, a firm that expects the other to choose the non-sustainable variant is referred to as a "first mover". For $M = 0$ investments in sustainability represent strategic complements, as a "second mover" has higher incentives compared to a "first mover". This formalizes in a simple way the notion of a "first-mover disadvantage", as discussed in the Introduction, which in our setting arises from the social-norm preferences that in turn give rise to such a positive network effect.

Competitive Choices when $M = 1$. We turn next to the case where $M = 1$, so that only market segment C exists. We consider now again first the specific case where $z = c_s$

(and thus $v = 0$), so that there is not an immediate (dis-)advantage for the sustainable variant. When only firm A chooses the sustainable variant, recall that firm A's competitive advantage from $\gamma > 0$ is then more than compensated by the profit reduction due to the increase in competition. We now continue this discussion and assume hypothetically that A would expect firm B to invest in sustainability. Ignoring for now the investment cost K, we can show that it is strictly profitable for A to do the same, as this both removes a competitive disadvantage and reduces competition. Thus, a "second mover's" incentives are again higher than those of a "first mover", i.e., investments in the sustainable products are again strategic complements, though the rationale is entirely different from the preceding case with $M = 0$.

What is, however, analogous in both cases is that strategic complementarity arises only when $\gamma > 0$ and thus not with standard consumer preferences ($\gamma = 0$). In fact, for such standard preferences, it is well known that when a product yields a direct advantage, here with $v = z - c_s > 0$, product choices instead represent strategic substitutes, not complements: Incentives are strictly lower for the "second mover" than for the "first mover".[20] Intuitively, the "first mover" will command over a larger market share from which the firm can recoup the fixed investment costs K. When also the "second mover" invests, gross profits return only to the previous level, and neither firm will recoup its investment costs. These standard results for $\gamma = 0$ suggest that for $M = 1$ and sufficiently large direct benefits $v > 0$,[21] product choices remain strategic substitutes also when $\gamma > 0$ remains small. Taken together, for $M = 1$ the parameters v and γ jointly determine whether product choices are strategic substitutes or complements. This determines again whether there exists a unique equilibrium or whether there exist multiple equilibria (with subsequent scope for coordination).

Proposition 2 *(Competitive Product Choices When $M = 1$) When there are no fringe segments A and B ($M = 1$), equilibrium product choices for given $\gamma > 0$ are characterized as follows, where $v' > 0$:*
(1) When $v < v'$, product choices are strategic complements: There exist thresholds $0 \leq K'_{M=1} < K''_{M=1}$ such that i) for $K < K'_{M=1}$ both firms choose the sustainable variant, ii) for $K > K''_{M=1}$ no firm chooses the sustainable variant, iii) for $K'_{M=1} \leq K \leq K''_{M=1}$ there exist multiple equilibria where either both or none of the firms choose the sustainable

[20] Cf. Athey and Schmutzler (2001).

[21] Recall that this relates only to a comparison of consumers' direct sustainability benefits z with higher marginal costs c_s, while ignoring hihger fixed investments costs K.

variant;

(2) When $v > v'$, product choices are strategic substitutes: There exist thresholds $0 < K'_{M=1} < K''_{M=1}$ such that i) for $K < K'_{M=1}$ both firms choose the sustainable variant, ii) for $K > K''_{M=1}$ no firm chooses the sustainable variant, iii) for $K'_{M=1} < K < K''_{M=1}$ only one firm chooses the sustainable variant.

Cooperating For or Against Sustainability As we discussed in the Introduction, we confine our analysis to firms' incentives to coordinate their sustainable investments. There is only scope for such coordination when there are multiple equilibria. Importantly, in the two analyzed corner cases firms would however use such coordination to different effect. When there is no direct competition as $M = 0$, it follows immediately from Proposition 1 and the subsequent discussion that firms' profits are higher when they coordinate on the sustainable choice. The opposite is the case when $M = 1$. From Proposition 2 firms would now want to coordinate on the non-sustainable outcome. In fact, as for $M = 1$ any advantages of the sustainable choice are competed away in case both firms choose the sustainable variant, firms' profits (gross of investment costs) are identical for the two symmetric outcomes, $\pi_{ns,ns}(M = 0) = \pi_{s,s}(M = 1)$, while they need to invest $K > 0$ in the sustainable case. We thus have the following result:

Corollary 1 *When $M = 0$, for intermediate levels of investment costs $K'_{M=0} \leq K \leq K''_{M=0}$ cooperation that allows firms to coordinate on their mutually preferred equilibrium outcome leads to the sustainable instead of the non-sustainable outcome. When $M = 1$ and $v < v'$ (Case 1 in Proposition 2), for intermediate levels of investment costs $K'_{M=1} \leq K \leq K''_{M=1}$ such cooperation instead allows firms to coordinate on the non-sustainable outcome. In all other cases there is no scope for coordination.*

In the interest of achieving greater sustainability, antitrust authorities should thus allow such coordination only in the first of the two analyzed corner cases. We acknowledge that in our presently analyzed corner cases these stark results may look obvious, as when $M = 0$ there is no market segment on which the two considered firms compete directly. The key insight is however that under the considered preferences (but not when $\gamma = 0$) firms have strictly positive incentives for such coordination both when $M = 0$ and when $M = 1$, but for different reasons and with orthogonal consequences. Furthermore, the presently obtained results will shape the outcome also in the subsequently discussed case with interior values of M, so that all market segments have a positive mass of consumers. We defer a policy recommendation until we have analyzed the more general case.

