Firm Objectives and Sustainability Agreements*

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Abstract

Recent changes in national competition laws and enforcement guidelines have increased the scope for the consideration of sustainability benefits. I analyze horizontal cooperations when sustainability enters directly firms' objectives rather than only through a profit motive. As this increases also the level of sustainability prevailing under independent choices, the impact of an agreement is a priori uncertain. Still, an agreement increases sustainability when firms have strong sustainability preferences, and in particular when these are broad in that they take into account total industry effects. For given firm preferences, abstracting from standard (cost-sharing) synergies, positive effects are more likely when greater sustainability increases marginal costs rather than fixed investment costs. As a quick guidance, positive effects should prevail when even absent an agreement firms are willing to increase sustainability to the point where this sacrifices profits. My results are also of relevance when policy makers delegate to industries the collective setting of standards.

Keywords: Sustainability; sustainability preferences; horizontal agreements; collective standard setting.

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1 Introduction

The draft guidelines of the European Commission on horizontal agreements between competitors, published in March 2022, explicitly recognize so-called "sustainability agreements" as a new category, and with it related efficiencies.[1] Such benefits are also recognized under the Netherland's new guidelines[2] and in the recently changed Austrian competition law.[3] Notably the latter go explicitly beyond a consumer welfare standard and are thus in line with prominent calls to promote sustainability through an adjustment of competition law and its enforcement.[4] Also outside Europe there are increasing calls to consider so-called "out-of-market" benefits in competition assessments.[5] For efficiencies to be recognizable, sustainability agreements must, however, still prove indispensable, and presently standard theories of efficiencies are applied, such as the sharing of fixed costs, knowledge spillovers, or strategic complementarities.

I take a different approach to analyze sustainability agreements and their likely effects. I stipulate that what may make sustainability different from other strategic choices, are firms' *direct* preferences for higher sustainability, thus deriving not only from profit motives. I ask how the recognition of such preferences *alone*, thus ignoring other efficiencies, should affect the likely outcome of a cooperation. The answer to this question should not only be useful to guide the assessment of an antitrust agency, but it should also inform policymakers who whish to delegate to an industry to setting of a joint standard.[6] Prima facie it seems not obvious, given that such direct preferences for sustainability also affect firms' independent choices and thus the counterfactual to cooperation.

[1] European Commission (2022a).

[2] ACM (2022). See Inderst et al. (2021) for a report conducted for ACM and the Hellenistic Competition Authority.

[3] Contributions to an ecologically sustainable or climate-neutral economy will now be considered alongside consumer benefits.

[4] See prominently Kingston (2011) and Holmes (2020). Badea et al. (2021) argue that a sustainability objective for competition policy derives from the declared ("Green Deal") goals of the European Commission.

[5] See OECD (2020).

[6] See the discussion of various examples in Inderst and Thomas (2022).

For my analysis I consider a standard two-stage model of strategic (sustainability) investment choices and subsequent product market competition. When I assume that firms care for sustainability *only* through its effects on profits, I recover the standard result that cooperation lowers sustainability when this involves (even only marginally) higher fixed costs.[7] My only departure from this benchmark is then to extend firms' preferences beyond a pure profit motive. I first analyze the case where such preferences are narrow, as they incorporate only a firm's own sustainability choice. Subsequently, I extend the analysis to broader preferences, internalizing, for instance, the industry's total emissions. Before spelling out my findings, I relate this key point of departure to recent contributions in the literature.

The notion that driven by various stakeholders, firms' objectives go beyond profits has recently gained traction also in the academic literature. In various contributions, Oliver Hart and co-authors have deduced such objectives from the altruistic preferences of firms' shareholders and the leverage that they (should) have on firms' decisions (Hart and Zingales 2017, Bordalo et al. 2022).[8] In Dewatripont and Tirole (2022) firms' objectives include a metric related to aggregate welfare, such as total emissions. They note that moral objectives could be derived from the preferences of workers, investors, or suppliers.[9]

Importantly, the respective stakeholder preferences must not already be captured by lower factor costs, e.g., lower wages or a lower interest rate, thereby entering the firm's

[7]Much of the extant literature, notably on R&D coordination and joint ventures, derive positive effects from synergies, following the seminal contributions of d'Aspremont and Jacquemin (1988), Kamien et al. (1992), and Suzumura (1992). In Albuquerque and Cabral (2023) there are synergies in cost reduction if more firms adopt socially responsible strategies. Various contributions in environmental and resource economics have extended this to include further (environmental) externalities, analyzing also the interaction with policy instruments, such as environmental taxes or standards (see Chiou and Hu 2001, Poyago-Theotoky 2007).

[8]In Magill et al. (2013) it is shown that a firm's orientiation towards stakeholders improves welfare.

[9]My choice of the term "sustainability" follows the European Commission's guidelines, which for my application represent the most important legal framework so far. The guidelines explicitly do not narrow this down to environmental sustainability and refer instead to the various legal and political commitments that the European Union has made, comprising international development, fair working conditions, or also animal welfare. Equally broad is the language of "ESG" (Environmental, Social and Governance), as used in financial regulation (such as in the nascent taxonomy of the European Commission).

profit function.[10] Active investors, including sovereign funds and families, may indeed affect directly notably longer-term strategic decisions.[11] But also within the firm, individuals may exert discretion so as to let their moral preferences shape decisions (or to derive personal benefits by establishing an ethical (self-)image). I acknowledge that for outsiders it may be hard to learn whether and how such preferences directly affect firms' decisions, so that policy guidance based on the strength and relevance of these preferences for firms' objectives may often prove impractical. My key guidance is, however, more simple and relates to more easily observable outcomes, such as whether prior to an agreement firms have already scarified competitiveness to increase sustainability. A robust implication, also across various specification of firm preferences for sustainability, is that an agreement increases sustainability if firms were already willing to make such profit sacrifices under independent choices, while when all participants to an agreement were not willing to do so, an agreement will result in lower sustainability.

The aforementioned changes in antitrust law and guidelines build on the presumption that other, more direct policy tools, such as minimum standards or taxes, are not sufficient to achieve a socially desirable outcome, e.g., due to a failure of the political process, cf. Tirole (2012). I take this as a given.[12] Also, the negative effects of production and consumption may not be sufficiently internalized by consumers, e.g., as they lack the respective knowledge or as they may perceive their own consumption as negligible.[13] From this perspective, as already noted above, my analysis should also be of relevance outside the narrow confines of antitrust. Instead of crafting regulation, such as minimum standards,

[10]This is the focus of much of the emerging theoretical corporate finance literature; cf. Oehmke and Opp (2019) and Gupta et al. (2022) with consequentialist investors and Inderst and Opp (2022) with investor "warm glow" preferences. Survey evidence suggests that at least some investors indeed take an ethical perspective (e.g., Riedl and Smeets 2017).

[11]In Morgan and Tumlinson (2019), where shareholders have preferences for the provision of a public good, management acting in their interest provides more than shareholders would individually, solving a collective action problem.

[12]There may, however, also be other reasons for why even the socially optimal choice may use more than one instrument; cf. the discussion in Stiglitz (2019).

[13]Overall, our focus is on firm preferences, and not on those of consumers (see recently Ambec and De Donder 2022 for an account of the literature on "green consumerism").

policy may delegate such responsibility to the industry. Absent other efficiencies, such as synergies and spillovers, existing theory would suggest that higher sustainability is achieved when such cooperation is instead forbidden. My results suggest that this may, however, be overturned when firms have direct preferences to raise standards.[14]

I now provide an account of the key isolated effects. In my benchmark firms do not have direct sustainability preferences, so that they care only about the profit implications of higher sustainability (i.e., sustainability is then not distinguishable from any other (quality) product attribute). The only change that I make from this point of departure is to let sustainability enter directly firms' objective function. This shifts upward firms' privately optimal choice, as firms now go beyond the level at which higher consumer willingness-to-pay warrants higher costs. As this renders a firm less competitive in the market, under standard properties of demand a rival's optimal response is to lower its own sustainability standard and thereby become more competitive, which I call "strategic leakage".

Other than overcoming such strategic leakage, the key implication of an agreement is that it makes firms internalize the effect of higher sustainability on each others' profits. When higher sustainability involves only higher marginal but not higher fixed costs, an agreement unambiguously increases firms' sustainability: While without the agreement a firm was not willing to increase sustainability further, as this would have eroded too much its competitive position, the firm's own profits receive less weight under a joint agreement, pushing up sustainability. When instead higher sustainability requires substantially higher fixed investment costs, firms that are allowed to cooperate would want to strictly reduce sustainability compared to the competitive outcome. Positive effects of an agreement should, however, still prevail when already absent an agreement firms' sustainability preferences lead them to increase sustainability up to the point where this

[14]Throughout I abstract from non-competitive strategies that firms jointly would like to implement and that could increase (environmental) sustainability, such as to reduce total output. A small literature on collective voluntary agreements has analyzed when such strategies are also self-sustaining (e.g., the strategy of reducing the output of a more polluting variant to thereby reduce price pressure on the more expensive and less polluting variant, see Ahmed and Segerson 2011).

sacrifices competitiveness.

