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Schinkel, M.P.; Tóth, L.

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UNIVERSITY OF AMSTERDAM

BALANCING THE PUBLIC INTEREST-DEFENSE IN CARTEL OFFENSES

Maarten Pieter Schinkel

Lukas Toth

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Balancing the Public Interest-Defense in Cartel Offenses

Maarten Pieter Schinkel*and Lukáš Tóth†

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Abstract

Horizontal agreements may be exempted from cartel law if they advance certain public interests, such as public health or the environment, enough to compensate the consumers damaged by their anti-competitive effects. We formalize the balancing of cartel unit price overcharges on a private good against the willingness of its consumers to pay for an accompanying public good. A cartel could improve upon the classic under-provision in competitive equilibrium, even though it crowds out private contributions. We show however that the required compensating public good level in no-contributor economies decreases in each consumer's willingness to pay, which is contrary to the Samuelson condition. With at least one private contributor, the policy can never attain first-best. Moreover, by self-selection the policy asks those individuals with the lowest willingness to pay for the public good to pay most, which is orthogonal to Lindahl-pricing. As a result, the public interest-cartel is typically not sustainable. To identify a genuine public interest-defense requires more information than a competition authority can reasonably be expected to have.

JEL-codes: H41, K21, L40, Q01

Keywords: cartel, public interest, public good, overcharge, exemption

*Department of Economics and ACLE, Universiteit van Amsterdam. Correspondence at: Plantage Muidergracht 12, 1018TV Amsterdam, The Netherlands. E-mail: m.p.schinkel@uva.nl.

†Department of Economics and ACLE, Universiteit van Amsterdam.

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1 Introduction

Concerns that certain public interests, such as environmental protection, public health or sustainability, may not be well served by competition has directed some antitrust agencies to weigh in their decisions other public interests than just competition. Restrictive agreements among competitors may take away negative externalities, such as industrial pollution, or ease commons problems, just by reducing output.¹ The more sophisticated argument is that when a horizontal agreement in restriction of competition amongst competitors actively promotes some wider public interest more than it harms consumers by its anticompetitive effects, the agreement should be exempted from the cartel law.²

The U.S. antitrust authorities and courts have resisted calls to consider wider public policy arguments on welfare merits against combinations in restraint of trade. In *National Society of Professional Engineers*, the Supreme Court rejected the argument that competition would produce inferior engineering work endangering public safety as a justification for suppression of price competition in violation of Section 1 of the Sherman Act. The Court held that even if competition would conflict with professional standards, that would be a matter of regulation, and "... not a reason, cognizable under the Sherman Act, for doing away with competition." ³

The European Commission, however, has been more receptive to public interest-defense arguments. In *CECED*, a landmark decision from 1999, it exempted horizontal agreements between manufacturers of washing machines to discontinue the production of their least energy-efficient models from the European cartel law, on the conclusion that the agreements would on balance bring about energy and water bill savings, as well as environmental benefits for society in excess of their negative effects from reduced competition.⁴ The 2001 Guidelines on Horizontal Agreements contained a separate chapter on allowing environmental agreements. While the Commission has since been reluctant to grant cartel exemptions on these grounds, recently there has been a revival in some Member States.⁵

The Dutch Ministry of Economic Affairs in May 2014 by law obliged the Dutch Authority for Consumers and Markets (ACM) to weigh whether "... in agreements that restrict competition made in order to promote sustainability, a fair share of the improvements benefits 'users' in the long run."⁶ The seminal case concerned an agreement between Dutch energy companies to close down five coal burning power plants, as part of the Dutch Energy Agreement for Sustainable Growth, a nation-wide

¹Adler (2004), for examples, argues that antitrust interventions in the California sardine fishery led to over-fishing and environmental damage. Crane (2005) suggests that United States Tobacco's monopolization attempts of the snuff tobacco market increased welfare through health improvements and health-care costs savings from lower tobacco consumption.

²See Townley (2009) and Kingston (2011).

³*National Society of Professional Engineers v. United States* 435 U.S. 679 (1978). See also Werden (2014).

⁴Commission Decision, Case IV.F.1/36.718, *CECED*, 24 January 1999. The exemption was given under paragraph 3 of Article 101 TFEU. It was shortly after stretched to include dishwashers and water heaters as well. See European Commission, "Commission approves agreements to reduce energy consumption of dishwashers and water heaters," IP/01/1659, Brussels, 26 November 2001.

