Firm Competition and Cooperation with Norm-Based Preferences for Sustainability

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

September 2021

Abstract

We posit that consumers' preferences for more sustainable products depend on the perceived social norm, which in turn is shaped by average consumption behavior. We explore the implications of such preferences for firms' incentives to introduce more sustainable products and to co-operate in order to either foster or forestall their introduction. Our main motivation lies in the increasing pressure put on antitrust authorities to exert more leniency towards horizontal agreements that are motivated by sustainability considerations.

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

Recently, various competition authorities have launched consultations and initiatives on whether to take a more lenient approach to cooperations, mergers, and restrictions to competition in case these foster sustainability, in particular environmental sustainability. For instance, the European network of competition authorities, including the European Commission's DG Comp, have initiated a taskforce to this aim, and the competition authorities of Greece and the Netherlands have jointly commissioned an expert report on how to measure such sustainability benefits.[1] In its current review of its guidelines on horizontal agreements, the Commission has identified the integration of sustainability as the key task.[2] Various European competition authorities have initiated further steps. For instance, the Dutch competition authority has already issued guidelines,[3] while Austria's draft competition law reform allows economic efficiencies to be equated with greater sustainability.[4] In parallel, a burgeoning law-and-economics literature discusses the potential merit and scope of such initiatives.[5]

In this discussion, it is typically taken as a given that the institutional environment as a whole falls short of realizing a welfare-maximizing outcome, including the avoidance of negative externalities. Agreements between firms should thus be permitted if they reduce such externalities. If this could be established with only a small margin of error and if it was also established with equal certainty that the restriction to competition is necessary to obtain such efficiencies, i.e., that they would not materialize without it, prima facie such an extended test should increase welfare.[6] But such low margins of errors can not be assumed,

[1] For the technical report see Inderst et al. (2021).

[2] https://www.europeansources.info/record/evaluation-of-the-horizontal-block-exemption-regulations/. The report states (p.19): "*The topic of sustainability was raised by many respondents to the public consultation and the NCA consultation as a significant development over the last 10 years.*" Respondents to its survey also identified the Commission's climate policy as the area deemed least coherent with the present guidelines (p. 99).

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

[4] "*Consumers shall also be considered to be allowed a fair share of the resulting benefit if the improvement of the production or distribution of goods or the promotion of technical or economic progress contributes to an ecologically sustainable or climate-neutral economy*" (original text: "*Die Verbraucher sind auch dann angemessen beteiligt, wenn die Verbesserung der Warenerzeugung oder -verteilung oder die Förderung des technischen oder wirtschaftlichen Fortschritts zu einer ökologisch nachhaltigen oder klimaneutralen Wirtschaft beiträgt*", file:///C:/Users/inder/AppData/Local/Temp/KaWeR%C3%84G_2021_Gesetzestext.pdf).

[5] Much of this literature discusses whether this lies within the existing mandate of competition authorities and, if not, the potential trade-offs of extending their mandate accordingly. To name just three recent contributions, Holmes (2020), Kingston (2019), and van der Zee (2020) all explore the possibility to extend competition law and its application to embrace sustainability.

[6] Still, it may not be within the current remit of competition law, notably when efficiencies are restricted

and with this in mind we need to ask which types of proposals competition authorities may realistically face and with this which incentives profit-maximizing firms could have. Taken thus as a given firms' self-interest in profits,[7] this raises the question of why firms would both like to and need to coordinate on sustainable activities, and, likewise, why comparable benefits would not materialize under competition. If (some) consumers put a premium on such sustainable production or consumption, we would trust competition to satisfy this need, rather than cooperation between competitors. And if consumers fail to sufficiently value such features, profit-oriented firms should have no incentives, unless the proposed cooperation is just a means to increase prices and profits.[8]

Advocates of a more lenient approach point to the need to share costs to develop more sustainable products, or to some sort of first-mover disadvantage. Prima facie it is, however, not obvious why this should be specific to such sustainable initiatives. In this paper we offer a rationale that should apply particularly to sustainable initiatives, as it relies on the notion that the introduction and diffusion of more sustainable products change the respective norms in society and thereby individual preferences for the (non-) sustainable variant. Coordination between firms may then facilitate a switch to more sustainable production and consumption. But we also point out when firms would rather want to coordinate *not* to introduce a more sustainable variant. The latter case is more likely to arise when the considered firms cover most of the relevant market. We find that then the (un-coordinated) unilateral introduction of a more sustainable variant would significantly intensify competition: Rather than leading to (vertical) differentiation, as market shares affect the social norm and thereby preferences, individual demand becomes more responsive to prices. Interestingly, we find that in either case, i.e., with and without such a market expansion, firms' choices of a more sustainable variant represent strategic complements (other than with standard consumer preferences), giving rise to multiple equilibria, but that coordination will lead to the more sustainable outcome only when this sufficiently expands the firm's market. We note that such coordination, even in the form of "cheap talk", would clearly be prohibited, unless it is treated as an admissible horizontal agreement.[9] Before returning to implications for antitrust practice, we motivate our key assumption regarding consumer preferences.

---

to consumers within the relevant market; cf. specifically Inderst and Thomas (2020) for proposals within the consumer welfare paradigm.

[7] Throughout this paper we build on this notion. However, we acknowledge that firms may inherit the "green objectives" of their investors, such as sovereign wealth funds, or of their founder-owners.

[8] Such criticism has been advanced (and formalized), for instance, by Schinkel and Spiegel (2017).

[9] That is, the term agreement does not imply that firms must sign some legally binding contracts.

For most products, consumers' utility derives from their immediate use benefits. Environmental and resource economics, in particular, acknowledge also so-called non-use benefits or non-use value, e.g., from the knowledge of the existence and preservation of particular species or from animal welfare.[10] Also, when the production or consumption of a product generates externalities on others, to what extent consumers regard or disregard the consequences of their choices should depend on the prevailing norm.[11] At the core of our model is the presumption that this norm is affected by the anticipated or observed behavior of others. The relevance of how others behave in the same or a similar situation has been confirmed repeatedly also in the experimental economics literature, notably in games of contributions to a public good, where it has also been associated with notions of fairness and reciprocity.[12] It has also been confirmed by various field studies and experimental evidence.[13] When an individual consumer takes the average behavior of all consumers as the norm, in case of choosing the (cheaper) non-sustainable variant she should perceive a disutility when her own choice thus lies below the norm. Such an experienced disutility should be greater the larger is the market penetration or share of the sustainable variant. We explore this type of preferences in our analysis of competition and coordination.