In the baseline analysis, I obtain these results under the presumption of narrow firm sustainability preferences, which do not take into account repercussions at the industry level. When instead firms have broader preferences, so that they care, for instance, about total industry emissions, rather than only about their own emissions, I uncover additional effects. With independent choices, a firm that becomes more sustainable at the expense of falling back in competitiveness will cede market share to a less sustainable rival ("leakage"), which dampens incentives. Moreover, under an agreement a firm with such broad sustainability preferences benefits from forcing a higher sustainability also upon the rival. As a consequence, broad preferences make it more likely that an agreement raises sustainability.[15]

I refer to Hart and Zingales (2017) for a brief account of the different strands of literature on firm objectives, notably in the law and finance literature.[16] The strand of literature focusing on corporate social responsibility has focused much on the normative question of whether a firm's board and CEO *should* pursue such objectives.[17] Instead, I take such objectives as given and turn to the positive question of whether this makes it more or less likely that firm cooperation increases sustainability. In this respect, the contribution closest to mine is Dewatripont and Tirole (2022), who analyze how moral choices are affected by the degree of competition, captured by a comparative analysis in the elasticity of demand.[18]

To my knowledge, the potential role of firm objectives has so far not been studied in the

[15] I thus tie into the large literature on (carbon) leakage. While the literature has analyzed different policy responses but als how market structure affects leakage (e.g., Babiker 2055), I analyze how cooperative agreements restrict both direct as well as strategic leakage.

[16] Magil et al. (2015) derive objectives for stakeholder preferences in a general equilibrium approach.

[17] For an early survey see Kitzmueller and Shimshack (2012).

[18] The role of market pressure in turning firms "green" has also been extensively researched in the management science literature (see the early contributions by Bansal and Roth 2000 or Porter and Kramer 2006). There is also a large theoretical literature in the intersection of environmental economics and industrial organization that analyzes how market structure affects measures of environmental sustainability, such as the depletion of natural resources or harmful emissions (see for an early survey Carraro et al. 1996 and more recently Lambertini 2017).

context of joint agreements.[19] One could argue that this is indeed not necessary, as what matters is the outcome, rather than why firms behave in a particular way. However, as I also discuss further below, to assess a proposed cooperation, an antitrust authority will typically not have precise information on its incremental benefit, i.e., the difference between the outcome under the agreement and the counterfactual. It is then indeed important to work with expectations, and my analysis informs on the likely role of firm (revealed) preferences. But I acknowledge that antitrust authorities must proceed with great care when basing their assessment on typically not directly observable firm objectives, which may also be subject to unforeseen changes.[20] This applies equally when one considers delegating to firms responsibility for the introduction of sustainability standards.

The rest of this paper is organized as follows. Section 2 introduces the model. The benchmark where firms do not have direct preferences for sustainability is analyzed in Section 3. Section 4 analyzes the case when firms have narrow sustainability preferences. Section 5 isolates additional effects under broad preferences. Section 6 concludes.

2 The Model

I set up a standard model of duopolistic competition in which firms make a strategic (investment) choice before engaging in product market competition. This choice can be the object of a joint agreement. I capture the strategic choice, made at time $t = 1$, by a real-valued variable $a_i \geq 0$ for firm $i \in I = \{A, B\}$. It affects a firm's competitiveness, as it can change marginal costs of production and shift demand, and it may come with fixed investment costs. Imposing for simplicity symmetry, I capture fixed costs by some (where positive, strictly) convex function $F(a)$. A firm's competitiveness is captured by a

[19] In fact, they are also not mentioned explicitly in the EU's new horizontal guidelines (European Commission 2022a) or in the commissioned expert report preceding the guidelines (European Commission 2022b), which was drafted by the author of this articule with an explicit focus on a consumer welfare standard.

[20] As I discuss below, future work my explicitly recognize the information asymmetry between the antitrust authority and firms, e.g., in a setting of optimal delegation (Holmström 1977).

real-valued and strictly concave function $v_i = v(a_i)$, which I endogenize shortly. In $t = 2$, firms engage in product market competition, and I denote their reduced-form profits as $\pi_i = \pi(v_i, v_j)$, with partial derivatives $\pi_1 = \partial\pi_i/\partial v_i > 0$ and $\pi_2 = \partial\pi_i/\partial v_j < 0$. It is convenient to suppose that $v_i \geq 0$ and that $\pi_i(v_i = 0, v_j) = 0$, so that a firm must raise v_i above zero to make positive profits.[21] Likewise, I suppose that $v(a) \to 0$ when a becomes sufficiently high.

I next provide some foundation for the functions $\pi(v_i, v_j)$ and $v(a)$. Then, I introduce firm (sustainability) preferences. These preferences over a_i will be the key difference to standard models of firm cooperation, and they are also the key reason for why I subsequently refer to a_i as a firm's standard of sustainability.

An endogenization of the functions $\pi(v_i, v_j)$ and $v(a_i)$. For such an endogenization only, suppose that firms produce at constant marginal costs $c(a_i)$, where c is increasing and strictly convex (where strictly increasing), and that they compete in prices p_i at stage $t = 2$. Demand of firm i is given by a function $D_i = D(\widehat{p}_i, \widehat{p}_j)$, where "net prices" satisfy $\widehat{p}_i = p_i - u(a_i)$, with u increasing and strictly concave (where strictly increasing). Thus, a more sustainable choice of production may result both in higher per-unit costs of production and higher demand. Denote $v_i = u(a_i) - c(a_i)$. This formulation through "net prices" follows Dewatripont and Tirole (2022), where $u(a_i)$ represents a homogeneous shift in all consumers' willingness to pay. They show that profits can then be expressed as functions $\pi_i(v_i, v_j)$. While there firms choose (a_i, p_i) simultaneously, I invoke a sequential structure, as in much of the literature, so that firms can agree on sustainability standards a_i without colluding on prices.[22]

[21] The chosen framework excludes incentives to differentiate in the sustainability dimension, so as to reduce competitive pressure (as analyzed in various contributions in enviromental economics, such as Eriksson 2004 or Conrad 2005).

[22] Still, with (gross) utility $U = u_A q_A + u_B q_B - \frac{\beta(q_A)^2 + \beta(q_B)^2 + 2\gamma q_A q_B}{2}$ for a representative consumer, I obtain after substituting for Nash equilibrium prices the profit functions $\pi_i = \pi_i(v_i, v_j) = (xv_i - yv_j)^2$, where $x = \frac{\beta(2\beta^2 - \gamma^2)}{(\beta^2 - \gamma^2)(4\beta^2 - \gamma^2)^2}$ and $y = \frac{\beta^2\gamma}{(\beta^2 - \gamma^2)(4\beta^2 - \gamma^2)^2}$.

Firm preferences and sustainability. In line with the motivation in the Introduction, I suppose that firms' choices may not be motivated by profits alone, $\Pi_i = \pi_i - F_i$. For this reason I stipulate in the baseline analysis the following firm objective function:

$$V_i = \Pi_i + \lambda_i a_i, \tag{1}$$

with $\lambda_i \geq 0$. I refer to these preferences as "narrow", as they focus on the firm's own strategy, rather than on a broader (welfare) criterion.[23] I now provide an example, before turning to an alternative specification as well as that of broader preferences. For this suppose that production $q_i = D_i$ generates emissions $e_i = \rho q_i(\phi - a_i)$, where $\phi > 0$ is always sufficiently high so as to generate an interior solution and where, for simplicity, I set $\rho = 1$. A firm's decision may also take into account emissions generated per unit of production, e_i/q_i, which would give rise to the objective

$$\Pi_i + \lambda_i \frac{e_i}{q_i} = \Pi_i + \lambda_i a_i - \lambda_i \phi.$$

Apart from the fixed term, $-\lambda_i \phi$, this is equivalent to (1).

I acknowledge that the objective (1) is specific. It brings out key effects of a sustainable agreement in the most tractable way. While I thus first work with these preferences, subsequently I extend the analysis, which reveals additional effects. As this requires to be more explicit about the nature of a_i, I specifically take up the case of emissions. With *broad preferences*, a firm takes into account the wider implications of its actions, here on total industry emissions, $e = \sum_I q_i(\phi - a_i)$:

$$V_i = \Pi_i - \lambda_i e. \tag{2}$$

[23] According to the terminology used in Dewatripont and Tirole (2022), these preferences are deontological, in that they value the action itself, rather than the result.

In addition, I consider an extension of the case with narrow preferences where now $V_i = \Pi_i - \lambda_i e_i$, which again depends only on the firm's own emissions e_i (instead of industry emissions e). This specification of preferences will help to clarify that the newly identified effects under broad preferences stem only from the direct incorporation of other firms' actions (emissions) into the objective function. Throughout I restrict attention to parameters λ_i that are not excessive, in that it will be optimal for firms to produce.

The specification of broad preferences is different from notably those in Bordalo et al. (2022), where firms place weight on a measure of total welfare, which includes consumer welfare. In contrast, the chosen formulation has a more partisan nature: Sustainability, here in the form of lower emissions, is seen by firm's key stakeholders as an objective on its own, and in its pursuit firms are not motivated by a concern for aggregate welfare, including that of consumers or even their rivals' shareholders.[24]

As already noted in the Introduction, the respective direct preferences for higher sustainability, both in (1) and (2), go beyond factor market benefits that the firm derives from higher sustainability, such as lower wages or interest rates, which are already captured in the function $v(a)$.