We thus allow now also for interior values of M. To restrict case distinctions in the subsequent proof, we set $v \geq 0$.[22] The previously derived results on firms' incentives to coordinate extend as follows:

Proposition 3 *(Competitive Product Choices When $0 \leq M \leq 1$) The results obtained in Propositions 1-2 for the two corner cases ($M = 0$ and $M = 1$) extend as follows (when $\gamma > 0$ and $v \geq 0$). Again, there exists a threshold $v' > 0$ so that for $v < v'$ firms' product choices are strategic complements, implying that for an intermediate interval of values K there exist multiple equilibria (with either none or both firms choosing the sustainable variant). In this case, there exists a threshold $M' = 1 - 2\frac{K}{v+\gamma}$ for the size of the (contested) market segment C, so that, when M' is interior, firms want to coordinate on the sustainable outcome when $M < M'$ and instead on the non-sustainable outcome when $M > M'$. When $v > v'$, there is no scope for coordination (for generic values of K).*

From this result we can derive some guidance for competition policy. When consumers' preferences for more sustainable products depend on social norms, which are again shaped by the behavior of other consumers, there is indeed a rationale for socially beneficial co-operation between firms. In this case, there is indeed a "first-mover disadvantage" and firms will use cooperation in a beneficial way. This case is more likely to arise when the sustainable variant enlarges their joint market share.[23] When no such expansion is possible through the sustainable variant, introducing the more sustainable variant is instead not the jointly preferred outcome of firms, though we showed that without coordination this (socially preferred) outcome may materialize, as each individual firm prefers to become more sustainable when it expects its rival to do so. Allowing firms to coordinate will then backfire in terms of sustainability. We recall from the Introduction the example of the (illegal) coordination among German premium brand manufacturers not to preempt the legally required timeframe of introducing higher emission standards. There can thus be no policy recommendation of turning a blind eye to firms' communication about their sustainability strategy, hoping that the aforementioned positive selection of equilibria may materialize. Instead, according to our formal analysis, the obtained threshold M' is decisive for which effect, positive or negative in terms of sustainability, will arise under such coordination. The beneficial outcome is more likely to arise when the market segments

[22] While then consumers' direct benefits z are at least equal to the difference in marginal costs c_s, the sustainable strategy still involves higher fixed investment costs K.

[23] Likewise, in a variant of our model this would hold when the sustainable choice shores up an otherwise eroding market.

on which co-operating firms can win additional volume at the expense of other (fringe) firms are sufficiently important. At this point we acknowledge that our analysis restricts cooperation to mere coordination in the sense of equilibria selection. More far reaching cooperation would require a binding agreement (or its support through repeated interaction). This can increase the danger of backfiring, notably when under the umbrella of some permitted cooperation firms start to collude.[24]

We conclude with a brief discussion of the threshold M' in Proposition 3. The cutoff takes a particularly simple form as for this we only have to compare profits in the symmetric cases. As we know that the sustainability benefits are competed away in market segment C, the gross difference between profits, $\pi_{s,s} - \pi_{ns,ns}$, is thus simply $m(\gamma + v)$ for each individual firm, which needs to be compared with the additional investment costs K. Coordination is thus ceteris paribus more likely to lead to the sustainable outcome when either the direct benefit or the social-norm effect is larger. We note again that the presence of the social-norm effect, $\gamma > 0$, is essential so as to generate multiple equilibria and thus the scope for coordination in the first place.

4 Robustness with Uniform Pricing

In our baseline analysis, we distinguished between the competitive segment served by the potentially cooperating firms and the fringe segment, allowing firms to set different prices on the respective market segments. Our key insights however do not hinge on this, only the thereby obtained greater tractability. In what follows, we thus suppose instead that each firm can set only one price, p_i. Also, we no longer assume that demand is degenerate on the fringe segment. More specifically, we now consider an expanded Hotelling model as follows (Figure 1): Along a line of length three, the two strategically acting firms (respectively, their products) are located at 1 (firm A) and 2 (firm B). At each of the two endpoints, 0 and 3, there is a competitive fringe that supplies the non-sustainable variant at cost (normalized to zero). The mass M of consumers is distributed uniformly over the interval $[1, 2]$ and, using again symmetry, the mass m over $[0, 1]$ and the mass m over $[2, 3]$. Figure 1 illustrates the three market segments:[25]

[24] Schinkel and Spiegel (2017) have analyzed the various cases where, with standard preferences, firms either collude or compete on product choice and/or on the choice of prices (or quantities). When there is subsequent competition on quantities or prices, they find that firms have high incentives to jointly reduce their investments in higher quality.

[25] We note that, as is well known, in such an extended Hotelling model demand and profits have a discontinuity. Hence, we need to restrict parameters so that deviations that capture a rival's backyard

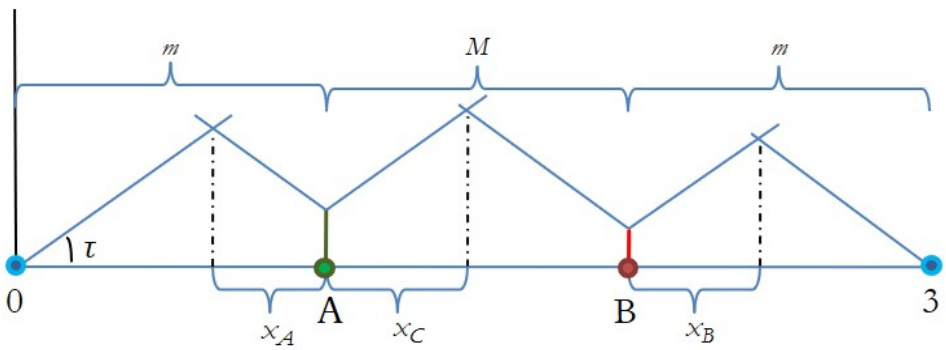

Figure 1: Extended Hotelling model with uniform pricing.

It turns out that for interior values of M, the social-norm effect $\gamma > 0$ considerably complicates the analysis under uniform pricing even in the considered simple workhorse model of price competition. We therefore relegate a characterization of equilibrium prices and profits to Appendix B and confine ourselves in the main text to a numerical illustration. Recall that for the baseline model Proposition 3 delineates the cases that are of interest for the analysis of the impact of coordination. Our present illustration focuses on these cases.

To describe this more formally, denote the incremental (gross) profits of a "first mover" and "second mover" by $D_1 = \pi_{s,ns} - \pi_{ns,ns}$ and $D_2 = \pi_{s,s} - \pi_{ns,s}$, respectively. There is thus scope for coordination when (i) $D_2 - D_1 > 0$, so that product choices are strategic complements, and when (ii) $D_2 \geq K$, so that the "second mover" indeed has positive incentives. Whether in the case of multiple equilibria firms prefer the sustainable or the non-sustainable outcome depends on the comparison between the net profits, $\pi_{s,s} - K$ and $\pi_{ns,ns}$. In the baseline analysis of Proposition 3 this lead to the explicit characterization of a threshold M'. No such explicit characterization, however, exists in the presently analyzed case with uniform pricing. For our subsequent illustration, we denote the gross difference in profits between the two outcomes by $D_3 = \pi_{s,s} - \pi_{ns,ns}$, so that when $D_3 > K$, firms would like to coordinate on the sustainable equilibrium while when $D_3 < K$ the opposite holds. Figure 2 depicts a numerical example with an interior threshold M'. All curves in Figure 2 are drawn for $\tau = 1$, $\gamma = 1/2$, and $v = 0.75$ (parameters satisfying assumption (2)).