In 2015 the Dutch competition authority, ACM, decided on a joint proposal by supermarkets, poultry farmers, and broiler meat processors to produce and sell chicken meat only under enhanced animal welfare standards, the so-called "Chicken-of-Tomorrow" case. To assess this proposal, the ACM conducted a conjoint analysis. There, subjects were confronted with a hypothetical choice situation in which, next to variations in price and several (sustainable) attributes, information was provided on whether a particular option was choice by a small or large number of other consumers. A re-analysis of this data confirms the following: Subjects are willing to opt for a cheaper, non-sustainable variant

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

[11] While the subsequently cited literature relates mostly to environmental concerns and respective norms, we refer to Benabou and Tirole (2006) for a more general persepctive on social norms.

[12] An early contribution by Sugden (1984) assumes 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". Cf. Bolton and Ockenfels (2000) for a theory of equity and reciprocity. A related, early theoretical analysis is that of Grillo et al. (2001) on price competition with (non-)conformists.

[13] 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 experimental studies on environmental behavior see Alcott and Rogers (2014) or Jakob et al. (2017).

when they believe that this is (still) chosen by a large number of other consumers.[14]

In the context of environmental economics, such preferences have been invoked by Nyborg et al. (2006), though without modelling market interactions. Instead, in environmental economics "green preferences" of some consumers are typically taken as exogenously given (e.g., Constantatos et al. 2019), albeit a consumer's "warm glow" may depend on the distance of her own choice to the lowest provided standard. Likewise, a consumer may derive disutility when falling back behind the highest provided standard. Such preferences have also been embedded into an analysis of oligopolistic competition, which generates incentives for firms to differentiate themselves.[15] Importantly, we show that with norm-based preferences for sustainability, differentiation may instead lead to more intense competition. Also, while with "warm glow" preferences sustainability investments are strategic substitutes, with norm-based preferences for sustainability they become strategic complements, which provides scope for firm coordination. We also note that the environmental economics literature has focussed mainly on how different environmental policies perform in different competitive environments, rather than on antitrust. We only dedicate a short discussion to the interaction between antitrust and environmental taxes or subsidies.

We acknowledge that a positive relationship between the choice of others and a consumer's individual choice may also have other foundations, such as imitation or learning about the existence of the respective products. In an analysis of optimal taxation, Sartzetakis and Tsigaris (2005) motivate networks effects mainly on the basis of required additional (infrastructure) investment. While Farrell and Saloner (1985) have already recognized the potential benefits from communication to avoid coordination failure in the presence of network effects, the subsequent Industrial Organization literature analyzes primarily competing networks (cf. Katz and Shapiro 1985).

In our analysis, we restrict consideration solely to coordination by communication, rather than binding agreements (or agreements that are supported by repeated interaction).[16] Consequently, as already noted, communication serves only to select among

[14] See Inderst et al. (2021). For the decision see https://www.acm.nl/en/publications/publication/13761/Industry-wide-arrangements-for-the-so-called-Chicken-of-Tomorrow-restrict-competition

[15] For this literature see, for instance, the references in Ambec and De Donder (2021) and, notably, the early models by Conrad (2005) and Eriksson (2004).

[16] In April 2019 the European Commission sent a Statement of Objections to German premium car manufactures BMW, Daimler, and Volkswagen, covering also brands like Porsche or Audi, accusing the companies of taking part in a collusive scheme, from 2006 to 2014, to limit the development and roll-out of emission cleaning technologies for new diesel and petrol passenger cars sold in the European Economic Area (EEA) (https://ec.europa.eu/commission/presscorner/detail/en/IP_19_2008). Together these companies are supposed cover more than 80 % of the premium market segment.

multiple equilibria. This promotes sustainability when firms thereby expect a sufficient expansion of the market. Otherwise, such coordination is more likely to forestall sustainability: Then, the fear that a rival may start to produce a more sustainable variant, which under our norm-based preferences would intensify competition, could trigger an industry-wide switch to more sustainable production, unless firms coordinate on the less sustainable status-quo.

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.

2 Model and Plan of Analysis

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 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 (ns) at marginal costs normalized to zero. The two strategic firms can offer the sustainable variant (s) 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.[17] A consumer's utility has four separable parts: its use value $u_0 > 0$, which we thus suppose to be equal for both variants; the subsequently introduced horizontal preferences for individual firms; the part that pertains to the product's sustainability feature; and price. We first discuss sustainability preferences.

We suppose that production and consumption of a unit of the non-sustainable variant cause damages of some given size $D > 0$, albeit those inflicted on the consumer herself are negligible. A consumer has no purely altruistic motivation, such that there are no direct sustainability benefits, but she derives disutility from falling behind a perceived social (sustainability) norm. Specifically, we suppose that the perceived behavior of other consumers constitutes such a norm. When a consumer thus expects that the fraction $\widehat{S}$ of other consumers purchase the sustainable variant, she experiences the (psychological) disutility[18]

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

[18] This seemingly relates our formalization of preferences also to the literature of psychological game theory (Geneakoplos et al. 1989, Battigalli and Dufwenberg 2009). There, however, such disutility is

$\rho_{ns}\widehat{S}$, with $\rho_{ns} > 0$, when she still consumes the non-sustainable variant. We allow $\widehat{S}$ to have also an impact on the utility obtained from the sustainable variant, captured by the term $\rho_s\widehat{S}$, though for the purpose of our competitive analysis we can be somewhat agnostic about ρ_s. All we need is that as $\widehat{S}$ increases, this makes the more sustainable variant relatively more attractive, which is the case when $\gamma = \rho_{ns} + \rho_s$ is strictly positive.[19] We also allow that there is a possible tax t that is levied on consumption of the nonsustainable variant, as well as a possible subsidy g for production or consumption of the sustainable variant. Denote $z = g + t$. We use this later to discuss the possible interplay with environmental policy. Throughout we ask whether and 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, which holds surely whenever the respective damages $D > 0$ are sufficiently high.[20]