Product market competition in $t = 2$ is not affected by firms' sustainability preferences. There, firms always interact, e.g., choose prices, so as to maximize profits. This implies that, irrespective of λ_i and cooperation (see next), the outcome is always captured by the reduced (net) profits π_i. I discuss this next.

The question whether a firm's board and CEO remain within their fiduciary duty to all shareholders when maximizing objectives other than only firm profit has been debated for a long time. As Hart and Zingales (2017) argue, this should be, in particular, the case when firms undertake long-term strategic decisions and may even be in a position to ask (key) investors' opinion (or indeed may act only in response to investor pressure; see

[24]Given the subsequently introduced policy objective function, it will be inconsequential whether firms' preferences, λ_i, are merely decisional, as in Bordalo et al. (2022), so that while affecting decisions, they should not be taken into account in a total welfare analysis.

the various examples there or in Condon 2020). In contrast, product market decisions (at $t = 2$ in our model, though this stands for possibly repeated, short-term pricing decisions) typically fall outside the scope of shareholder involvement. This both shields management from investor pressure, and in case of litigation by individual shareholders they should find it much harder to justify prices that do not maximize profits. This justifies my (only for-profit) assumption for product market competition.

Cooperation under an agreement. Under an agreement, I suppose that firms jointly choose a sustainability standard $a_i = a$ that maximizes the sum of their objectives $V_A + V_B$, subject to the constraint that each firm is willing to participate (individual rationality constraint). I thus exclude side payments. Formally, under an agreement $a_i = a$ maximizes $V_A + V_B$ subject to $V_i \geq \widehat{V}_i$ for all i, where $\widehat{V}_i$ denotes the respective payoff in the equilibrium with independent strategy choices. Note that the respective fixed costs $F_A = F_B = F(a)$ have to be incurred still at either firm, as I abstract from synergy benefits.

Cooperation does not alter firms' choices on the product market, as this would amount to unlawful collusion. I now comment on the chosen formalization of cooperation.

That firms must agree on a standard and can not resort to side payments is motivated by realism, as typically firms will turn to an antitrust authority precisely with the proposal to cooperate on a joint standard. This may also be easier to jointly implement and enforce (as firms will have incentives to deviate unilaterally). I make also the following technical observation. When firms could jointly commit to heterogeneous standards (a_A, a_B) and make side payments, then, given that there are no fixed-costs synergies, it would be frequently optimal to invest only at one firm. This seems an unrealistic outcome without full integration under a merger.[25]

Given the chosen objective function under cooperation, in what follows I will need to distinguish between two cases. In the first case, I can ignore firms' participation constraints

[25] The same could arise even when under an agreement strategies a_i were still chosen independently while internalizing also the rival's objective.

and focus on the respective first-order condition for maximizing the joint objective V_A+V_B. This case will always apply when firms' preferences are homogeneous, $\lambda_i = \lambda$, and it will be particularly instructive to obtain my key results. In the second case, the participation constraint of one firm will bind. I extend results also to this case, and subsequently I discuss how results also extend to other formulations of the objective function under cooperation.

To obtain a unique outcome under an agreement, I assume that $\pi(v(a), v(a))$ is strictly concave in a.[26] Throughout I will make explicit when I use that firm objective functions are strictly quasiconcave. I further assume that when both firms' competitiveness $v_i = v$ increases, ceteris paribus, this strictly increases each firm's profits,[27]

$$\frac{d}{dv}\pi(v, v) = \pi_1 + \pi_2 > 0 \text{ (where } \pi > 0). \tag{3}$$

Objective of my analysis. My interest lies in a positive analysis of the different causal channels through which cooperation affects equilibrium sustainability, and to provide guidance as to whether and when a positive overall effect can be expected. In an antitrust context, I thus presume that the authority cannot decide directly on a required sustainability standard, and it may lack the necessary information to compare a proposed standard to the expected counterfactual (independent) choices. One could also think of the cooperation as a joint-venture, where I, however, abstract from direct cost synergies.

A full-scale normative analysis would depend on the applied welfare criterion. As noted in the introduction, under a total welfare standard I implicitly assume that neither consumers nor firms sufficiently internalize the societal benefits of higher sustainability, e.g., as there are (political) restrictions towards imposing respective taxes, which justifies

[26] I acknowledge that for many specifications of demand, including linear demand, $\pi(v, v)$ may be convex in v, so that $v(a)$ needs to be sufficiently concave.

[27] When instead $\frac{d}{dv}\pi(v, v) = 0$, firms would be indifferent, thus strictly preferring to lower v as much as possible when $F' > 0$. This would be the case when the market was fully covered, as in Dewatripont and Tirole (2022). For instance, in the case of Hotelling competition, abstracting from sustainability preferences with $\lambda_i = 0$ and supposing that $F' > 0$, under an agreement firms would lower a at least to the point where the full-market coverage assumption was (just) no longer satisfied, and they would thus operate as monopolists in their respective local markets.

a focus on (higher) sustainability. With respect to consumer welfare alone, I note that consumer welfare should increase in competitiveness v_i, which I can confirm for linear demand, though this comes with the caveat that consumers are adequately informed and aware of the consequences of their choices. In my concluding remarks I discuss various aspects of consumer welfare as a metric of antitrust.

3 Benchmark with only Profit Motives

Set now $\lambda_i = 0$. As already remarked, the parameter a_i is then indistinguishable from any other quality attribute. When firms choose a_i independently, the respective first-order condition for the maximand $a_{i,Ind}$ for profits Π_i becomes

$$\pi_1 v'\left(a_{i,Ind}\right) - F'(a_{i,Ind}) = 0. \tag{4}$$

When this does not involve a change of fixed costs, $F' = 0$, this simplifies to $v'\left(a_{i,Ind}\right) = 0$. I denote the respective choice by $v'(\widehat{a}) = 0$, so that at $\widehat{a}$ a firm's level of competitiveness is highest: $v_i = \widehat{v} = v(\widehat{a})$. When a higher sustainability standard involves higher fixed costs, $F' > 0$, the optimal choice is strictly lower. Given symmetry (with $\lambda_i = 0$), I denote this independently chosen sustainability level by $a_{Ind} < \widehat{a}$.

I turn now to an agreement, where with $\lambda_i = 0$ sustainability maximizes the sum of profits $\Pi_A + \Pi_B$. For the respective standard, a_{Agr}, I obtain the first-order condition[28]

$$(\pi_1 + \pi_2) v'\left(a_{Agr}\right) - F'(a_{Agr}) = 0. \tag{5}$$

We see immediately that without fixed costs, $F' = 0$, an agreement does not change the outcome: Given $\pi_1 + \pi_2 > 0$ from (3), when $F' = 0$ the sign of the derivative is determined by that of v', which changes sign at $a_{Agr} = \widehat{a}$. Instead, with $F' > 0$ the

[28] Note that starting from $\frac{d}{da}\left(\Pi_A + \Pi_B\right) = 0$ and using symmetry, I can then drop the multiplier two.

agreement leads to strictly lower sustainability. Formally, evaluating the left-hand side of (5) at the independent equilibrium choice and using now that $a_{Ind} < \widehat{a}$ and thus $v' > 0$, the additional term in the derivative under an agreement (5) becomes negative, $\pi_2 v' < 0$. Under an agreement, it thus pays to strictly lower sustainability compared to the outcome with independent choices, and Proposition 1 follows immediately from the imposed strict quasiconcavity of the objective function. Note that given symmetric firm preferences, I can safely ignore firms' participation constraint under an agreement.

Proposition 1 *Suppose that firms have standard (profit-only) preferences, $\lambda_i = 0$. Then an agreement leaves a_i unchanged when it does not involve higher fixed costs, $a_{Agr} = a_{Ind} = \widehat{a}$. When instead $F' > 0$, the agreement strictly lowers sustainability, $a_{Agr} < a_{Ind} < \widehat{a}$.*

With $\lambda_i = 0$, an agreement internalizes the negative effect that a change in competitiveness, v, has on the rival's profits. When trading off competitiveness with fixed costs, this leads to a strictly lower value of a. When there is no trade-off with fixed costs, sustainability remains unchanged at the level where competitiveness is highest.

Note again that with $\lambda_i = 0$, one may consider the variable a more generally as a (vertical) quality attribute (recalling also our interpretation $v(a) = u(a) - c(a)$, so that a higher a induces higher willingness-to-pay u but also higher marginal costs c). In other words, there is thus nothing special about the choice of a, and Proposition 1 simply recovers well-known results: When there are no synergies from an agreement, internalization of the effect on the rival decreases a (with $F' > 0$ strictly), pushing up firm profits.[29]

[29] This has been applied in Schinkel and Spiegel (2017), where standard preferences are considered (and thus nothing distinguishes sustainability from any other quality attribute).