We now use Figure 2 for some additional discussion. Note that at $M = 0$, where there

are not profitable. As this involves a comparison of discrete profit levels, rather than marginal conditions, the respective expressions are quite cumbersome and can be obtained from the authors upon request. Essentially, they impose a minimum degree of horizontal differentiation τ.

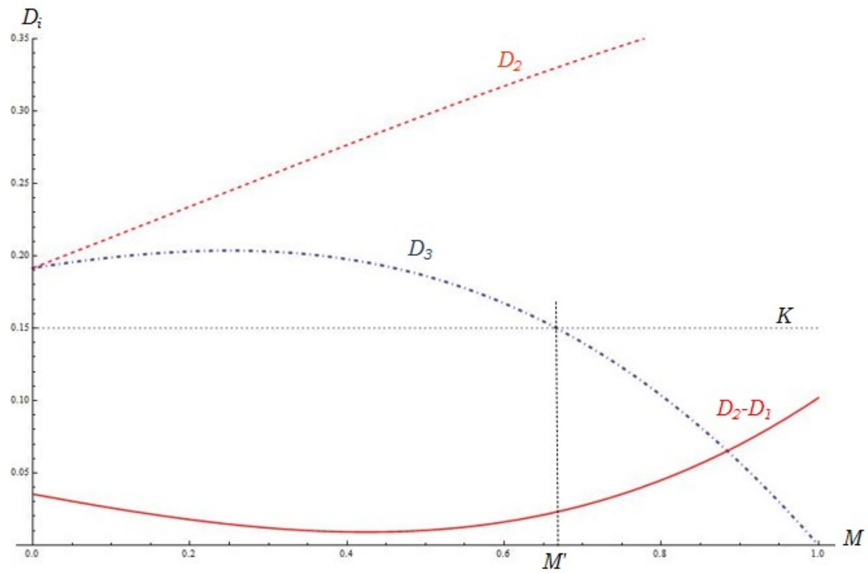

Figure 2: Incentives for coordination for and against sustainability.

is no competitive segment, it holds that $D_3 = D_2$. Formally, since $D_3 = \pi_{s,s} - \pi_{ns,ns}$ and $D_2 = \pi_{s,s} - \pi_{ns,s}$ this follows as then a non-sustainable firm's profits are independent of the other firm's choice, $\pi_{ns,ns} = \pi_{ns,s}$. We note that D_2 increases in M, so that the "second mover" incremental profit increases as the competitive segment becomes more important. As we already discussed, one key effect is that with social-norm preferences such catching up reduces the degree of competition (more formally, the responsiveness of demand to prices). We next observe that for the chosen parameters condition (i) $D_2 - D_1 > 0$, indeed holds, so that product choices are strategic complements: the incentives to become sustainable are for all values M strictly higher for the "second mover" compared to "the first mover". Further, we have set $K = 0.15$ so that $D_2 \geq K$ (condition (ii)) holds for all values of M. Considering finally $D_3 = \pi_{s,s} - \pi_{ns,ns}$, there is indeed a cutoff M' so that $D_3 - K$ is positive for lower values and negative for higher values of K. This replicates the finding for the baseline model, and we refer to the respective rationale provided there.

What is now however also interesting is that D_3 becomes non-monotonic for relatively low values of M. Starting from $M = 0$, as M increases the benefits from a (coordinated) joint switch to the sustainable variant first increase, before they decrease. This is due to the assumption of uniform pricing across all market segments that a firm serves, in difference to separate pricing in the baseline model. The higher price that the sustainable product can command on the fringes essentially mitigates price competition on the contested interval. As this is not a focus of our analysis, we relegate to future work a further analysis of firms' pricing under such social-norm preferences in different market scenarios.

5 Concluding Remarks

The present analysis is motivated by various initiatives and a broadening scholarly dispute on whether and how to integrate sustainability considerations into competition analysis. While discussion often focuses on environmental sustainability, these initiatives take a broader perspective, for instance, including explicitly fair trade or animal welfare (as in the case of the aforementioned new guidelines of the European Commission and the Netherland's competition authority). All these notions of sustainability refer to a product's non-use value. We hypothesize that consumers' preferences should then be shaped also by prevailing social norms. Our key assumption is that such norms depend on the perceived or observed behaviour of others, captured by the respective market share of the more sustainable variant. We analyzed the implications of such preferences in the most simple workhorse model of oligopolistic price competition. We showed that such preferences give rise to multiple equilibria for firms' investment in a more sustainable variant, and we asked when firms' cooperation through coordination will lead to the more or the less sustainable outcome.

We unearthed two main effects. The first effect provides a positive response to the question of whether issues of sustainability, when framed in this way (through a norm effect), may warrant a more lenient approach. Firms may want to coordinate to jointly offer the more sustainable variant. The second effect also involves a strategic complementarity, but it induces firms to instead coordinate on the less sustainable variant. Taken together, when the considered norm effect is of importance, it would be wrong to blindly take either a more lenient approach to firms' communication about their sustainability strategy or to opt for a general prohibition. Our guidance is to, ceteris paribus, take a less lenient approach when cooperating firms control most of the relevant market and when this makes an expansion of the market through the joint choice of a more sustainable variant unlikely.