⁵The revised 2011 Guidelines no longer mentions the possibility for exemption, and in several cases the Commission has not accepted the argument. For example, in Case COMP/39579, *Consumer Detergents* of 13 April 2011, it fined a trade association initiative that claimed to improve the environmental performance of detergent products as a cartel.

⁶Policy rule *Competition and Sustainability*, nr. WJZ / 14052830, 6 May 2014 (in Dutch).

contract to switch to green energy, initiated by the Ministry. The ACM considered the agreement collusive and gave an informal view that the closure of the plants, which accounted for approximately 10% of the Dutch generating capacity, would harm consumers by leading to higher energy prices. The environmental benefits for the Dutch consumers were deemed insufficient to compensate their harm from increased energy prices, in particular because the lower CO₂ emissions in the Netherlands would be offset by higher emissions by plants in neighboring countries acquiring the surplus emission allowances through the EU system of emissions trading (ETS) and using them, which would still affect the Dutch.⁷

Another informal view the agency gave in *Chicken of Tomorrow*. This case involved poultry farmers, broiler meat processors and Dutch supermarkets, who responded to a public outcry against the poor living conditions of chicken in factory farms - referred to by an animal rights organization as ‘exploding chicken’ (“plofkip”) - by making arrangements to sell chicken meat produced under enhanced animal welfare-friendly conditions. Among other things, supermarkets agreed to remove regular chicken meat from their shelves. The ACM prohibited the agreement as collusive, after concluding from questionnaires that although consumers were willing to pay 0.82 euro/kilo for more sustainable chicken meat on average, with a 1.46 euro/kilo price rise they would not benefit from the initiative on balance.⁸

Cartel coordination may in theory improve upon the classic under-provision of public goods in unregulated economies that results from free-riding.⁹ Arguably also the industries concerned will have superior knowledge and special skills to actively promote public interests in their sectors through self-regulation. They would know best air pollution control systems, cradle-to-cradle designs or humane farm animal care, as well as any latent willingness to pay with consumers for more socially responsible and sustainable production, such as green energy or fair trade products. Private companies may therefore be the most innovative and efficient producers also of certain public interests.¹⁰

However, admitting the public interest-defense for cartel offenses raises some immediate concerns. Horizontal agreements are known to carry direct and indirect risks of collusion, including higher prices and lower quality of products and variety.¹¹ Allowing collusion hardly creates private incentives to

⁷See ACM (2013) and Kloosterhuis & Mulder (2015).

⁸The ACM asked consumers to compare two discretely different market situations, one with and one without the exploding chicken on offer in supermarkets, thus including a collective switch to more animal friendly chicken meat production for the Dutch market. See ACM (2015).

⁹We note that legally a horizontal agreement that is exempted under Article 101(3) is not a cartel. We nevertheless refer in this paper to a horizontal agreement with anticompetitive effects in the meaning of Article 101(1) in brief as a ‘cartel’, ‘cartel agreement’ or ‘collusion’.

¹⁰See Shleifer (1998). Coase (1974) famously claims that lighthouses, which Paul Samuelson had made a textbook example of services that could only be provided by the government, were in fact in late 19th century Britain efficiently built and operated by private individuals that were granted the right by the government to levy tolls on passing ships calling at British ports. While Coase’s lighthouse case has been criticized as a pure example of efficient private production of a public good because of the government backing, a cartel exemption would be like that. However, as Bertrand (2006) documents, the statutory authority at the time, Trinity House, also imposed strict quality requirements for the building, maintenance and operation of lighthouses, while excludability from port services enforced the levying of the tolls. Also, several privately owned lighthouses needed to be taken over by Trinity House when their service was neglected.

¹¹Fonseca & Normann (2012) reports experimental evidence that talking helps collusion, which is continued after communication is disabled. Duso *et al.* (2013) establishes empirically that networks between competitors participating

promote sustainability sufficiently, even when consumers do have a willingness to pay for it.¹² While corporations may want to be seen taking social responsibility, the actual effects thereof need not exceed what suffices for self-promotion.¹³ Moreover, it is not clear why stimulating more corporate social responsibility would require a restriction of competition.

Also, many public interest benefits are hard to quantify as a mitigating factor. Sustainability appears to be sufficiently widely interpretable a concept to invite overly rosy contribution claims. The policy burdens antitrust agencies with a complex monitoring and balancing task. Objectionable cartels may misuse the policy in an attempt to get away with hard core collusion under the guise of green. As a result, the availability of the public interest-defense can undermine deterrence.