4 Analysis with Narrow Sustainability Preferences

4.1 The Case without Fixed Investment Costs

Allowing now for $\lambda_i > 0$, it is instructive to begin first with the case where $F' = 0$. This case may realistically describe some applications. For instance, firms may be retailers deciding on the sustainability of their procurement strategies, with different suppliers having more or less sustainable production and products. The choice of a particular supplier should typically not come with different fixed (investment) expenditures.

Recall now the specification of firm preferences $V_i = \Pi_i + \lambda_i a_i$. With independent choices and now $F' = 0$ and $\lambda_i \geq 0$, the first-order condition becomes

$$\pi_1 v'(a_{i,Ind}) + \lambda_i = 0. \tag{6}$$

Irrespective of the rival's choice a_j, it follows from concavity of v and from $\pi_1 > 0$ that for $\lambda_i > 0$ the optimal choice satisfies $a_{i,Ind} > \widehat{a}$ (when $\lambda_i > 0$). As the firm derives additional benefits from a more sustainable production, it is thus willing to accept a competitive disadvantage, $v(a_{i,Ind}) < \widehat{v}$.

When firm i is expected to choose a higher sustainability standard a_i and thereby reduce v_i, when also $\lambda_j > 0$, so that also $a_{j,Ind} > \widehat{a}$, the sign of the reaction of rival j depends on the cross-derivative of π, i.e., on whether firms' levels of competitiveness, v_i and v_j, are strategic substitutes or complements. With linear demand, it holds that

$$\pi_{12} < 0. \tag{7}$$

That firms' strategies to lower marginal costs or raise consumer willingness-to-pay are strategic substitutes is a common feature of many demand systems (Athey and Schmutzler, 2001). Then, when firm i's sustainability preferences increase and it is thus willing

to accept lower competitiveness in exchange for higher sustainability, its rival optimally becomes more competitive and lowers its own sustainability standard.

Proposition 2 *Suppose that higher sustainability does not involve additional fixed investment costs, $F' = 0$. When firm i cares directly about sustainability, $\lambda_i > 0$, its independent equilibrium choice of the sustainability standard satisfies $a_{i,Ind} > \widehat{a}$, and its profits are strictly decreasing in λ_i. As λ_i increases, its competitor's equilibrium choice remains at $a_{i,Ind} = \widehat{a}$ if $\lambda_j = 0$, while $a_{j,Ind}$ strictly decreases under (7) .*

To realize a higher sustainability standard, when $\lambda_i > 0$, firm i is willing to accept a reduction in profits. Under (7) this is aggravated by the reaction of firm j, provided that firm j does not already choose a_i so as to maximize its competitiveness (in case $\lambda_j = 0$). Profits of firm i are then compromised also by a downward adjustment of the rival firm's sustainability. Before shedding more light on this type of "strategic leakage", I note that the required (standard) assumption (7) is, however, not necessary for the subsequent comparison with an agreement, which is my main object of analysis.

Effect of an agreement under symmetric sustainability preferences. Still assuming $F' = 0$, under a joint agreement the chosen sustainability standard a_{Agr} now maximizes the sum of payoffs V_i, $\sum(\pi_i + \lambda_i a_i)$, giving rise to the first-order condition[30]

$$(\pi_1 + \pi_2)\, v'(a_{Agr}) + \frac{\lambda_A + \lambda_B}{2} = 0, \tag{8}$$

provided that the outcome satisfies firms' individual rationality constraint (see below). Under symmetry, $\lambda_i = \lambda$, this simplifies to

$$(\pi_1 + \pi_2)\, v'(a_{Agr}) + \lambda = 0. \tag{9}$$

[30] To obtain this expression, the derivative has been divided by two.

I first compare the outcomes with and without an agreement under symmetric preferences. For this I evaluate the derivative (9) under the (symmetric) equilibrium outcome when firms act independently, $a_i = a_{Ind}$. From $\pi_2 < 0$ and $v'(a_{Ind}) < 0$ as $a_{Ind} > \widehat{a}$, the respective derivative of the objective function under an agreement is thus (still) strictly positive at $a_i = a_{Ind}$. With strict quasiconcavity of the objective, this implies for the optimum that $a_{Agr} > a_{Ind}$: The agreement leads to a strictly higher level of sustainability.

The intuition for that $a_{Agr} > a_{Ind}$ is straightforward. Recall that already in the case of independent choices, when $\lambda_i > 0$, firm i is willing to forego a competitive advantage by increasing sustainability beyond the level $\widehat{v}$ at which v_i is highest. Under a joint agreement, firms internalize the negative effect that a higher level of competitiveness (higher v_i) has on the respective rival, given that $\pi_2 < 0$. This affects the trade-off with sustainability, as now the direct benefits from sustainability are traded off against $(\pi_1 + \pi_2)v'$, rather than merely against $\pi_1 v'$. As a consequence, the optimal level of sustainability increases. Put differently, under an agreement firms essentially put less emphasis on how sustainability affects own profits, as their importance is mitigated by the internalized effect on the rival's profit.

The negative direct effect on profits from reducing v, by increasing a beyond $\widehat{a}$, outweighs the positive effect on the rival's profits (see (3)), so that the choice of a higher sustainability standard under an agreement strictly reduces firm profits. Still, with symmetry each firm realizes a strictly higher objective V_i under an agreement, so that their individual rationality constraint is satisfied.

Proposition 3 *Suppose that higher sustainability does not involve higher fixed costs,* $F' = 0$. *When firms have strictly positive and symmetric sustainability preferences,* $\lambda_i = \lambda > 0$, *an agreement leads to a strictly higher sustainability standard,* $a_{Agr} > a_{Ind}$.

Agreement with heterogeneous preferences. With heterogeneous sustainability preferences, firms' independent choices are likewise heterogeneous. When such heterogeneity

remains small, but $\lambda_i > 0$ for both firms, a_{Agr} solving (8) will still be strictly higher than either firms' independent choice $a_{Agr} > a_{Ind,i}$, while the participation constraints of both firms do not bind. When firms' preferences are, however, sufficiently different, prima facie one could conjecture that the agreed sustainability standard lies between the two independent choices. But this is not possible as it would violate the individual rationality of the firm that thereby raise its own standard beyond the level chosen independently, thus becoming less competitive, while the rival lowers its standard, thus becoming more competitive. When an agreement is successful, it must still raise sustainability for both firms.

Proposition 4 *Suppose still that higher sustainability does not involve higher fixed costs,* $F' = 0$. *Also when firms have heterogeneous sustainability preferences,* $\lambda_i > 0$, *an agreement still leads to a sustainability standard that strictly exceeds that of both firms' independent choices,* $a_{Agr} > a_{i,Ind}$ *for both* i.

Still restricting attention to the case with $F' = 0$, Proposition 4 extends the previous insight to the case where firms have heterogeneous sustainability preferences: If an agreement is concluded, it leads to strictly higher sustainability for both firms. However, recall that when firms' sustainability preferences are sufficiently diverse, a sustainability agreement may not arise and will thus not be put before an antitrust authority. Still, it already follows from Proposition 3 and a continuity argument that when preferences are not too diverse, there will be a successful agreement (see also the proof of Corollary 1).

Comparative analysis. Recall now for independent choices that with (7) the rival's sustainability $a_{j,Ind}$ decreases when $a_{i,Ind}$ increases, following an increase in the latter firm's sustainability preferences (higher λ_i). This strategic leakage is absent under an agreement whenever a_{Agr} solves the unconstrained program (thus, ignoring firms' participation constraint) and with it the first-order condition (8). In fact, under strict quasiconcavity it is

then immediate that $\frac{da_{Agr}}{d\lambda_i} > 0$ holds for the jointly agreed standard. However, this is not necessarily the case when firms' sustainability preferences are sufficiently diverse, as then a_{Agr} is pinned down by the participation constraint of the firm with lower sustainability preferences (see the proof of Corollary 1). As its rival's sustainability preferences increase, a firm's payoff under independent choices strictly increases, affecting its participation constraint and thereby additionally constraining the choice under an agreement.

Corollary 1 *Suppose still that $F' = 0$ and consider how the sustainability standard under an agreement varies with firm preferences, λ_i. If i is the firm that has still lower such preferences, $\lambda_i < \lambda_j$, a marginal increase in λ_i strictly increases the agreed sustainability standard a_{Agr}. If instead λ_i increases for the firm with already higher sustainability preferences, $\lambda_i > \lambda_j$, the effect depends on whether the participation constraint for the agreement already binds for the rival j or not: If the difference in sustainability preferences is not too large, so that the participation constraint does not bind yet, a_{Agr} increases with λ_i; if instead the difference is already large and the participation constraint binds, a_{Agr} decreases.*

4.2 When Greater Sustainability also Involves (Higher) Fixed Costs

Recall first the two results that I obtained so far. In the benchmark case where $\lambda_i = 0$, I showed that an agreement always lowers sustainability when it involves higher investment costs, $F' > 0$ (Proposition 1). When firms directly care for sustainability, $\lambda_i > 0$, but when this does not involve higher fixed costs, I showed that sustainability is always higher under an agreement (Proposition 4). Analyzing now the case where both $\lambda_i > 0$ and $F' > 0$, intuitively the two isolated effects work in opposite directions, and I show when one or the other dominates.