Our present analysis is restricted to what is essentially a static model. Future work could consider the timing of such investments, notably also when consumer preferences undergo exogenous changes as well. The latter may also depend on the respective sustainable choices of society in various areas, i.e., also other than the choice of products in the particular market. Firms' and consumers' choices in different markets may then interact through the changes of such norms. Another restriction of our model is that it focuses entirely on the policy of allowing firms to coordinate their sustainability strategies. While we noted in the main text that a more lenient approach could also increase the risk that firms are tempted to exchange sensitive information or even collude on other strategic choices, one could also question more generally the relevance of competition policy and antitrust to address, in particular, environmental sustainability. Put differently, one may ask to what extent there exists a "residual market failure" that is not already addressed by other, more targeted instruments. Such instruments may involve lump-sum subsidies as part of a targeted industry policy (reducing K in our model). To the extent that the benefits of such an instrument are compromised, for instance, by deadweight loss from raising the respective funds through taxes, total funds that are needed to ensure the sustainable outcome may be lower when firms can coordinate on a more sustainable outcome. In terms of taxes imposed on the non-sustainable product, to the extent that they are passed-on to consumers these may in turn prove insufficient to tilt firms' behaviour, while having considerable distributional implications. We leave it to future work to fully model the interaction of competition and antitrust policy with such wider policy instruments.

References

ACM (Autoriteit Consumer & Markt), 2014, Economische Effecten van 'Kip van Morgen', available at: https://www.acm.nl/nl/publicaties/publicatie/13759/Onderzoek-ACM-naar-de-economische-effecten-van-de-Kip-van-Morgen.

ACM (Autoriteit Consumer & Markt), 2020, Draft Guidelines: Sustainability Agreements – Opportunities within Competition Law, available at: https://www.acm.nl/en/publications/second-draft-version-guidelines-sustainability-agreements-opportunities-within-competition-law.

Alcott, H., Rogers, R., 2014, The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation, American Economic Review 104, 3003-3037.

Ambec, S., De Donder, P., 2021, Environmental Policy with Green Consumerism, mimeo.

Athey, S., Schmutzler, A., 2001, Investment and Market Dominance, Rand Journal of Economics 32, 1-26.

Benabou, R.,Tirole, J., 2006, Incentives and Prosocial Behavior, American Economic Review 96, 1652-1678.

Constantatos, C., Pargianas, C., Sartzetakis, E.S., 2020, Green Consumers and Environmental Policy, Journal of Public Economic Theory, 1-36.

European Commission, 2022a, Draft 'Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to Horizontal Cooperation Agreements', available at: https://ec.europa.eu/competition-policy/public-consultations/2022-hbers_en.

European Commission, 2022b, Incorporating Sustainability Benefits into an Effects Analysis of Horizontal Agreements - Expert Report by Roman Inderst, available at: https://ec.europa.eu/competition-policy/system/files/2022-03/kd0722074enn_HBER_sustainability.pdf

Farrell, J., Saloner, G., 1985, Standardization, Compatibility, and Innovation, Rand Journal of Economics, 70-83.

Grillo, I., Shy, O., Thisse, J.F., 2001, Price Competition when Consumer Behavior is Characterized by Conformity or Vanity, Journal of Public Economics 80, 385-408.

Griva, K., Vettas, N., 2011, Price Competition in a Differentiated Products Duopoly under Network Effects, Information Economics and Policy 23, 85-97.

HCC (Hellenic Competition Commission), 2020, Competition Law and Sustainability.

Inderst, R., Sartzetakis, E., Xepapadeas, A., 2021, Technical Report on Sustainability and Competition, Report commissioned by ACM and HCC.

Jakob, M., Kübler, D., Steckel, J.C., van Velderhuizen R., 2017, Clean up Your Own Mess: An Experimental Study of Moral Responsibility and Efficiency, Journal of Public Economics 155, 138-146.

Mulder, M., Zomer, S., 2017, Dutch Consumers' Willingness to Pay for Broiler Welfare, Journal of Applied Animal Welfare Science 20, 137-154.

Nyborg, K., Horwarth, R.B., Kjell, A.B., 2006, Green Consumers and Public Policy: On Socially Contingent Moral Motivation, Resource and Energy Economics 28, 351-366.

Pachali, M., Kurz, P., Otter, T., 2020, How to Generalize from a Hierarchical Model? Quantitative Marketing and Economics 18, 343–380.

Pearce, D., Atkinson, G., Mourato, S., 2006, Cost-Benefit Analysis and the Environment: Recent Developments. Paris, France: OECD Publishing.

Sartzetakis, E., Tsigaris, P., 2005, Journal of Regulatory Economics 28, 309-326.

Schinkel, M.P., Spiegel, Y., 2017, Can Collusion Promote Sustainable Consumption and Production?, International Journal of Industrial Organization, 371.

Schultz, P.A., 2002, Knowledge, Information, and Household Recycling: Examining the Knowledge-deficit Model of Behavior Change. In: Dietz, T., Stern, P.C. (Eds), New Tool for Environmental Protection: Education, Information, and Voluntary Measures. National Academy Press, Washington, DC.

Sugden, R., 1984, Reciprocity: The Supply of Public Goods through Voluntary Contributions, The Economic Journal 94, 772- 787.

Train, K., 2009, Discrete Choice Methods with Simulation, New York: Cambridge University Press.

Appendix A: Proofs

Proof of Lemma 1. Recall that in the respective (fringe) market segments, there is at least one firm that offers the non-sustainable product and is otherwise undifferentiated. Hence, when also the respective firm A or B offers the non-sustainable product, price equals costs (normalized to zero). Suppose next that firm A offers the sustainable variant and recall that $\widehat{S}$ denotes consumers' expectations of the choices of all consumers. Consumers in market segment A who purchase the sustainable product from firm A derive the utility $u_0 + z + \rho_s \widehat{S} - p_A$, while they derive utility $u_0 - \rho_{ns} \widehat{S}$ from the non-sustainable fringe offer (at price equal to cost of zero). This obtains the equilibrium price $p_A = \gamma \widehat{S} + z$, provided that this does not fall below cost c_s Depending on the strategy choice of firm B, we can substitute $\widehat{S} = 1$ or $\widehat{S} = m + M\widehat{x}_C$. **Q.E.D.**