What distinguishes our analysis is thus the specification of consumer preferences. As discussed in the Introduction, it conforms with various empirical observations that document how the (expected) behavior of other consumers affects individual consumers' preferences and choices. While we already acknowledged that such a relationship may arise also for different reasons, such as learning and imitation, notably the non-use value associated with sustainable consumption should depend also on prevailing social norms and these should be shaped by the observed or expected behavior of other consumers. In this sense, our analysis applies specifically to such choices, with the strength of the norm-induced preferences being captured by γ. The comparison with $\gamma = 0$ will subsequently prove instructive to isolate what effects are novel. In fact, the identified effects of firm cooperation hinge entirely on the norm-induced preferences and are consequently absent when $\gamma = 0$.

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, in our baseline model we introduce three market segments: In market segment A the respective firm A competes with a fringe, firm B

experienced in case of "letting down" others, i.e., acting differently from what they expected. Such a feeling of guilt may describe more appropriately a situation with personal interactions.

[19] This immediately holds when $\rho_s > 0$. We note that the case with $\rho_s < 0$ could arise when the additional utility experienced with the sustainable variant decreases with the social norm (and thus the extent to which own behavior exceeds the norm).

[20] This also allows us to sidestep the question of whether and how ρ_{ns} and ρ_s should enter a welfare analysis.

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 at which firms A and B compete and, assuming symmetry, by m for each of the two fringe market segments, with $2m+M=1$ (so that $M=1-2m$). In our baseline model, we allow firms A and B to set different prices in the respective market segments, which greatly simplifies the analysis. In the subsequent section we then extend our results to uniform pricing across all market segments. 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.

In our baseline model, only market segment C is modelled in this way, with a standard linear differentiation parameter $\tau > 0$. That is, when purchasing from firm i, a consumer in market segment C with respective (preference) distance x derives disutility $x\tau$. In the baseline model, again for tractability, we suppose instead that in firms' local market segments there is at least one fringe firm that is not horizontally differentiated. We denote prices in market segments A and B with capital letters (p_A and p_B) and prices in market segment C with small letters (p_a and p_b).[21]

Denote $v = z - c_s$. Leaving out the social norm effects, v captures the net benefits of the sustainable variant, which comprises the respective tax or subsidy as well as cost differences. To restrict attention to interior pricing solutions, we require that horizontal differentiation in market C is sufficiently important with

$$\tau > \gamma + \max(0, v/3). \tag{1}$$

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.

[21] Note again that in our extension to a single (extended) Hotelling line we will impose uniformity ($p_A = p_a$ and $p_B = p_b$).

3 The Baseline Model: Pricing and Profits

3.1 Equilibrium Prices

Recall that in our baseline model, firms can set separate prices in the three considered market segments. These are now considered in turn, always taken as given firms' sustainability choices.[22]

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 $u_0+g+\rho_s\widehat{S}-p_A$, while they derive utility $u_0-t-\rho_{ns}\widehat{S}$ 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.[23] Suppose for now that indeed $p_A>c_s$. As this then holds symmetrically for firm B, consumers can rationally expect $\widehat{S}=1$ when both firms offer the sustainable variant, which holds independently of how market segment C is shared between the two firms, so that $p_A=p_B=\gamma+z$. Instead, when only one firm offers the sustainable product, say again A, $\widehat{S}$ depends on consumers' beliefs about how market C is shared between the two firms, $\widehat{x}_C$.

Lemma 1 *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* $p_A=p_B=\gamma+z$. *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 same product variant, pricing in market segment C is standard. Still, for subsequent comparison it is useful to make also this transparent. Take the case where both firms offer the sustainable variant. A consumer at location x then derives utility $u_0+g+\rho_s\widehat{S}-x\tau-p_A$ from the offer of firm A and utility $u_0+g+\rho_s\widehat{S}-(1-x)\tau-p_A$

[22] We suppose that, for reasons of costs or credibility, a firm can not supply different variants to different market segments.

[23] This presentation of sustainability preferences as a network effect is closely related to Griva and Vettas (2011) for the particular case with asymmetric product choices and no fringe competitors.

from the offer of firm B. When comparing these two utilities, clearly the terms $u_0+g+\rho_s\widehat{S}$ drop out, and we obtain for the critical type

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

This hold obviously as well when both firms offer the non-sustainable variant, as now the respective terms $u_0 - t - \rho_{ns}\widehat{S}$ drop out. As is well-known, in such a symmetric Hotelling setting firms prices are equal to marginal costs plus a margin equal to the differentiation parameter, τ.

Lemma 2 *When both firms offer the nonsustainable variant, in market segment C they set the price $p_a = p_b = \tau$ (given costs of zero). When both offer the sustainable variant, they set $p_a = p_b = c_s + \tau$.*

We turn now to the asymmetric case and suppose for specificity that only firm A introduces the sustainable variant. Now the offer of firm A yields the utility $u_0 + \rho_s\widehat{S} + g - x\tau - p_a$ and that of firm B the utility $u_0 - \rho_{ns}\widehat{S} - t - (1-x)\tau - p_b$, which, from indifference, yields

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

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

$$x_C = \frac{1}{2\tau - \gamma M}\left[\tau + z + \gamma m - p_a + p_b\right]. \tag{4}$$

This derivation makes transparent the role of the modified consumer preferences. 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: 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 $M/(2\tau - \gamma M)$, compared to $M/2\tau$ when both firms choose the sustainable or the nonsustainable product (expression (2)). Note that our parameter assumptions imply that $\gamma M < 2\tau$. Hence, for $\gamma > 0$ demand becomes more responsive to price changes, given the feedback effect that a change in the market share of the sustainable or the non-sustainable product has on consumers' preferences. This intensifies competition, but only so in the asymmetric case, where only one firm offers the sustainable product. Furthermore, for $\gamma > 0$ there is an interaction between the two segments of the market that firm A serves, A and C: As also the mass m of consumers in market segment A choose the sustainable variant, this makes A's product more attractive to all consumers and pushes up x_C. Solving for equilibrium prices, we obtain:

Lemma 3 *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

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

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

We note that $x_C < 1$ holds if $z - c_s < 3\tau - \gamma(2M + m)$, which is implied by assumption (1).[24] We now briefly comment on the role of γ (as the dependency of prices and market shares on all other parameters is standard). Take first prices. The aforementioned increase in the responsiveness of demand to prices unambiguously reduces the price for the non-sustainable 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 price, dominates.[25] Next, plugging prices into (4) yields (6) for the equilibrium cutoff in market segment C. Taking first the standard case with $\gamma = 0$, it is immediate that firm A has a larger share of the market if and only if $z > c_s$: The direct benefits must outweigh the respective cost disadvantage. When $z < c_s$, as the advantage from the tax and subsidy does not sufficiently the cost disadvantage of the sustainable variant, while also $\gamma > 0$, there are two different forces at work. Then, x_C exceeds one half only if $\gamma > 2\left(c_s - z\right)$.[26] The preceding characterization and discussion are now of immediate use to calculate profits.

[24] 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).

[25] As is immediate, we also have that $p_a > p_b$, which follows from higher costs $c_s \geq 0$, from the immediate advantage $z \geq 0$, and from $\gamma > 0$.

[26] Transforming $x_C > 1/2$ yields $\gamma > \frac{c_s - z}{\frac{1}{2}M + m}$, which given $2m + M = 1$ can be written as $\gamma > 2\left(c_s - z\right)$.

3.2 Profits

We turn now to equilibrium profits under different product choices. Given symmetry of the two fringe market segments, we can conveniently define such 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 results:

Lemma 4 *Suppose both firms choose the same product variant. If they choose the non-sustainable 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

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

In words, 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 $\gamma + z - c_s > 0$). 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. We turn next to the asymmetric case. The following characterization of profits follows again from summing up over market segments and making use of Lemmas 1 and 3.

Lemma 5 *Suppose only firm A offers the sustainable product variant. Then firms' gross profits are given by*

$$\begin{aligned} \pi_{s,ns} &= m(z + \rho(m + Mx_C) - c_s) + Mx_C\left[\tau + \frac{1}{3}\left[z + \rho(m - M) - c_s\right]\right], \quad (7) \\ \pi_{ns,s} &= M(1 - x_C)\left[\tau + \frac{1}{3}\left[c_s - z - 2\rho(m + M)\right]\right]. \end{aligned}$$

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

We conclude the characterization with additional observations regarding profits obtained in market segment C. These will be important both for our subsequent discussion of firms' incentives to coordinate product choice and for our final extension of the model. Substituting x_C and slightly abusing notation, while again focusing on the case where A offers the sustainable variant, we have for the respective profits (gross of investment costs) obtained from market segment C alone:

$$\pi_{A,C} = \frac{M\left[3\tau - (c_s - z) + \gamma(m - M)\right]^2}{9\left(2\tau - \gamma M\right)}, \tag{8}$$

$$\pi_{B,C} = \frac{M\left[3\tau + (c_s - z) - \gamma(m + 2M)\right]^2}{9\left(2\tau - \gamma M\right)}. \tag{9}$$

The difference between the two firms' profits is,

$$\pi_{A,C} - \pi_{B,C} = \frac{M}{3}\left[2\left(z - c_s\right) + \gamma(2m + M)\right],$$

which, taking into account $2m + M = 1$, becomes,

$$\pi_{A,C} - \pi_{B,C} = \frac{M}{3}\left[2\left(z - c_s\right) + \gamma\right].$$

Thus, the firm introducing the sustainable variant, firm A, gains higher profits in the contested market C, if $\gamma > 2\left(c_s - z\right)$, which is equivalent to the condition that yields $x_C > 1/2$. As we already observed, this holds when $z \geq c_s$ or when $z < c_s$ and $\gamma > 2\left(c_s - z\right)$.

We conclude by considering the case where the sustainable product has no direct advantage or disadvantage, as $z = c_s$. Suppose first as well that $M = 1$, so that there is only market segment C, in which case

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

which is strictly decreasing in γ.[27] The reason for this lies in our preceding observation that with asymmetry, $\gamma > 0$ intensifies competition. Even though firm A has an increasing advantage as $\gamma > 0$ increases, which shows up in a rising market share $x_C > 1/2$, its profits

[27] In fact, we have

$$\frac{d}{d\gamma}\frac{(3\tau - \gamma)^2}{(2\tau - \gamma)} = \frac{2\gamma - 6\tau}{2\tau - \gamma}.$$

Recall now the (interior solution) condition $z - c_s < 3\tau - 4\gamma(M - m)$, which for $z = c_s$ becomes $\gamma < \frac{3}{4}\tau$, which implies that $2\tau - \gamma > 0$ and $2\gamma - 6\tau < 0$.

drop. This relationship holds as long as market segment C is sufficiently important, but we can show that $\pi_{A,C}$ increases in γ when, instead, the fringe segments become sufficiently important.[28] This short discussion offers a first glimpse at how notably the social norms parameter γ drives the comparison of profits, which in turn determines equilibrium product choice, which is analyzed next.

4 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. 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.

4.1 Competitive Choices for the Corner Cases

Take first the corner case with $M = 0$, so that only the fringe market segments exist. Recall the notation $v = z - c_s$. When we shut down market segment C, where the two firms compete, we have the following result (derived formally in the Appendix):

Proposition 1 *Take the case where $M = 0$. 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 in a pure-strategy equilibrium, for $K < K'_{M=0}$ both firm 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 will choose the more sustainable variant, and likewise both firms choose the non-sustainable

[28] When still $z = c_s$, we have

$$\frac{d\pi_{A,C}}{d\gamma} = \frac{d}{d\gamma}\frac{(3\tau + \gamma(m - M))^2}{(2\tau - \gamma M)} = -\frac{2}{2\tau - M\gamma}(M - m)(3\tau - M\gamma + m\gamma),$$

which is now positive when $m - M > 3\tau/\gamma$ or, using $M = 1 - 2m$, $M < 2/3 - \tau/(3\gamma)$.