Consider thus the now extended first-order conditions, first, under independent choices

$$\pi_1 v'\left(a_{i,Ind}\right) - F'(a_{i,Ind}) + \lambda_i = 0, \tag{10}$$

and, second, under an agreement

$$\left(\pi_1 + \pi_2\right) v'(a_{Agr}) - F'(a_{Agr}) + \frac{\lambda_A + \lambda_B}{2} = 0. \tag{11}$$

With symmetric sustainability preferences, $\lambda_i = \lambda$, the latter simplifies to

$$\left(\pi_1 + \pi_2\right) v'(a_{Agr}) - F'(a_{Agr}) + \lambda = 0. \tag{12}$$

Consider first independent choices. Whether these lie now above or below $\widehat{a}$, where a firm is most competitive, depends on both the required incremental investment costs and sustainability preferences. Precisely, with

$$\widehat{\lambda} = F'\left(\widehat{a}\right),$$

I now have $a_{Ind} > \widehat{a}$ only if $\lambda > \widehat{\lambda}$, which is strictly positive when $F' > 0$. When sustainability preferences are, however, less pronounced, so that $\lambda < \widehat{\lambda}$, fixed costs dominate: Firms could still improve their competitive position by raising sustainability, as the implied change in consumer willingness-to-pay exceeds potentially higher marginal costs, but this would involve too high additional investment.

Proposition 5 *Suppose firms have strictly positive and symmetric sustainability preferences, $\lambda_i = \lambda > 0$. Then an agreement leads to a strictly higher sustainability standard ($a_{Agr} > a_{Ind}$) if firms' sustainability preferences are sufficiently strong with $\lambda > \widehat{\lambda}$, to a strictly lower sustainability standard ($a_{Agr} < a_{Ind}$) if $\lambda < \widehat{\lambda}$, and it leaves sustainability unchanged ($a_{Agr} = a_{Ind}$) if $\lambda = \widehat{\lambda}$.*

Proposition 5 includes Proposition 3 as a special case, namely when with $F' = 0$ the threshold satisfies $\widehat{\lambda} = 0$. When higher sustainability involves higher fixed investment costs, $\widehat{\lambda} > 0$, the agreement raises sustainability only when firms' sustainability preferences are sufficiently strong. To assess the implications of the agreement for sustainability we thus need to know which of the two cases applies. The agreement is more likely to raise sustainability when the relevance of fixed investment costs is relatively low or when firms' sustainability preferences are sufficiently strong, as made precise by the threshold $\widehat{\lambda} = F'(\widehat{a})$.

Note that Proposition 5 does not imply that a_{Agr} has a discontinuity at (symmetric) preferences $\widehat{\lambda}$. Instead, there the agreement has no effect, and as preferences change marginally around $\widehat{\lambda}$, also the effect of an agreement is only marginal, though the sign depends on the comparison with $\widehat{\lambda}$.

There is also a more direct test for the outcome of an agreement, which focuses on the outcome prior to the agreement (or without it). The agreement raises sustainability if $a_{Ind} > \widehat{a}$, i.e., if already prior to the agreement firms choose a sustainability level that compromises their competitive position in the market. Whether this is the case may be established, for instance, by a comparison of consumers' incremental willingness-to-pay with the respective higher marginal costs (i.e., with $v(a) = u(a) - c(a)$ by comparing $u'(a_{Ind})$ with $c'(a_{Ind})$). Such a test can also be applied in case of asymmetric preferences, as follows:

Corollary 2 *Suppose firms have potentially different but sufficiently strong sustainability preferences, $\lambda_i > \widehat{\lambda}$, implying that under independent choices each firm is (weakly) willing to sacrifice competitiveness so as to realize higher sustainability, $a_{i,Ind} > \widehat{a}$. Then an agreement always strictly increases both firms' sustainability preferences, $a_{Agr} > a_{Ind,i}$. When instead both $\lambda_i < \widehat{\lambda}$, an agreement unambiguously lowers both firms' sustainability standard.*

The first part of the Corollary extends Proposition 4. As already noted there, however, when preferences are too heterogeneous, there may not be a successful agreement. In this case, an antitrust agency would, however, not be confronted with such a proposal.

4.3 Strategic Leakage and Potential First-Mover Disadvantage

To discuss further the notion of a potential strategic leakage, I now briefly deviate from the model where firms choose their sustainability standard simultaneously. Suppose thus instead that sustainability decisions are taken sequentially, with firm $i = A$ moving first. The subsequent, additional analysis relates to the European Commission's new horizontal guidelines, as discussed in the Introduction. There, as an efficiency rationale for sustainability agreements, the Commission advances the theory of a "first-mover disadvantage".[31]

The first mover's derivative is given by

$$\frac{dV_A}{da_A} = [\lambda_A + \pi_1(v_A, v_B)v'(a_A)] - F'(a_A) + \frac{da_B}{da_A}\pi_2(v_A, v_B)v'(a_B),$$

where the last term takes into account the response of the second mover, firm B. Under an agreement, firms must agree on $a_i = a_{Agr}$, so that in the present model this would also change the timing of moves.

From (7) I know that the reaction of firm B is always substitutive to firm A's choice in terms of competitiveness: Following a marginal increase (decrease) in v_A, v_B decreases (increases). How this translates into the choice of sustainability depends on whether the respective choice a_i lies above or below the threshold $\widehat{a}$. When $a_{i,Ind} > \widehat{a}$ for both firms, so that $v' < 0$, it holds (locally) that $\frac{da_B}{da_A} < 0$, so that sustainability standards are strategic substitutes. The strategic reaction of the second mover dampens the first mover's incentives to raise sustainability.

[31] Here, the term "disadvantage" does not necessarily relate to lower profits of a first mover, but to the observation that a first-moving firm has lower incentives to become sustainable. Of course, there may be other, standard rationales, such as cost synergies and knowledge spill-overs. Inderst et al. (2021b) identify norm-based sustainability preferences of consumers as another potential rationale.

Suppose now instead that incremental costs $F' > 0$ are sufficiently important so that $a_i < \widehat{a}$ holds for both firms. An increase in a_A makes firm A now more competitive, so that the second mover's response is to become less competitive, which now results in a lower value of a_B. While firms' choices of sustainability standards are thus still strategic substitutes, now the reaction of the rival no longer gives rise to a first-mover disadvantage, as it increases the first mover's incentives to raise sustainability. When only one of the two firms chooses sustainability above $\widehat{a}$, sustainability choices become instead strategic complements.

Observation. *Consider a modified, sequential game where firms choose sustainability independently, with firm A moving first. Locally, when firm A's sustainability preferences are sufficiently strong so that $a_A > \widehat{a}$, the rival's response dampens the first mover's incentives to raise the sustainability standard. When instead $a_A < \widehat{a}$, the strategic response of the second mover increases the first mover's incentives to raise sustainability. Whether sustainability standards are (locally) strategic substitutes or complements depends on both a_A and a_B: They are strategic substitutes when either $a_i < \widehat{a}$ or $a_i > \widehat{a}$ for both firms, while they are strategic complements when $a_i < \widehat{a}$ while $a_j > \widehat{a}$ (for $i, j \in I$).*

4.4 Discussion of (Alternative) Narrow Preferences

The specification of narrow preferences in (1) is consequentialist only with respect to the chosen measure of the firm's sustainability strategy, a_i. For the specific application where sustainability relates to firm's emissions (and is thus directly tied to output), I now stipulate, instead, preferences

$$V_i = \Pi_i - \lambda_i e_i \text{ with } e_i = q_i(\phi - a_i), \tag{13}$$

which still relate narrowly only to the firm's own emissions, but depends also on output.

It is convenient to also introduce a reduced form representation of firms' quantities as

a function of competitiveness, $q_i(v_i, v_j)$, with partial derivatives

$$\frac{\partial q_i}{\partial v_i} > 0 \text{ and } \frac{\partial q_j}{\partial v_i} < 0 \text{ (where strictly positive).} \tag{14}$$

In words, higher own competitiveness results in an expansion of own output and a reduction of the rival firm's output.

For this subsection only, I make an additional parameter restriction to rule out potentially unrealistic cases in which a firm would want to cede competitive advantage to its rival for the sole purpose that this would subsequently shrink its own output and thereby emissions. For this I restrict attention to where

$$\pi_2(v_i, v_j) - \lambda_i(\phi - a_i)\frac{\partial q_i}{\partial v_j} \leq 0, \tag{15}$$

which holds notably when λ_i is not too large.

When firms choose sustainability independently, I have the first-order condition

$$\begin{aligned} \frac{dV_i}{da_i} &= \pi_1 v'(a_{i,Ind}) + \lambda_i q_{i,Ind} - F'(a_{i,Ind}) \\ &\quad + \lambda_i v'(a_{i,Ind})\frac{\partial q_i}{\partial v_i}(\phi - a_{i,Ind}) \\ &= 0. \end{aligned} \tag{16}$$

Without direct preferences for sustainability, $\lambda_i = 0$, the characterization still collapses to condition (4) in the benchmark analysis. For $\lambda_i > 0$ I now compare the derivative in (16) to that with the previous specification of narrow preferences in (10).