Proof of Lemma 2. For the sake of completeness we briefly reproduce demand (on segment C) for the symmetric case. Take thus the case where both firms offer the sustainable variant. A consumer at location x then derives utility $u_0 + z + \rho_s \widehat{S} - x\tau - p_A$ from the offer of firm A and utility $u_0 + z + \rho_s \widehat{S} - (1-x)\tau - p_A$ from the offer of firm B, yielding the critical type

$$x_C = \frac{1}{2\tau}\left[\tau - p_a + p_b\right]. \tag{8}$$

This applies also when both firms choose the non-sustainable product. We can now appeal to standard results, as in such a symmetric Hotelling setting firms' prices are equal to marginal costs plus a margin equal to the differentiation parameter, τ. **Q.E.D.**

Proof of Proposition 1. Using symmetry, we have for $M = 0$ that $\pi_{ns,ns}(M = 0) = \pi_{ns,s}(M = 0) = 0$, $\pi_{s,s}(M = 0) = \frac{1}{2}(\gamma + v)$, and $\pi_{s,ns}(M = 0) = \frac{1}{2}(\frac{1}{2}\gamma + v)$. The respective thresholds follow then immediately from substitution into $K'_{M=0} = \pi_{s,ns}(M = 0) - \pi_{ns,ns}(M = 0)$ and $K''_{M=0} = \pi_{s,s}(M = 0) - \pi_{ns,s}(M = 0)$. **Q.E.D.**

Proof of Proposition 2. Observe first for the two symmetric choices that $\pi_{ns,ns}(M = 1) = \pi_{s,s}(M = 1) = \frac{\tau}{2}$. For the asymmetric case we have with $M = 1$ that

$$\pi_{s,ns}(M = 1) = \frac{(3\tau + v - \gamma)^2}{9\,(2\tau - \gamma)} \text{ and } \pi_{ns,s}(M = 1) = \frac{(3\tau - v - 2\gamma)^2}{9\,(2\tau - \gamma)}.$$

The "first mover" incremental profit, denoted by D_1, becomes after substitution

$$D_1 = \pi_{s,ns}(M = 1) - \pi_{ns,ns}(M = 1) = \frac{2\,(v - \gamma)^2 + 3\,(4v - \gamma)\,\tau}{18\,(2\tau - \gamma)}.$$

This is strictly increasing in v, since

$$\frac{\partial D_1}{\partial v} = \frac{2(3\tau + v - \gamma)}{9(2\tau - \gamma)} > 0.$$

Next, $D_1(v = 0) = \gamma \frac{2\gamma - 3\tau}{18(2\tau - \gamma)}$, which is strictly negative from (2). Define now the unique value $D_1(v_0) = 0$. The incremental profit for the "second mover", D_2, is given by

$$D_2 = \pi_{s,s}(M = 1) - \pi_{ns,s}(M = 1) = \frac{\tau}{2} - \frac{(3\tau - v - 2\gamma)^2}{9(2\tau - \gamma)} = \frac{3(4v + 5\gamma)\tau - 2(v + 2\gamma)^2}{18(2\tau - \gamma)},$$

where now

$$\frac{\partial D_2}{\partial v} = \frac{2(3\tau - v - 2\gamma)}{9(2\tau - \gamma)} > 0.$$

Hence, D_2 is increasing in v iff $3\tau > v + 2\gamma$, which holds by (2). Note now that

$$D_2(v = 0) = \frac{\gamma(15\tau - 8\gamma)}{18(2\tau - \gamma)},$$

which from (2) is strictly positive, so that $D_2 > 0$ for all parameter values.

Consider first the case where $v < v_0$, so that $D_1(v) < 0$. Then for all K there exists an equilibrium where no firm chooses the sustainable product. Define now, for these values of v, $K''_{M=1} = D_2(v) > 0$. Thus, when $K > K''_{M=1}$, also $D_2 < 0$, so that the equilibrium with only nonsustainable choices is unique. When $K \leq K''_{M=1}$, however, $D_2 - K \geq 0$, so that there exists also an equilibrium where both firms choose the sustainable variant. For ease of exposition we set $K'_{M=1} = 0$ when $v < v_0$. Observe next that

$$D_2 - D_1 = \frac{\gamma(9\tau - 5\gamma) - 2v(v + \gamma)}{9(2\tau - \gamma)}.$$

This confirms for $\gamma = 0$ that $D_2 < D_1$. When $v = 0$ but $\gamma > 0$, using (2), the converse holds strictly with $D_2 > D_1$. As $D_2 - D_1$ strictly decreases in v, since $\frac{\partial(D_2 - D_1)}{\partial v} = -\frac{4v + 2\gamma}{9(2\tau - \gamma)} < 0$, and as at $v = v_0$ we know $D_1 = 0$ and $D_2 > 0$, so $D_2 - D_1 > 0$, we can define a value $v' > v_0$ where $D_2(v') - D_1(v') = 0$ (provided that this exists while still satisfying (2), which, for given τ and γ, imposes an upper boundary on v). Hence, up to $v < v'$ the incentives of the "second mover" are still strictly higher. The preceding characterization for $v < 0$ now fully extends up to $v < v'$ by using, in addition, $K'_{M=1} = D_1(v)$ when positive.

When $v > v'$, the "first mover" incentives are strictly higher, $D_2 < D_1$. Setting now $K'_{M=1} = D_2(v)$ and $K''_{M=1} = D_1(v)$, we obtain the characterization for Case 2. **Q.E.D.**

Proof of Proposition 3. For general M, using the respective expressions from Propositions 1 and 2, profits are given in the symmetric cases as $\pi_{ns,ns} = M\frac{\tau}{2}$ and $\pi_{s,s} =$

$M\frac{\tau}{2} + m(\gamma + v)$. In the asymmetric case, after substituting x_C and $m = (1 - M)/2$ into

$$\pi_{s,ns} = m(v + \rho(m + Mx_C)) + Mx_C \left[\tau + \frac{1}{3} \left[v + \rho(m - M) \right] \right],$$
$$\pi_{ns,s} = M(1 - x_C) \left[\tau - \frac{1}{3} \left[v + 2\rho(m + M) \right] \right],$$

we have

$$\pi_{s,ns} = \frac{4v \left[M(v - 2\gamma) + 3\tau (3 - M) \right] + \gamma M \left(9\gamma M^2 - 5\gamma - 6\tau - 3\gamma M\tau \right) + 18 (\gamma + 2M\tau)}{36 (2\tau - \gamma M)},$$
$$\pi_{ns,s} = \frac{M (2v + \gamma + 3M\gamma - 6\tau)^2}{36 (2\tau - \gamma M)}.$$