In this paper, we formalize the antitrust balancing of cartel damages against public interest benefits, supposing that the latter can somehow only be had by a horizontal industry-wide agreement. We restrict public interests to public goods, in conformity with the cartel benefits in our leading examples, which are non-excludable and non-rivalrous. No individual can be excluded from an improved environment, public health or better animal well-being, nor does anyone's enjoyment thereof take away from someone else's. The policy then amounts to government mandating an industry to collude to impose a unit tax on the private consumption good(s) it produces, provided that part of the proceeds are contributed to one or more public goods that compensate the consumers of the private good(s) for the harm caused by the cartel price overcharge.

Samuelson (1954) determines that the efficient level of public good provision is where sum of the marginal rates of substitution of all individuals is equal to the economy's marginal rate of transformation between the public good and any private good. Lindahl (1958) suggests individuals be taxed personalized prices, so as to contribute their marginal willingness to pay at the optimal level of the public good, times that level, for government to provide. The maximum willingness to pay for changes in the availability of a public good is a compensating variation.¹⁴ The social demand curve for a public good is the aggregation of all individuals' willingness to pay for each level of that public good.

Without coordination, public goods will be under-provided and Olson (1965) designates the provision of public goods in larger economies a government task. In practice, it is complex to implement optimal public goods production, as it requires private information about preferences that people would have an incentive not to reveal. Optimal taxation theory seeks to design tax-subsidy schemes for financing public goods that achieve efficiency without specific knowledge about the individual preferences, including by targeting revealed consumption patterns.¹⁵ Even though incentive-compatible

in R&D joint ventures in the US are conducive to collusion. Awaya & Krishna (2016) models how cheap talk within a cartel makes equilibria possible with near-perfect collusion by improving monitoring.

¹²Schinkel & Spiegel (2016) shows that when consumers value sustainable products and firms choose investments in sustainability before output, coordination of sustainability actually reduces it. A production cartel will invest more in sustainability, but harms consumers. The requirement to compensate consumers again reduces investments in sustainability below the competitive level.

¹³See Delmas & Montes-Sancho (2010).

¹⁴See Hanemann (1991).

¹⁵See Boadway & Keen (1993) on the use of observables, including revealed preferences and self-selection, to determine

implementation schemes do exist, government policy can only be second-best.¹⁶

We examine the trade-off between the cartel's public interest benefits against a unit price overcharge, using a standard public economics model with private consumption and voluntary public goods contributions. Heterogeneous individuals spend their endowment on a private good, a public good, and a composite commodity. Depending on relative preferences and the wealth distribution, some or all consumers of the private good also contribute to the public good. The cartel price rise has various substitution and income effects. The public interest-cartel's compensating contribution crowds out private contributions, as individuals free-ride on the public good contributions by others. For example can improvements in the energy efficiency of appliances be offset by lax morals in their use. With improved living conditions for chicken overall, some consumers may switch from buying high-end free range chicken to a generic biological brand.

We find that contrary to the Samuelson condition the public good level a cartel is required to produce in compensation decreases in consumers' willingness to pay for the public good. A cartel cannot produce the efficient public good supply if there is some crowding out. Moreover, the public interest-defense policy in essence targets exactly those individuals with a relatively low preference for the public good, to pay most for it, which is orthogonal to Lindahl-pricing. As a result, the industry can afford the required compensation from the cartel proceeds only in quite special circumstances, in which sufficiently many consumers have relative preferences for the private and the public good that stays constant within narrow bounds. In addition, the information requirements for a competition agency to identify a genuine public interest-defense seem too large for the policy to be practical.

Our analysis builds on a literature that studies government provision of the public good in economies with voluntary private contributions. Pareto improvements can be obtained through commodity taxation in such economies, and efficiency in public good provision via lump-sum taxation. However, if consumers anticipate that the government will use the tax revenue to finance purchases of the public good, they adjust their own public good spendings. Bergstrom *et al.* (1986) show that for income redistributions smaller than the initial individual voluntary contributions to the public good, crowding out of government spending on the public good by lump sum taxation is full. Bernheim (1986) establishes a similar neutrality result for 'distortionary' taxation on labor income as well, provided consumption bundles do not change. The latter is obtained by government also setting labor incomes and spending all revenues only on the one of two public goods to which all consumers are contributors.

Andreoni & Bergstrom (1996) points out that local neutrality crucially depends also on the structure of the game. If government commits to no change in taxes and balances the budget by adjusting its contribution to the public good, consumers can keep their private consumption constant, no matter what the other consumers do, and so offset the policy. In different setups, government can unambiguously increase total contributions.¹⁷ In our model, the cartel price rise has real effects and its

who to tax what for which type of public good.