There are two differences under the now modified preferences. The first difference can be found in the first line of (16), where the direct effect of the firm's sustainability preferences is now given by the product $\lambda_i q_{i,Ind}$, as the firm cares about the respective impact on emissions (for given quantity $q_{i,Ind}$). The second difference is the addition of

the second line in (16), which captures the effect on emissions through a change in own quantity, following a change in a_i and thus v_i. When, for instance, $a_i > \widehat{a}$, so that $v' < 0$, the firm derives additional incentives from raising sustainability as this lowers emissions through a subsequent reduction in own quantity.

With a focus on symmetry, define

$$\widetilde{\lambda} = \frac{F'(\widehat{a})}{\widehat{q}_i} \text{ with } \widehat{q}_i = q_i(v(\widehat{a}), v(\widehat{a})). \tag{17}$$

With symmetric sustainability preferences the most competitive outcome $\widehat{a}$ and thus $\widehat{v} = v(\widehat{a})$ is thus obtained when $\lambda_i = \widetilde{\lambda}$. Setting $\lambda_i = \widetilde{\lambda}$ and $a_i = \widehat{a}$, the first-order condition (16) is just satisfied. Under the adjusted narrow preferences, also the threshold adjusts, compared to $\widehat{\lambda}$, as now also quantity matters for the firm's sustainability preferences.

Under an agreement, a_{Agr} still maximizes the joint objective $V_A + V_B$. Focussing in the main text on symmetry, the first-order condition under an agreement becomes

$$(\pi_1 + \pi_2)\, v'(a_{Agr}) + \lambda q - F'(a_{Agr}) + \lambda v'(a_{Agr}) \frac{\partial q}{\partial v}(\phi - a_{Agr}) = 0. \tag{18}$$

The first term in (18) captures again the key difference to the independent choice, namely the internalization of the rival's profit. The remaining terms are identical to those in the respective derivative (16) with independent choices.

With narrow preferences a firm' objective V_i still captures only its own emissions, also under the now modified preferences. This will be the key point of departure under broad sustainability preferences. For now, I obtain the following confirmation of the preceding results:

Proposition 6 *Suppose firms' narrow preferences for sustainability are given alternatively by $V_i = \Pi_i - \lambda_i e_i$, with $e_i = q_i(\phi - a_i)$. Then the preceding implications of an agreement from Proposition 5 (under symmetry) and Corollary 2 (with heterogenous preferences) still*

continue to hold, with the threshold $\widehat{\lambda}$ *replaced by* $\widetilde{\lambda}$.

5 Broad Sustainability Preferences

Recall first the specification of broad sustainability preferences in (2). Taking specifically the case where higher sustainability reduces emissions, a firm maximizes $V_i = \Pi_i - \lambda_i e$, where total emissions equal $e = \sum_I q_i(\phi - a_i)$. The key difference to the preceding analysis with narrow preferences is thus that firm i cares about total industry emissions and thus directly about the sustainability choice of its rival, a_j.

I first complete the preceding description of partial derivatives for the reduced form expressions. With $Q = q_A + q_B$, I stipulate for the case with $v_A = v_B = v$ that

$$\frac{dQ}{dv} > \frac{\partial Q}{\partial v_i} > 0 \text{ (where } Q > 0). \tag{19}$$

In words, the effect on output is larger when both firms, instead of only one, become more competitive.

Leakage. When firms choose sustainability independently, the first-order condition for firm i now becomes

$$\begin{aligned} \frac{dV_i}{da_i} &= \pi_1 v'(a_{i,Ind}) + \lambda_i q_{i,Ind} - F'(a_{i,Ind}) \\ &\quad + \lambda_i v'(a_{i,Ind}) \left[\frac{\partial q_i}{\partial v_i}(\phi - a_{i,Ind}) + \frac{\partial q_j}{\partial v_i}(\phi - a_{j,Ind}) \right] \\ &= 0. \end{aligned} \tag{20}$$

For a comparison, I turn to (16), where I stipulated for narrow preferences $V_i = \Pi_i - \lambda_i e_i$. With broad preferences, the firm cares about total emissions, rather than only about its own emissions. To see the difference, suppose that $a_i > \widehat{a}$ so that $v' < 0$. As the firm increases a_i further and thereby becomes less competitive, its own output and with it

emissions decrease. This effect, captured by the first term in rectangular brackets in (20), is now, however, counteracted by the second term, capturing the rival firm's expansion of quantity and thus emissions, as $v' < 0$ and $\frac{\partial q_j}{\partial v_i} < 0$.

This leakage effect weighs less when the other firm has higher own sustainability, as then emissions per additional output, $\phi - a_{j,Ind}$, are lower. However, when the rival firm's sustainability is (much) lower than that of firm i, the term in rectangular brackets could even be positive, so that the second line in (20) is altogether negative: Then, the leakage effect to the much less sustainable firm can outweigh the overall reduction in quantity, as $\frac{\partial Q}{\partial v_i} > 0$.

Additional sustainability benefits of an agreement under broad preferences. Under an agreement, I obtain for the first-order condition under an agreement

$$\begin{aligned} & (\pi_1 + \pi_2)\, v'(a_{Agr}) + \frac{\lambda_A + \lambda_B}{2} Q - F'(a_{iAgr}) \qquad (21) \\ & + \frac{\lambda_A + \lambda_B}{2} v'(a_{Agr}) \frac{dQ}{dv} (\phi - a_{Agr}) \\ = \; & 0 \qquad (22) \end{aligned}$$

and, with symmetry,

$$(\pi_1 + \pi_2)\, v'(a_{Agr}) + \lambda Q - F'(a_{Agr}) + \lambda v'(a_{Agr}) \frac{dQ}{dv} (\phi - a_{Agr}) = 0. \qquad (23)$$

Again the first difference to the case with independent choices is the presence of the internalization term π_2. With broad preferences, however, there are now important additional effects of an agreement, which arise from the fact that under an agreement a change in the sustainability standard is always also imposed on the rival firm.

Consider the case with symmetric preferences $\lambda_i = \lambda$ and note the following two differences: First, the term $\lambda_i q_{i,Ind}$ in the derivative with independent choices is replaced by λQ, i.e., with the total quantity instead of only that of firm i; second, the term

$\lambda v'(a_{Ind})\frac{\partial Q}{\partial v_i}(\phi - a_{Ind})$ is replaced by $\lambda v'(a_{Agr})\frac{dQ}{dv}(\phi - a_{Agr})$, i.e., again with the total effect $\frac{dQ}{dv}$, given a change in both $v_A = v_B = v$, instead of only the partial effect $\frac{\partial Q}{\partial v_i}$. In both cases, the control over also the other firm's sustainability level thus raises incentives to increase sustainability under an agreement, compared to the case with independent choices.

This additional channel through which sustainability can be higher under an agreement was absent under narrow preferences, as there a firm cared only about its own sustainability and emissions, instead of total emissions. The additional effects are now responsible for that a cooperation strictly increases sustainability already when at $\lambda = \widetilde{\lambda}$ the outcome with independent choices is $a_{Ind} = \widehat{a}$. (Recall that with narrow preferences, when $a_{Ind} = \widehat{a}$, the agreement did not affect sustainability.) This insight extends to heterogeneous preferences.[32]

Proposition 7 *Suppose firms have broad sustainability preferences. Then, compared to narrow preferences, these make it more likely that cooperation leads to higher sustainability. Precisely, when now $\lambda_i \geq \widetilde{\lambda}$, implying that under independent choices each firm is (weakly) willing to sacrifice competitiveness so as to realize higher sustainability, now $a_{Agr} > a_{i,Ind}$ holds for both firms. Instead, $\lambda_i < \widetilde{\lambda}$ for both firms is no longer sufficient to lower sustainability under an agreement.*

6 Conclusion

In the Introduction, I motivated my analysis by recent changes in competition law and policy initiatives that increase the scope for firm cooperation when this potentially advances sustainability. In my analysis, sustainability is different from other (vertical) attributes of products in that firms may have direct preferences for higher sustainability, which go

[32]The most competitive outcome $\widehat{a}$ is now reached under an agreement only when sustainability preferences are half as large, at $\lambda = F'(\widehat{a})/\widehat{Q}$ with $\widehat{Q} = 2q(v(\widehat{a}), v(\widehat{a}))$. It is instructive to recall again that regardless of the specified form of sustainability preferences, at $\lambda_i = 0$ we are entirely back at the benchmark, where for $F' > 0$ the agreement strictly lowers sustainability.

beyond a pure profit motive. As this increases sustainability also in the counterfactual without an agreement, it is a priori uncertain if and why cooperation would further increase sustainability, in particular as I abstract from standard synergy effects.

When higher sustainability involves a trade-off only between higher marginal costs and possibly higher consumer willingness-to-pay, an agreement always increases sustainability. The simple reason is that when firms also internalize their rivals' profits, they put less weight on own profits and are thus willing to increase sustainability further, even at the expense of undermining own competitiveness. When firms have broad preferences and thus also internalize the emissions caused by competitors, this further boosts the benefits of an agreement, as an agreement allows firms to also control directly the sustainability and thereby emissions of their rivals. I also identify two different kinds of leakage effects that cooperation resolves. Even under narrow preferences, sustainability is undermined by a strategic leakage, when with independent choices a rival responds by lowering sustainability to boost competitiveness. With broad preferences, a firm may hold back sustainability as lower competitiveness will shift market share to a more polluting rival.