Again with $D_1 \equiv \pi_{s,ns} - \pi_{ns,ns}$ and $D_2 = \pi_{s,s} - \pi_{ns,s}$,

$$D_2 - D_1 = \frac{Mv (3\gamma M - 7\gamma - 4v) + \gamma M (6\gamma M - 7\gamma - 9\gamma M^2) + 9\gamma M (1 - M) \tau + 9\gamma\tau}{36 (2\tau - \gamma M)}.$$

Note that

$$\frac{\partial (D_2 - D_1)}{\partial v} = -\frac{M (8v + 7\gamma - 3\gamma M)}{18 (2\tau - \gamma M)},$$

which is surely strictly negative when $v \geq 0$ and $\gamma > 0$. We note again that $D_1 = D_2 = 0$ at $v = 0$ and $\gamma = 0$, while $D_2 - D_1 > 0$ when $v = 0$ and $\gamma > 0$. Taken together, this implies again a unique cutoff value $v' > 0$, where $D_2(v') = D_1(v')$. By the argument in the proof of Proposition 2 we thus have no multiple equilibria when $v < v'$. When $v < v'$, instead, multiple equilibria exist for an intermediate (positive) range of values K when $D_2 > 0$, which holds for $v < v'$.

Finally, regarding which equilibria firms prefer, we need to compare net profits, i.e., $\pi_{s,s} - K$ and $\pi_{ns,ns}$, i.e., $m(\gamma + v) - K$. This obtains a cutoff m' given by $m' = \frac{K}{v+\gamma}$ and from this a cutoff $M' = 1 - 2m'$ (when interior). **Q.E.D.**

Summary for the characterization of the benchmark case with $\gamma = 0$: We first note that the derivations for Lemmas 1-5 did not hinge on $\gamma > 0$. For greater transparency, we now however briefly reproduce the respective profits when $\gamma = 0$:

$$\pi_{ns,ns} = M\frac{\tau}{2},$$
$$\pi_{s,s} = mv + M\frac{\tau}{2},$$
$$\pi_{s,ns} = mv + Mx_C \left(\tau + \frac{1}{3}v \right),$$
$$\pi_{ns,s} = M(1 - x_C) \left(\tau - \frac{1}{3}v \right),$$

where we use $v = z - c_s$ and now, in the asymmetric case, $x_C = \frac{3\tau+v}{6\tau}$. The "first-mover" incremental profit is given by

$$D_1 = \pi_{s,ns} - \pi_{ns,ns} = mv + M\frac{1}{18}\frac{v}{\tau}\left(6\tau + v\right)$$

and the "second-mover" incremental profit by

$$D_2 = \pi_{s,s} - \pi_{ns,s} = mv + M\frac{1}{18}\frac{v}{\tau}(6\tau - v).$$

Now $D_1 \geq 0$ holds only when $v \geq 0$. We thus suppose now that $v \geq 0$. Comparing the incremental profits of the "first mover" and the "second mover", we see immediately that $D_2 \leq D_1$ (and strictly so when $v > 0$).

Appendix B: Derivations for the Single Market

As in the baseline case, we first take product choices as given, deriving equilibrium prices and profits for the different combinations. We begin with the standard case where both firms $i = A, B$ choose the nonsustainable variant. Take firm A. As the fringe sets the price of the non-sustainable variant equal to its cost (normalized to zero), given firm A's price of p_A, the cut-off type at the segment $[0, 1]$ is given by $x_A = \frac{1}{2\tau}(\tau - p_A)$. Likewise, at the segment $[2, 3]$ we have $x_B = \frac{1}{2\tau}(\tau - p_B)$ for firm B's share. At the segment $[1, 2]$, firm A's share is given by $x_C = \frac{1}{2\tau}(\tau - p_A + p_B)$. Summing up and substituting yields the respective quantities

$$q_i = mx_i + Mx_C = \frac{m(\tau - p_i) + M(\tau - p_i + p_j)}{2\tau}.$$

The first-order condition for firm i's profit maximization problem yields the price reaction functions

$$p_i = \frac{(M + m_i)\,\tau + Mp_j}{2\,(M + m)},$$

yielding the symmetric equilibrium outcome $p^* = \frac{(1+M)\tau}{2}$. Substituting p^* yields firm equilibrium demand $q^* = \frac{(1+M)^2}{8}$. Given zero costs, profits are $\pi_{ns,ns} = p^*q^*$ and thus

$$\pi_{ns,ns} = \frac{(1 + M)^3}{16}\tau. \tag{9}$$

Assume next that both firms offer the sustainable variant. Note that the intermediate market segment is then surely covered by the sustainable product. The coverage of the market segments on the former fringe markets depends now on the respective cutoffs. Given consumers' expectations about the respective cutoff in the backyard of firm j, we obtain for the backyard of firm i the indifferent consumer

$$x_i = \frac{\tau + z + \gamma M + \gamma m\widehat{x}_j - p_i}{2\tau - \gamma m}.$$

In equilibrium expectations must be satisfied, which is why we substitute $\widehat{x}_j = x_j$ in what follows. It is now worthwhile to note the dependency of x_i on the expected cutoff $\widehat{x}_j$: When the anticipated market share of firm j in its backyard increases, this pushes up demand for firm i in its own backyard, provided that both firms choose the sustainable variant. Solving for x_A and x_B jointly, we obtain

$$x_i = \frac{2\tau\,(\tau + z + \gamma M - p_i) - \gamma m\,(p_j - p_i)}{4\tau\,(\tau - \gamma m)}. \tag{10}$$

Now, the aforementioned positive effect shows up as a decrease in p_j expands firm i's share of its own backyard market. Considering only the respective backyard market segments, there is thus a complementarity in firms' offering and pricing of the sustainable variant. In segment C we already know that $x_C = \frac{1}{2\tau}(\tau - p_A + p_B)$ when both firms offer the sustainable variant. With $q_i = mx_i + Mx_C$, the total change in demand of firm i with respect to firm j's price is thus

$$\frac{dq_i}{dp_j} = M\frac{1}{2\tau} - m\frac{m\gamma}{4\tau(\tau - \gamma m)}.$$