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 obviously only exists due to the social norms effect, as we have that $K''_{M=0} - K'_{M=0} = \frac{1}{4}\gamma$. This difference captures the positive externality that the choice of the sustainable product of one firm has on the other firm's demand in its respective local market, when $\gamma > 0$. That is, from the perspective of firm A, when also firm B starts to offer the sustainable variant, this increases all consumers' willingness-to-pay for the sustainable variant as the change in society's consumption pushes up the respective social norm. Consequently, firm A can charge a higher price relative to the nonsustainable product offered by the fringe.

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" thus has higher incentives compared to a "first mover".

We turn next to the case where $M = 1$, so that only market segment C exists. Recall our preceding observations for the 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 the competitive advantage from $\gamma > 0$ is lower than the profit reduction due to the increase in competition. We now continue this discussion and assume hypothetically that firm B still expects firm A to invest in sustainability. Ignoring for now the investment cost K, it would now be strictly profitable for firm B to do the same, as this both reduces competition and resolves a competitive disadvantage. As we show formally, a "second mover's" incentives are again higher than those of a "first mover". Investments in the sustainable products are again strategic complements, though the rationale is clearly entirely different from the preceding case with $M = 0$.

Furthermore, once again this relationship holds only when $\gamma > 0$ and thus not with standard preferences ($\gamma = 0$). In fact, for such standard preferences, when $v > 0$ it is well known that product choices instead represent strategic substitutes, not complements: Incentives are strictly lower for the "second mover" than for the "first mover".[29] Intuitively, the "first mover" will command over a larger market share from which he can recoup the fixed investment costs. When also the "second mover" invests, with $\gamma = 0$ gross profits return only to the previous level, and neither firm will recoup its investment costs.

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

Summing up, this initial discussion suggests that 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). These parameter, next to the size of investment costs K, also determine whether the sustainable choice is profitable, both as "first mover" or "second mover". In the Appendix, we prove the following result:

Proposition 2 *Take the case where $M = 1$. When $\gamma > 0$, there exists $v' > 0$ so that the following characterizes all pure-strategy equilibria in sustainable investments:*
(1) When $v < v'$: 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 variant;
(2) When $v > v'$: 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 (while thus only for $K = K'_{M=1}$ and $K = K''_{M=1}$ there are multiple equilibria).

Hence, in Case 1, with $v < v'$, firms' sustainable investments represent strategic complements (as when $M = 0$, albeit for different reasons, as we already explained).[30] This generates again scope for coordination.

4.2 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.

Remaining still within the confines of our two corner cases, Propositions 1 and 2 show that for $\gamma > 0$ in both cases there is thus scope for coordination (though for $M = 1$ only when the direct benefits of the sustainable choice are not too large, with $v < v'$). Importantly, in the two cases firms would however like to use such coordination in different ways. 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

[30] We note that Case 1 contains two subcases, one where the lower threshold $K'_{M=1}$ is zero, which applies for low values of v, and one where it is strictly positive, which applies for higher values of v; cf. the proof in the Appendix.

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, $\pi_{ns,ns}(M = 1) = \pi_{s,s}(M = 1)$, while they need to invest $K > 0$ in the sustainable case. We thus have the following result:

Corollary 1 *When $M = 0$, for $K'_{M=0} \leq K \leq K''_{M=0}$ cooperation that allows firms to coordinate on their mutually preferred equilibrium leads to the sustainable instead of the non-sustainable outcome. When $M = 1$ and $v < v'$ (Case 1), for $K'_{M=1} \leq K \leq K''_{M=1}$ 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 when $M = 0$, but not when $M = 1$. We acknowledge that in our presently analyzed corner cases these stark results may look obvious, as when $M = 0$ the considered firms do not compete in their respective market segment. The key insight is however that both when $M = 0$ and when $M = 1$ firms have strictly positive incentives for such coordination when $\gamma > 0$. When $\gamma = 0$, instead, there is always (generically) a unique equilibrium, so that there is no scope for such coordination. The presently obtained insights 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 also the general case.

We acknowledge that our analysis restricts cooperation to firm coordination (in case of multiple equilibria). More far reaching cooperation would require a binding agreement. When $M = 1$, firms have indeed incentives to cooperate in this way even further in their product choice. This is most immediately seen for all sufficiently low values of K where there exists a unique equilibrium with both firms choosing the sustainable variant ($K < K'_{M=1}$). As noted above, then firms compete themselves down to gross profits that are identical to those when they both had chosen the non-sustainable variant, $\pi_{ns,ns}(M = 1) = \pi_{s,s}(M = 1)$. In this case they need however a binding agreement (as otherwise either firm would want to deviate).[31]

[31] 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 also find that firms have high incentives to jointly reduce their investments in higher quality.

4.3 Completing the Analysis of the Baseline Model (Interior M)

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

Proposition 3 *For general M, the characterization obtained in Propositions 1-2 extends as follows (when $\gamma > 0$ and $v \geq 0$). Again, there exists $v' > 0$ 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 $0 < M' < 1$ for the size of the (contested) market segment C, so that firms want to coordinate on the sustainable outcome when $M < M'$ and on the non-sustainable outcome when $M > M'$. When $v > v'$, the (pure-strategy) equilibrium is unique (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 a rationale for beneficial cooperation between firms. That firms use cooperation in a beneficial way is more likely when they expect to enlarge their joint market with the sustainable variant.[32] When no such expansion is possible through the sustainable variant, introducing the more sustainable variant is instead not the preferred outcome of firms, though we showed that without coordination this (socially preferred) outcome may materialize, as each individual firm may introduce the sustainable variant based on the expectation that also its rival does so. This shows that obviously there can 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.

In our formal analysis, the obtained threshold M' is decisive for which effect, positive or negative in terms of sustainability, will arise under such coordination. In simple terms, the beneficial outcome is more likely to arise when the market segments on which co-operating firms can win additional volume at the expense of other (fringe) firms are sufficiently important. In our subsequently analyzed extended model we will express this recommendation in terms of the firms' joint market share.