When higher sustainability involves (also) higher fixed investment costs, there is a known countervailing effect: Internalizing each others' profits under an agreement induces firms to reduce such investment. When firm sustainability preferences are sufficiently strong or the required incremental investment sufficiently small, an agreement still increases sustainability. As a guideline, cooperation increases sustainability when already prior to that firms were willing to increase sustainability even beyond the point where it reduced competitiveness. Confirming that this is the case may thus be precondition when delegating responsibility for sustainability standards to cooperating firms or industry associations, or when exempting an agreement from prohibition under competition law.

I conclude with additional remarks on the treatment of sustainability agreements under antitrust law. As I noted throughout the analysis, while it leads to higher sustainability,

an agreement that makes firms less competitive should reduce consumer welfare, provided that, first, there are no additional synergies and, second, demand indeed fully captures consumer welfare. I briefly discuss the second condition. Consumers may not always be fully aware of the consequences of their actions. Also, in case of emissions they may simply not care about the effect on others, but they may well be concerned about the negative consequences that their fellow consumers' consumption has on them. The European Commission's new horizontal guidelines (see the Introduction) effectively allow to increase the scope of consumer welfare in these two directions (calling the latter "collective benefits"). Acknowledging the analyzed benefits of a sustainability agreement may thus be possible already under such an extended consumer welfare standard, rather than only under a total welfare standard (as practiced by only a few competition authorities) or when extending an antitrust agency's metric to incorporate sustainability considerations.

7 Proofs

Proof of Proposition 2. I first consider firms' best responses, as derived from (6). Under the assumed strict quasiconcavity of the objective, best responses are unique and the sign of the slope $da_{i,Ind}/da_{j,Ind}$ is given by the expression $\pi_{12}v'(a_i)v'(a_j)$. Take now first the comparative analysis of a_j. The assertion follows as, first, $v'(a_{i,Ind}) < 0$ and $v'(a_{j,Ind}) < 0$, and as, second, the best response $a_{i,Ind}$ shifts outwards when λ_i is higher.

Next, that firm profits are strictly lower for i follows from $\pi_2 < 0$ and as $v(a_j)$ strictly increases (given the decrease in $a_{j,Ind}$ and as $v' < 0$). Note finally that I do not make an assertion regarding the comparative statistics of $a_{i,Ind}$ in λ_i (as this depends on how the direct effect of an increase in λ_i and the indirect effect of a higher $a_{j,Ind}$ trade off with each other). **Q.E.D.**

Proof of Proposition 4. With heterogeneous preferences, firms' participation con-

straints may bind in case of an agreement, as given by $V_i \geq \widehat{V}_i$ for all i, where $\widehat{V}_i$ denotes the respective payoff in the equilibrium with independent strategy choices, $a_{i,Ind}$.

Note now first that from the first-order condition (8) the unconstrained choice always satisfies $a_{Agr} > \widehat{a}$, as $\lambda_i = 0$ holds for at most one firm. Recall also that $a_{i,Ind} \geq \widehat{a}$ (and strictly when $\lambda_i > 0$). I need to rule out the following cases: case i, where the agreement increases sustainability only for one firm, and case ii, where both firms' sustainability decreases. (As is immediate, the case where both remain unchanged can only arise when $\lambda_i = 0$ for both firms.) I can now consider both cases i and ii jointly. Considering the objective V_i, I argue to a contradiction and suppose thus that for the rival firm j it holds that $a_{Agr} < a_{j,Ind}$. Consider the change in V_i,

$$\begin{aligned} & V_{i,Agr} - V_{i,Ind} \\ = \; & \pi(v(a_{Agr}), v(a_{Agr})) - \pi(v(a_{i,Ind}), v(a_{j,Ind})) + \lambda_i \left(a_{Agr} - a_{i,Ind}\right), \end{aligned}$$

and decompose this as follows:

$$\begin{aligned} & \left[\pi(v(a_{Agr}), v(a_{j,Ind})) - \pi(v(a_{i,Ind}), v(a_{j,Ind}))\right] + \lambda_i \left(a_{Agr} - a_{i,Ind}\right) \\ & + \left[\pi(v(a_{Agr}), v(a_{Agr})) - \pi(v(a_{Agr}), v(a_{j,Ind})\right]. \end{aligned} \tag{24}$$

Hence, in the first line of (24) I still keep the rival's sustainability standard constant at $a_{j,Ind}$. The resulting expression is strictly negative by optimality of $a_{i,Ind}$ (for given $a_{j,Ind}$) and $a_{i,Ind} \neq a_{Agr}$. Turn now to the second line of (24), where I now keep $a_i = a_{Agr}$ constant while decreasing a_j, as by assumption $a_{Agr} < a_{j,Ind}$. Given $v' < 0$ over the considered range and $\pi_2 < 0$, also the second line is thus strictly negative, so that $V_{i,Agr} < V_{i,Ind}$, contradicting the assumption that the agreement was individually rational for firm i. **Q.E.D.**

Proof of Corollary 1. Recall first from Proposition 4 that under a successful agreement

with $\lambda_i > 0$ for at least one firm, it must hold that $a_{Agr} > a_{i,Ind}$. Recall also that participation constraints are slack when $\lambda_i = \lambda_j$. Suppose now without loss of generality that $\lambda_A < \lambda_B$.

I show first that the constraint does not bind for firm B with higher sustainability preferences. To see this, define by $\widehat{V}_i$ the equilibrium payoff under independent choices and by $\widetilde{V}_i(a)$ the payoff when the sustainability standard was set equal to a under an agreement. I thus want to show that $\widetilde{V}_B(a = a_{Agr}) > \widehat{V}_B$ holds strictly when a_{Agr} solves the first-order condition. Note first that surely $\widetilde{V}_B(a_{B,Ind}) > \widehat{V}_B$. Define next $\widetilde{a} > a_{Agr}$ as the maximand of $\widetilde{V}_B(a)$ and note that $\widetilde{V}_B$ strictly increases between $a_{B,Ind}$ and $\widetilde{a}$ and thus surely between $a_{B,Ind}$ and a_{Agr}, so that the participation constraint must indeed be slack.

I turn next to firm A with $\lambda_A < \lambda_B$. Here, I conduct the following comparative analysis: Holding λ_A fixed, I increase λ_B, starting from $\lambda_B = \lambda_A > 0$, where we know that $\widetilde{V}_A(a_{Agr}) > \widehat{V}_A$. As I now increase λ_B, note first that $\widehat{V}_A$ strictly increases, which follows as $a_{A,Ind}$ is firm A's best response, $a_{B,Ind}$ strictly increases in λ_B, $v'(a_{B,Ind}) < 0$, and $\pi_2 < 0$. At the same time, the unconstrained a_{Agr} strictly increases in λ_B, and $\widetilde{V}_A(a)$ strictly decreases. From this it follows that if the constraint binds at some distance $\lambda_B - \lambda_A$, this is uniquely determined. Recall finally that $\pi(0, \cdot) = 0$ and that $v(a)$ goes to zero as a becomes sufficiently large.

When the individual rationality constraint of firm A binds, as $\widetilde{V}_A(a)$ is strictly decreasing, a_{Agr} is uniquely determined by

$$\widetilde{V}_A(a_{Agr}) = \widehat{V}_A. \tag{25}$$

I am now in a position to prove the comparative claims. When no participation constraint binds, a_{Agr} increases with λ_i, which follows immediately from (implicit differentiation of) the first-order condition (8).

It thus remains to consider the case where the constraint binds, which. As I have shown,

in this case the constraint binds only for the firm with the lower sustainability, i.e., without loss of generality for firm A with $\lambda_A < \lambda_B$. When the participation constraint of firm A binds and λ_B increases, this increases $\widehat{V}_A$, while we know that locally $\widetilde{V}_A(a)$ decreases, implying from (25) that a_{Agr} must indeed decrease. Finally, suppose that the participation constraint again binds for A, but that now λ_A marginally increases, in which case a_{Agr} should strictly increase. In what follows, I use that $\widetilde{V}_A(a)$ is locally strictly decreasing at $a = a_{Agr}$, so that I need to show that, holding a_{Agr} now fixed, as λ_A increases and $a_{i,Ind}$ adjusts, the difference $\widetilde{V}_A(a_{Agr}) - \widehat{V}_A$ strictly increases. Using the envelope theorem for $a_{A,Ind}$, the derivative of this difference with respect to λ_A (and at constant a_{Agr}) is given by

$$(a_{Agr} - a_{A,Ind}) - \pi_2(v(a_{A,Ind}), v(a_{B,Ind}))\frac{dv(a_{B,Ind})}{d\lambda_A},$$

which is indeed strictly negative as, first, $a_{Agr} - a_{A,Ind} > 0$, and, second, $\pi_2 < 0$ and $\frac{dv(a_{B,Ind})}{d\lambda_A} > 0$ (see Proposition 2). **Q.E.D.**