Here, the first expression captures the standard effect from the contested market, where products are substitutes, while the second expression captures the effect on the backyard market segment. We use subsequently the following: The second effect outweighs the first, so that, after substituting $m = (1-M)/2$,

$$\frac{dq_i}{dp_j} < 0 \iff M < \frac{1}{3\gamma}\left(-(4\tau - \gamma) + \sqrt{4\tau^2 + \gamma^2 - 2\gamma\tau}\right).$$

This observation confirms the respective results obtained for the baseline case. Again solving the first-order conditions leads to the symmetric pricing outcome

$$p^* = \frac{4\tau\left[(1+M)\tau + (1-M)z\right] + \Omega c_s}{8\tau - (1-M)(1+3M)\gamma}$$

and for the respective quantity

$$q^* = \frac{\Omega\left[(1+M)\tau + (1-M)v\right]}{2\left[\tau - (1-M)\gamma\right]\left[8\tau - (1-M)(1+3M)\gamma\right]},$$

where here and in what follows we use

$$\Omega = 4(1+M)\tau - (1-M)(1+3M)\gamma > 0.$$

With $\pi_{s,s} = q^*(p^* - c_s)$ we finally obtain

$$\pi_{s,s} = \frac{2\Omega\left[(1+M)\tau + (1-M)v\right]^2}{\left[2\tau - (1-M)\gamma\right]\left[8\tau - (1-M)(1+3M)\gamma\right]^2}\tau. \tag{11}$$

It is useful to collect results as follows:

Lemma 6 *Take now the model with a single market. When both firms offer the non-sustainable variant, their profits are (9). When both offer the sustainable variant, their profits are (11).*

We finally consider the case of asymmetric product choices. When only firm A offers the sustainable variant, using again rational expectations for $\widehat{x}_A = x_A$, the respective cutoff becomes

$$x_C = \frac{\tau + z + \gamma m x_A - p_A + p_B}{2\tau - \gamma M}. \tag{12}$$

The expression for when B offers the sustainable variant is analogous. The cutoffs on the fringe market segments do not change. We obtain the following equilibrium profits in this case:

Lemma 7 *When only one firm offers the sustainable variant, equilibrium profits in the model with a single market are as follows:*

$$\begin{aligned} \pi_{s,ns} &= \frac{(1+M)\left[\left(\Phi - M^2\tau\right)v + (1+M)\Psi\right]^2}{4\left[4\tau - (1+M)\gamma\right]\Phi^2}, \\ \pi_{ns,s} &= \frac{(1+M)^2\,\Omega\,(X - 4Mv)^2}{16\left[4\tau - (1+M)\gamma\right]\Phi^2}\tau. \end{aligned} \tag{13}$$

where we use $X = 4(1+2M)\tau - (1+4M+3M^2)\gamma > 0, \Psi = 4(1+2M)\tau - (1+3M)\gamma > 0$, $\Phi = 4(1+2M)\tau - (1-M^2)(1+3M)\gamma > 0$, *and* $\Phi - M^2\tau > 0$.

Proof. We consider the case where only firm A offers the sustainable variant. The case where only firm B offers this variant is symmetric. To derive the marginal consumer of the sustainable variant in the two market segments $[0,1]$ and $[1,2]$ as a function of prices, we use

$$x_A = \frac{2\tau(\tau + z - p_A) + \gamma M p_B}{2\tau(2\tau - (m+M)\gamma)}, \ x_C = \frac{2\tau(\tau + z - p_A) + (2\tau - \gamma m)p_B}{2\tau(2\tau - (m+M)\gamma)}.$$

Substituting the above into $q_A = m x_A + M x_C$ we derive firm A's total demand, which after substituting $m = (1-M)/2$, is

$$q_A = \frac{(1+M)(\tau + z - p_A) + 2M p_B}{4\tau - (1+M)\gamma}$$

and from maximization of $(p_A - c_s)q_A$ its price reaction function

$$p_A = \frac{(1+M)(\tau + z + c_s) + 2M p_B}{2(1+M)}.$$

Firm B captures a segment $x_B = \frac{\tau - p_B}{2\tau}$ of its backyard market and $(1 - x_C)$ of the contested market, and thus its total demand is $q_B = m x_B + M x_C$, which after substituting $m = (1-M)/2$, yields

$$q_B = \frac{8M\tau(p_A - z) - \Omega p_B + X\tau}{4\tau\left[4\tau - (1+M)\gamma\right]},$$

where $X = 4(1+2M)\tau - (1+4M+3M^2)\gamma$. The first-order condition for $p_B q_B$, given that the marginal cost of the non-sustainable variant is zero, yields the price reaction function

$$p_B = \frac{[4\tau - \gamma + 8M(p_A - z) + 4M\tau - (4+3M)\gamma]\,\tau}{4\Omega}.$$

Solving firms' reaction functions yields equilibrium prices

$$\begin{aligned} p_A^* &= \frac{(1+M)\Omega(c_s+z) - 8M^2\tau z + (1+M)\Psi\tau}{2\Phi}, \\ p_B^* &= \frac{(1+M)(X - 4Mv)\,\tau}{2\Phi}, \end{aligned}$$

as well as quantities,

$$\begin{aligned} q_A^* &= \frac{(1+M)\,[(1+M)\Omega(v+\tau) - 8M^2 v\tau]}{2\,[4\tau - (1+M)\gamma]\,\Phi}, \\ q_B^* &= \frac{(1+M)\Psi(X - 4Mv)}{8\,[4\tau - (1+M)\gamma]\,\Phi}, \end{aligned}$$

where, $\Phi = 4(1+2M)\tau - (1-M^2)(1+3M)\gamma > 0$ and $\Psi = 4(1+2M)\tau - (1+3M)\gamma > 0$. Substituting back into $(p_A - c_s)q_A$ and $p_B q_B$ yields the respective expressions for $\pi_{s,ns}$ and $\pi_{ns,s}$. **Q.E.D.**

For the numerical illustration in the main text we can use the derived profits for the various combinations of product choices to obtain the depicted profit levels and differences D_1, D_2, and D_3.