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

4.4 Interaction with Environmental Policy

Our focus lies on analyzing when firm cooperation fosters or forestalls sustainability. There is only scope for such cooperation when from $\gamma > 0$ consumer preferences depend on the (expected) behavior of others, which captures our concept of norm-induced preferences. We are however silent on whether and when competition law and its enforcement should be concerned with sustainability in the first place. We acknowledge that there are various arguments, as discussed notably in the legal literature referenced in the Introduction, both for and against such a wider mandate. In our model, we may interpret the choices of taxes and subsidies, t and g, as instruments of environmental policy. We now briefly discuss the interaction.

For this we note first that for various reasons the choice of $z = g+t$ may face constraints. When the fringe market represents foreign imports, it may simply not be possible to tax such imports or to subsidize national sustainable production sufficiently without infringing on trade agreements and WTO-rules or inviting retaliatory actions. There may also be deadweight losses relating to raising and spending taxes (on subsidies).[33] For simplicity we now first return to the case with $M = 0$. Recall that then, without coordination, to ensure that the sustainable outcome is the unique equilibrium, it must hold that $z \geq 2K - \frac{1}{2}\gamma + c_s$. When there is coordination, it only needs to hold that $z \geq 2K - \gamma + c_s$, which represents a strictly lower threshold. Hence, by allowing cooperation the necessary subsidy or tax is strictly lower (or such instruments may not be needed at all).

In the opposite case where $M = 1$, note first that firm profits under the non-sustainable outcome are not affected by taxes, as these are fully passed on to consumers. If firms could form binding agreements, such instruments would thus be fully ineffective. And even absent such binding agreements, as in our analysis, under a lenient antitrust policy firm cooperation forestalls a sustainable equilibrium for intermediate values of K. To still ensure the sustainable outcome requires, for given investment costs K and given c_s, a higher value of z.

We finally acknowledge that we have not discussed the possibility to directly subsidize firms' lump-sum investment costs K. This is clearly akin to directly govern firms' actions. Policymakers' limited knowledge about these costs, firms' reduced incentives to invest efficiently in case of such subsidies, as well as deadweight costs associated with raising the respective funds should limit the scope also for this alternative strategy.

[33] We note, however, that in the presently analyzed stylized model the respective tax would only be paid off equilibrium as the market is covered by the sustainable product alone.

5 Single Market

In our baseline analysis, we distinguished between the competitive segment served by the potentially cooperating firms and the fringe segment, also 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. Also, we no longer assume that demand is degenerate on the fringe segment. More specifically, we now consider an expanded Hotelling model as follows: 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, we assume that 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 $[1, 2]$, the mass m_A over $[0, 1]$ and m_B over $[2, 3]$. Throughout we set again $m_A = m_B = m$ and specify that $2m + M = 1$. Figure 1 illustrates the three market segments:

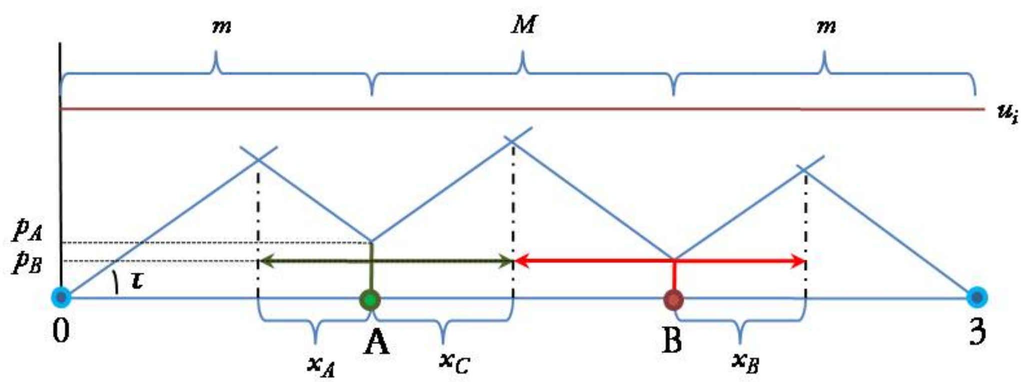


Figure 1: Illustration of the three segments' market

Given the illustration in Figure 1, the quantity sold by firm A is given by $q_A = mx_A + Mx_C$ and that sold by firm B by $q_B = mx_B + M(1 - x_C)$. Now, there is only a single price p_i set by either firm.[34]

[34] 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 are not profitable that capture a rival's backyard. 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.

5.1 Pricing Equilibrium

We begin with the standard case, where both firms $i = A, B$ choose the nonsustainable variant, so that all offers in the market are homogeneous in this respect. Take first 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

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

We can again solve the first-order conditions for the unique equilibrium in prices and obtain profits. We postpone a statement of the respective results. Assume next that bot 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. This derivation makes again transparent the role of consumer preferences. We have already commented on the effect on the slope of the cutoff type, albeit previously for the asymmetric choice in segment C. Note now 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 now for x_A and x_B jointly, we obtain

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

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. Of course, this is different in market segment $[1,2]$, which is contested by the two firms. As in the baseline analysis, we have $x_C = \frac{1}{2\tau}(\tau - p_A + p_B)$, given that 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

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

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. The second effect outweighs the first, so that, after substituting $m = (1-M)/2$,

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

Hence, firm i profits from a price increase of its rival if and only if the importance of the contested market segment C remains small compared to the size of the respective backyard. In the Appendix we obtain from the respective first-order conditions for prices the following characterization of profits:

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

$$\pi_{ns,ns} = \frac{(1+M)^3}{16}\tau. \tag{11}$$

When both offer the sustainable variant, their profits are

$$\pi_{s,s} = \frac{2\Omega\left[(1+M)\tau + (1-M)v\right]^2}{\left[2\tau - (1-M)\gamma\right]\left[8\tau - (1-M)(1+3M)\gamma\right]^2}\tau. \tag{12}$$

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

We note that when removing costs and benefits of the sustainable variant, that is, $\gamma = c_s = z = 0$, expression (12) reduces comfortably to expression (11). Furthermore, in the absence of backyard markets, $m = 0$, firms earn the same margin τ, regardless of whether they both offer the sustainable or the non-sustainable variant, and thus make profits of $\frac{1}{2}\tau$ (given that then $M = 1$).