Proof of Proposition 5. To assess the implications of an agreement, I proceed again by analyzing the derivative in (12) at $a = a_{i,Ind} = a_{Ind}$, satisfying (10). The additional effect arising under (12) is given by the term $\pi_2 v'$ with $\pi_2 < 0$. The sign of this depends thus on v' as follows: When $\lambda < \widehat{\lambda}$ and thus $a_{Ind} < \widehat{a}$ I have $v' > 0$, when $\lambda > \widehat{\lambda}$ and thus $a_{Ind} > \widehat{a}$, I have $v' < 0$, and when $\lambda = \widehat{\lambda}$ and thus $a_{Ind} = \widehat{a}$ I have $v' = 0$. Appealing to strict quasiconcavity, this proves the claim for the comparison of a_{Agr} (at which the derivative in (12) must be zero). Note finally that by the maximization problem in case of a cooperation and by symmetry, the individual rationality constraint of both firms is satisfied. **Q.E.D.**

Proof of Corollary 2. I now adjust the argument in Proposition 4, where I used $F' = 0$. Suppose thus first that $\lambda_i > \widehat{\lambda}$ and thus $a_{i,Ind} > \widehat{a}$. By optimality of a_{Agr} and thus also $a_{Agr} > \widehat{a}$, I have again $v'(a) \leq 0$ for the whole range of parameters used for the decomposition in (24). There, fixed costs only enter in the first line, via subtraction of

$F(a_{Agr}) - F(a_{i,Ind})$, but this is inconsequential as I use only that $a_{i,Ind}$ is firm i's optimal response to $a_{j,Ind}$.

Turn now to the case where $\lambda_i < \widehat{\lambda}$, so that again by optimality $a_{Agr} < \widehat{a}$. Arguing to a contradiction, I suppose now that $a_{Agr} > a_{j,Ind}$ for the rival j. The argument for the first line in (24) is unaffected by the ordering of sustainability levels, as $a_{j,Ind}$ is kept constant. That the second line, $\pi(v(a_{Agr}), v(a_{Agr})) - \pi(v(a_{Agr}), v(a_{j,Ind}))$, is still negative follows from $\pi_2 < 0$, $a_{Agr} > a_{j,Ind}$, and $v'(a) \geq 0$ over the relevant range. **Q.E.D.**

Proof of Proposition 6. Note first that the first-order condition for an agreement, divided by two and with $q_A = q_B = q$, becomes

$$\begin{aligned} & (\pi_1 + \pi_2)\, v'(a_{Agr}) + \frac{\lambda_A + \lambda_B}{2} q - F'(a_{Agr}) \\ & + \frac{\lambda_A + \lambda_B}{2} v'(a_{Agr}) \frac{\partial q}{\partial v} (\phi - a_{Agr}) \\ = \; & 0. \end{aligned} \tag{26}$$

At $\widehat{a}$ where $v' = 0$, the additional terms that arise only under the modified narrow preferences disappear (which is also why now when $\lambda_i = \widetilde{\lambda}$ for both firms, $a_{Agr} = a_{Ind}$). Start with the case where $\lambda_i > \widetilde{\lambda}$. To show that a successful agreement must lead to $a_{Agr} > a_{i,Ind}$ for both firms, I suppose instead that $a_{j,Ind} > a_{Agr}$ (but $a_{Agr} > \widehat{a}$), and consider now the following decomposition of $V_{i,Agr} - V_{i,Ind}$:

$$\begin{aligned} & [\pi(v(a_{Agr}), v(a_{j,Ind})) - \pi(v(a_{i,Ind}), v(a_{j,Ind}))] - [F(a_{Agr}) - F(a_{i,Ind})] \\ & + \lambda_i \left[q_{i,Ind}(\phi - a_{i,Ind}) - \widehat{q}_{Agr}(\phi - \widehat{a}_{Agr}) \right] \\ & + \left[\pi(v(a_{Agr}), v(a_{Agr})) - \pi(v(a_{Agr}), v(a_{j,Ind})] + \lambda_i \left[\widehat{q}_{Agr}(\phi - \widehat{a}_{Agr}) - q_{Agr}(\phi - a_{Agr}) \right] . \right. \end{aligned} \tag{27}$$

Note that in the first two lines I keep again constant $a_{j,Ind}$, so that $\widehat{q}_{Agr} = q(v(a_{Agr}), v(a_{j,Ind}))$. That the overall expression in these two lines is negative follows again from optimality of $a_{i,Ind}$. In the now third line, I change also $a_{j,Ind}$ to a_{Agr}, and given the changed prefer-

ences, I need now to consider also the change of quantity to $q_{Agr} = q(v(a_{Agr}), v(a_{Agr}))$. Here, I use (15), and $v(a_{j,Ind}) < v(a_{Agr})$ by assumption, to again conclude that this line is non-positive. As then (27) is negative, I have arrived at a contradiction with respect to optimality, thereby confirming the claim when $\lambda_i > \widetilde{\lambda}$. The proof for $\lambda_i < \widetilde{\lambda}$ is analogous (following the previous extension in Corollary 2). **Q.E.D.**

Proof of Proposition 7. It is instructive to formalize the claim precisely at $\lambda_i = \widetilde{\lambda}$. Inspection of (20) confirms $a_{Ind} = \widehat{a}$. Substitution of $\lambda = \widetilde{\lambda}$ and $\widehat{a}$ into the left-hand side of (23), and noting $v'(\widehat{a}) = 0$ and $F'(\widehat{a}) = \widetilde{\lambda}Q/2$, reveals that the term $\widetilde{\lambda}Q/2 > 0$ remains. Under strict quasiconcavity, the maximand is thus indeed strictly higher, $a_{Agr} > \widehat{a}$ at $\lambda_i = \widetilde{\lambda}$. I recall that with symmetry both firms' objective is higher under an agreement (and strictly so when $a_{Agr} \neq a_{Ind}$). Under symmetry, an argument by continuity proves that $a_{Agr} > a_{Ind}$ for all $\lambda > \lambda'$ and some $\lambda' < \widetilde{\lambda}$.

I now extend the argument to heterogeneous preferences. For this I proceed again by decomposing $V_{i,Agr} - V_{i,Ind}$, now further extending expression (27). For this I now consider the two respective parts separately: the first part expands as

$$\begin{aligned} &[\pi(v(a_{Agr}), v(a_{j,Ind})) - \pi(v(a_{i,Ind}), v(a_{j,Ind}))] - [F(a_{Agr}) - F(a_{i,Ind})] \\ &-\lambda_i \left[\widehat{q}_i(\phi - a_{Agr}) + \widehat{q}_j(\phi - a_{j,Ind})\right] \\ &+\lambda_i \left[q_{i,Ind}(\phi - a_{i,Ind}) + q_{j,Ind}(\phi - a_{j,Ind})\right] \end{aligned} \tag{28}$$

where I use $\widehat{q}_i = q_i(v(a_{Agr}), v(a_{j,Ind}))$ and $\widehat{q}_j = q_j(v(a_{j,Ind}), v(a_{Agr}))$, and the second part expands as

$$\begin{aligned} &[\pi(v(a_{Agr}), v(a_{Agr})) - \pi(v(a_{Agr}), v(a_{j,Ind})] \\ &-\lambda_i \left[q_{Agr}(\phi - a_{Agr}) + q_{Agr}(\phi - a_{Agr})\right] \\ &+\lambda_i \left[\widehat{q}_i(\phi - a_{Agr}) + \widehat{q}_j(\phi - a_{j,Ind})\right]. \end{aligned} \tag{29}$$

The first part, now given by (28), is again strictly negative by optimality of $a_{i,Ind}$, holding $a_{j,Ind}$ fixed. Turning to (29), I take first the case where $\lambda_i \geq \widetilde{\lambda}$ and where I want to contradict existence of an agreement with $a_{Agr} \leq a_{j,Ind}$. I argue again to a contradiction, supposing thus $a_{j,Ind} > a_{Agr}$ (but $a_{Agr} > \widehat{a}$). Again, as I vary a_j between a_{Agr} and $a_{j,Ind}$, I can thus use throughout that $v' > 0$. That (29) is negative follows now from two separate reasons. First, the profit difference in the first line is negative from $\pi_2 < 0$ and $v(a_{Agr}) > v(a_{j,Ind})$. Second, noting that $a_{j,Ind} > a_{Agr}$ and that also total output $Q(v(a_{Agr}), v(a_{j,Ind}))$ is strictly lower than $Q_{Agr} = Q(v(a_{Agr}), v(a_{Agr}))$, I have stepwise for the last two lines in (29)

$$\begin{aligned} & \lambda_i \left[\widehat{q}_i(\phi - a_{Agr}) + \widehat{q}_j(\phi - a_{j,Ind}) - Q_{Agr}(\phi - a_{Agr})\right] \\ = \; & \lambda_i \left[(Q_{Agr} - Q(v(a_{Agr}), v(a_{j,Ind})))(\phi - a_{Agr}) + \widehat{q}_j(a_{Agr} - a_{j,Ind})\right] \\ < \; & 0. \end{aligned}$$

Q.E.D.

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