Appendix C: "Chicken of Tomorrow" Conjoint Analysis

For research purposes only we received from the Dutch Competition Authority (ACM) data from the discrete choice experiment conducted in 2014 for the "Chicken of Tomorrow" case. A panel of 1,603 members was selected and was exposed to repeated choice situations.[26] Each setting consisted of two purchase options characterized by a price and various attributes, four of which related to animal welfare (see below), as well as the option of not purchasing. Each panel member had to answer one questionnaire containing 15 different choice sets. The subsequent table (inserted as Figure 3) describes how we regrouped the four sustainability attributes so as to make them binary, thereby also ensuring a relatively balanced number of responses in the remaining two categories.

Attribute	**Indicator = 0 (less sustainable)**	**Indicator = 1 (more sustainale)**
Lifetime in days	40	60, 80
Outdoor access	No	Yes
Number of mature chicken per square meter	15, 20	10
Anaesthesia method	Chicken may not be sufficiently anesthetized.	Always sufficiently anesthetized.

Figure 3: Sustainable (animal welfare) attributes.

The price variable takes on the values 4, 5, 6, 8, or 12 Euros per 500 gram of broiler meat. Choice alternatives contained, in addition, the following information, which is however not of relevance for our analysis (though the respective variables are included): the source of certification (independent or through legislation or collective agreement).

For simplicity and greater transparency we now represent the respective utility that consumer i derives from the choice option j by modelling solely a single sustainability attribute and only including, in addition, price and the fraction of consumers choosing the same option as further attributes. With this simplification, we have

$$U_{i,j} = \beta_{i,s} I_{j,s} + \beta_{i,size} I_{j,size} + \beta_{i,sXsize} I_{j,sXsize} - \beta_{price} p_j + \varepsilon_{i,j}, \tag{14}$$

[26] Though this is of lesser relevance for our purose, by drawing on the Dutch CentER panel, which is professionally managed standing panel of 2,500 Dutch households, the analysis can be considered as representative of Dutch households that purchase chicken meat.

where the indicator variable $I_{j,s}$ equals 1 (0) if alternative j is sustainable (not sustainable), the indicator variable $I_{j,size}$ equals 1 (0) if the indicated fraction of consumers purchasing this alternative is large (small), and the indicator variable $I_{j,sXsize}$ equals 1 only if the alternative is both sustainable and chosen by a large fraction of consumers. For simplicity we present price as a continuous variable p_j, where for ease of interpretation the respective term is subtracted. We note that, as is common, the price coefficient is not varied between individuals. The error term $\varepsilon_{i,j}$ is assumed to be i.i.d. extreme value distributed, which gives rise to the conditional logit model (cf. for a standard textbook reference Train 2009). For a given individual the effect on willingness-to-pay is captured by the ratio $\beta_{i,s}/\beta_{price}$ for the sustainability attribute, by $\beta_{i,size}/\beta_{price}$ for a switch from a small to a large fraction of consumers choosing the same option, and by $\beta_{i,sXsize}/\beta_{price}$ for the interaction term. In what follows, we restrict ourselves to reporting the respective averages.[27]

Before we report the respective regression results, we relate to the notation used in the main text. For this we denote the two values for $\widehat{S}$, the share of the more sustainable variant, by $S_l < S_h$ (so that the respective share of the less sustainable variant is $1-S_l = S_h$ and $1 - S_h = S_l$, respectively). We now drop the error term and the subscript for the respective consumer i. With $\Delta_S = S_h - S_l$ and a slight abuse of notation, we then have the differences

$$\begin{aligned} u_{ns,large} - u_{ns,small} &= \rho_{ns}\Delta_S = \beta_{size}, \\ u_{s,large} - u_{s,small} &= \rho_s\Delta_S = \beta_{size} + \beta_{sXsize}. \end{aligned}$$

Hence, when the non-sustainable variant is chosen by a small instead of a large number, this would reduce willingness-to-pay by $\beta_{size}/\beta_{price}$. The respective upwards lift for the sustainable product is strictly smaller when the interaction term β_{sXsize} is strictly negative. Note also that the change in the difference of the respective valuations when the more sustainable product is first consumed by a small and then by a large number of consumers is finally given by

$$\begin{aligned} [u_{s,large} - u_{ns,small}] - [u_{ns,large} - u_{s,small}] &= (\rho_s + \rho_{ns})\Delta_S = \gamma\Delta_S \\ &= 2\beta_{size} + \beta_{sXsize}. \end{aligned}$$

[27] While here the coefficients $\beta_{i,k}$ are assumed to be normally distributed, we note that for the sustainability attribute(s) also order (sign) constraints would be appropriate, so that $\beta_{i,sust} \geq 0$. We have also estimated the model by substituting the respective coefficients by $e^{\beta_{i,sust}}$, albeit we have thereby used a Bayesian approach (implementing the techniques and code developped in Pachali et al. 2020). The values for the (expected) willingness-to-pay, including for the interactive term, are largely comparable. Results can be obtained upon request.

We now recall that there are four different sustainable attributes in the choice experiment. The table (inserted as Figure 4) reports the respective results. For all four attributes the coefficients have the expected (positive) sign, while that for price is negative. The coefficient for the number of other consumers choosing the same option is strictly positive, while all interaction terms with the sustainable attributes have indeed a negative sign (where two are also highly significant at the 1% level).

Variable	**Estimate**	**Standard error**	**WTP estimate**
Price	-0.279***	(0.004)	
Lifetime	0.218***	(0.043)	0.783
Outdoor access	0.744***	(0.040)	2.668
Living space	0.451***	(0.036)	1.618
Anesthesia method	0.974***	(0.041)	3.491
Number of Dutch consumers	0.547***	(0.069)	1.962
Interaction: No. Dutch cons. – Lifetime	-0.076	(0.043)	**-0.272**
Interaction: No. Dutch cons. – Outdoor access	-0.237***	(0.068)	**-0.850**
Interaction: No. Dutch cons. – Living space	-0.285***	(0.058)	**-1.021**
Interaction: No. Dutch cons. – Anaesthesia	-0.121	(0.070)	**-0.434**
Legislation/Collective agreement	0.161***	(0.022)	0.577
Outside option	-1.172***	(0.050)	-4.204
N	72,135		
Pseudo R^2	0.246		

Note: p<0.05, ** p<0.01, *** p<0.001.

Figure 4: Coefficients of the discrete choice model.