We finally consider the case of asymmetric product choices. Here, the key difference with respect to the preceding analysis concerns the contested, intermediate market segment. When only firm A offers the sustainable variant, using again rational expectations for $\widehat{x}_A = x_A$, the respective cutoff becomes

$$x_C = \frac{\tau + z + \gamma m x_A - p_A + p_B}{2\tau - \gamma M}. \tag{13}$$

The expression for when B offers the sustainable variant is analogous. In the Appendix we derive the respective asymmetric equilibrium profits from the first-order conditions for prices. We note that the respective expressions are far more complex than in the baseline model. The subsequent discussion of product choice will therefore only be carried out numerically.

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

$$\begin{aligned}\pi_{s,ns} &= \frac{(1+M)\left[(\Phi - M^2\tau)v + (1+M)\Psi\right]^2}{4\left[4\tau - (1+M)\gamma\right]\Phi^2}, \\ \pi_{ns,s} &= \frac{(1+M)^2\,\Omega\,(X - 4Mv)^2}{16\left[4\tau - (1+M)\gamma\right]\Phi^2}\tau.\end{aligned} \tag{14}$$

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* $\Phi - M^2\tau > 0$.

Note that we have signed the abbreviated parameters so as to facilitate an immediate comparative analysis. For instance, it is intuitive (and now immediately evident), that $\pi_{s,ns}$ increases in v.

5.2 Sustainability and Cooperation

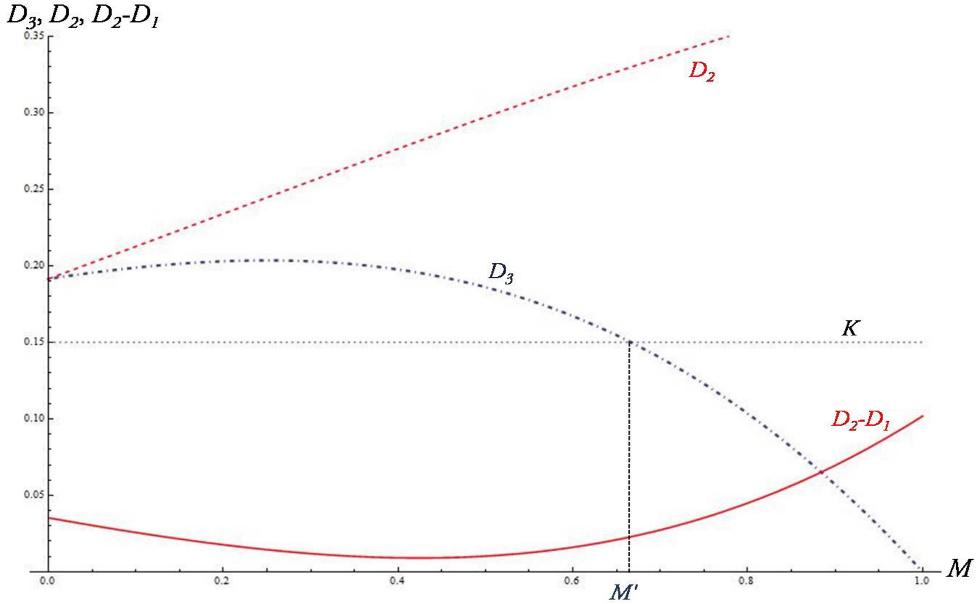
In discussing firms' sustainable investment choices, we resort to numerical simulations due to the complexity of the expressions involved. Recall that for the baseline model Proposition 3 delineates the cases that are of interest for the analysis of the impact of coordination. We now illustrate these cases for the adjusted model. Here, we use for the incremental (gross) profits of a "first mover" and "second mover", D_1 and D_2 (as also in the proofs in the Appendix). Recall that coordination plays a role when the following conditions are satisfied: (i) $D_2 - D_1 > 0$, so that product choices are strategic complements and (ii) $D_2 \geq K > 0$, so that the "second mover" indeed has positive incentives. Note that it does not matter whether $D_1 - K$ is positive or negative: From conditions (i) and (ii) there is always an equilibrium where both firms choose the sustainable product variant. For the corner case with $M = 1$, we know immediately that both firms prefer the non-sustainable outcome, as all potential benefits (from $v > 0$) are competed away, while for $M = 0$ the opposite is true. In Proposition 3 a comparison between the net profits, $\pi_{s,s} - K$ and $\pi_{ns,ns}$, was also immediate and obtained the asserted threshold M'.[35] In the presently analyzed

[35] As is immediate from the profit expressions and as noted in the proof, the threshold is simply $M' = 1 - 2\frac{K}{v+\gamma}$ (when interior).

model with a single market, the derivation is again less immediate. We denote the gross difference $D_3 = \pi_{s,s} - \pi_{ns,ns}$, 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 now depicts a numerical example where such a threshold for M arises again. All curves in Figure 2 are drawn for $\tau = 1$, $\gamma = 1/2$, and $\upsilon = 0.75$, values that respect assumption (1).

2



2.jpg

Figure 2: Incentives for coordination as the size of the contested market changes

It is evident that for $M = 0$, $D_3 = D_2$, since $D_3 = \pi_{s,s} - \pi_{ns,ns}$, $D_2 = \pi_{s,s} - \pi_{ns,s}$, and obviously $\pi_{ns,ns} = \pi_{ns,s}$, without a competitive segment. We note that D_2 increases,so that the "second mover" incremental profit increases as the competitive segment becomes more important. This is due to the already described effect, whereby generating symmetry (by also switching to the sustainable variant) reduces competition (or, more formally, the responsiveness of demand to price setting). It holds next that $D_2 - D_1 > 0$, so that we can choose a value K that satisfies both conditions i) and ii). We have set $K = 0.15$ in Figure 2, and we see that this generates the cutoff M' so that $D_3 - K$ is indeed 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 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 (down to $D_3 = 0$). 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. We admit that this somewhat complicates our simple cutoff-rule for M , but we note that, as in the baseline model, coordination is always to the non-sustainable outcome for high enough M.

6 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, including, for instance, explicitly fair trade or animal welfare (as in the case of the aforementioned new guidelines of the Netherland's competition authority). All these notions of sustainability refer to a product's non-use value. Consumers' preferences should thereby be shaped also by prevailing social norms. Our key assumption is that such norms depend on the perceived or observed behaviour of others. We analyzed such preferences in the most simple workhorse model of oligopolistic 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 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. A further avenue for future work concerns more closely the area of antitrust. Given the immense current interest of competition agencies at least in Europe, economic analysis should inform any changes of the respective laws and their enforcement. For this it is crucial to understand what (apart from externalities in case of environmental sustainability) is specific about sustainable production and consumption.

References

ACM (Autoriteit Consumer & Markt), 2020, Draft 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.

Battigalli, P., Dufwenberg, M., 2009, Dynamic Psychological Games, Journal of Economic Theory 144, 1-35.

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

Bolton, G.E., Ockenfels, A., 2000, ERC: A Theory of Equity, Reciprocity, and Competition. American Economic Review 90, 166-193.

Conrad, K., 2005, Price Competition and Product Differentiation when Consumers Care for the Environment, Environmental and Resource Economics 31, 1-19.

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

Eriksson, C., 2004, Can Green Consumerism Replace Enviromental Regulation? A Differentiated-Products Example, Resource and Energy Economics 26, 281-293.

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

Geanakoplos, J., Pearce, D., Stacchetti, E., 1989, Psychological Games and Sequential Rationality, Games and Economic Behavior 1, 60-80.

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.

Holmes, S., 2020, Climate Change, Sustainability, and Competition Law, Journal of Antitrust Enforcement, 354-377.

Inderst, R., Rhiel, F., Thomas, S., 2021, Sustainable Agreements, mimeo.

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

Inderst, R., Thomas, S., 2020, Reflective Willingness to Pay: Preferences for Sustainable Consumption in a Consumer Welfare Analysis, forthcoming Journal of Competition Law and Economics.

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.

Kingston, S., 2019, Competition Law in an Environmental Crisis, Journal of European Competition Law & Practice, 517.

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

Nyborg, K. et al., 2016, Social Norms as Solution, Science 354, 42-43.

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.

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.

Van der Zee, E., 2020, Quantifying Benefits of Sustainability Agreements Under Article 101 TFEU, World Competition, 189.

Appendix: Proofs

Proof of Proposition 1. Using symmetry, we have for $M = 0$

$$\begin{aligned}
\pi_{ns,ns}(M &= 0) = \pi_{ns,s}(M = 0) = 0, \\
\pi_{s,s}(M &= 0) = \frac{1}{2}(\gamma + v), \\
\pi_{s,ns}(M &= 0) = \frac{1}{2}(\frac{1}{2}\gamma + v).
\end{aligned}$$

The respective thresholds follow then immediately from

$$\begin{aligned}
K'_{M=0} &= \pi_{s,ns}(M = 0) - \pi_{ns,ns}(M = 0), \\
K''_{M=0} &= \pi_{s,s}(M = 0) - \pi_{ns,s}(M = 0).
\end{aligned}$$

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

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

and that

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

We first discuss the incremental profit (gross of K) for a firm that alone chooses the sustainable variant ("first mover"):

$$\pi_{s,ns}(M = 1) - \pi_{ns,ns}(M = 1) = \frac{(3\tau + v - \gamma)^2}{9(2\tau - \gamma)} - \frac{\tau}{2} = \frac{2(v - \gamma)^2 + 3(4v - \gamma)\tau}{18(2\tau - \gamma)} =: D_1.$$

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 (1). Define now the unique value $D_1(v_0) = 0$.

Next, the incremental profit for the "second mover" is

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

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 (1). Note now that

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

which from (1) is strictly positive, so that $D_2 > 0$ for all parameter values.

It is now instructive to first consider 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, $K''_{M=1} = D_2(v) > 0$. When $K > K''_{M=1}$, also a "second mover" is strictly worse off when choosing the sustainable variant, so that the equilibrium with only nonsustainable choices is unique. When $K \leq K''_{M=1}$, however, we know that $D_2(v) - K \geq 0$, so a firm has (weak) incentives to choose the sustainable variant when it anticipates the rival to do so. For $K \leq K'_{M=1}$ there thus exists also an equilibrium where both firms choose the sustainable variant. We set in addition $K'_{M=1} = 0$ when $v < v_0$.

Observe next that

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

As discussed in the main text, for $\gamma = 0$, $D_2 < D_1$. When $v = 0$ but $\gamma > 0$, using (1), the converse holds strictly with $D_2 > D_1$, as also discussed in the main text. 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 (1), 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, profits are given as

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

Substituting x_C and $m = (1 - M)/2$ yields for the asymmetric case

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

$$\pi_{ns,s} = \frac{M\left(2v+\gamma+3M\gamma-6\tau\right)^{2}}{36\left(2\tau-\gamma M\right)}$$

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

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

Note that

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

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 $v < v'$.

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

Proof of Lemma 6. Take first the case where both firms choose the non-sustainable variant. The first-order condition for firm i's profit maximization problem yields the price reaction functions

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

Reaction functions are uniquely solved, using symmetry and after substituting $m = (1 - M)/2$, as $p^* = \frac{(1+M)\tau}{2}$ Substituting p^* yields firm equilibrium demand $q^* = \frac{(1+M)^2}{8}$. Given zero costs, profits are $\pi_{ns,ns} = p^*q^*$, which becomes expression (11).

For the case where both firms offer the sustainable variant, we can proceed likewise to obtain for the symmetric equilibrium price

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

and for the respective quantity

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

where, $\Omega = 4(1+M)\tau - (1-M)(1+3M)\gamma > 0$. With $\pi_{s,s} = q^*(p^* - c_s)$ we finally obtain expression (12). **Q.E.D.**

Proof of Lemma 7. 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

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

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

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

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

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

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

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

as well as quantities,

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

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.**