¹⁶See Diamond & Mirrlees (1971), Stiglitz & Dasgupta (1971) and Walker (1981).

¹⁷See Boadway *et al.* (1989).

compensating contribution is typically not fully crowded out. Also we do not impose a balanced budget, as not all cartel profits need to be contributed to the public good. Our model furthermore has only one public good and includes a third, composite commodity, so that consumers can substitute away from the cartellized product and mitigate the damage.

Closest to our application, the public goods model with private contributions has been used to study the extent to which corporate social responsibility may contribute to public interests. Bagnoli & Watts (2003) shows that firm contributions to a public good when consumers are socially responsible vary across market structures. Besley & Ghatak (2007) finds that corporate social responsibility does not improve upon private voluntary contributions. Kotchen (2006) confirms that in ‘green markets’, which offer bundled private and public goods, company contributions to more sustainable production are often neutralized by reduced consumer donations. In sufficiently large economies can green technology increase the general level of provision, despite crowding out all private provision of the associated environmental public good.

The remainder of the paper is organized as follows. Section 2 details the policy. In Section 3 we formalize the trade-off involved in compensating consumers for price increases in the private good industry by firm-provided public goods to study the extent to which it can contribute to welfare. In Section 4 we examine sustainability for constant elasticity of substitution utility functions. In Section 5 we discuss alternative welfare measures to the policy. Section 6 concludes on some policy implications and extensions. Derivations are provided in the appendix.

2 The Public Interest-Defense Policy

The keystone for the public interest-defense policy is in the European Treaty provision under paragraph 3 of Article 101 TFEU that the prohibition of all agreements between firms which have as their object or effect the prevention, restriction or distortion of competition within the internal market, may be declared inapplicable if such an agreement: "...contributes to improving the production or distribution of goods or to promoting technical or economic progress, while allowing consumers a fair share of the resulting benefit." In essence, the policy stretches the efficiency gains here intended by the drafters to include the advance of wider public interest such as more sustainable production.

The conditions to qualify for a cartel exemption under Article 101(3) are that: (i) the benefits must be objective and clearly visible; (ii) the restrictions must be indispensable to obtain the benefits; (iii) consumers must receive a fair share of the resulting benefits, and (iv) competition in the market in question should not be fully eliminated. In principle all four conditions would need to be fulfilled to mount a successful public interest-defense. However, in practice there is no clarity on what exactly constitutes sufficient residual competition and so condition (iv) is hardly enforced.

The European Commission’s guidelines explain to condition (iii) that allowing ‘consumers a fair share’ means that the benefits of the agreement are passed on, so that: "the net effect of the agreement

must *at least be neutral* from the point of view of those consumers directly or indirectly affected by the agreement."¹⁸ On the basis of case law, it is further clarified that what matters is: "the overall impact on *consumers of the products within the relevant market* and not the impact on individual members of this group of consumers."¹⁹ The grounds for the latter are in the ruling of the Court of First Instance in *Shaw* that in assessing compensation (in that case of a group of vertically tied lessees): "it is not material that the benefits produced by the notified agreements do not entirely compensate the price differential suffered by a particular tied lessee if *the average lessee* does enjoy that compensation and it is therefore such as to produce an effect on the market generally."²⁰

Even though *Shaw* is not a horizontal case, the European Court of Justice seems to have confirmed that the Pareto-criterion that each and every individual consumer in the relevant market would minimally made indifferent does not apply in *Asnef-Equifax*.²¹ Note that this widens the space for the policy considerably, as it avoids that a single individual with no willingness to pay for the public good can block any initiative. Yet of course, assessing on the basis of 'the average consumer' implies interpersonal utility comparisons, which require a cardinal utility measure. This means that there is no unambiguous welfare measure to implement the policy. Differently put, government has wide discretion to implement the policy where it sees fit, simply by choosing a suitable set of welfare weights.

3 Public Goods Provision by a Private Cartel

Consider an economy with n individuals $i = 1, \dots, n$, who each spend their income between consuming a private good x that is produced by an industry that is considered for a public interest-cartel exemption, a composite commodity y that represents all other consumption of goods supplied on markets that remain unchanged, and making a private contribution g_i to the total public good

$$G = \sum_{i=1}^n g_i + g_N + g_F, \quad (1)$$

in which $g_N \geq 0$ is the initial provision of the public good by nature and $g_F \geq 0$ is a firm contribution. If the public good is clean air, $g_i \geq 0$ can be investments in the installation of solar panels, for example, soot filters on cars or a more sustainable consumption pattern. In the following, we denote by G_{-i} the amount of public good contributions by other individuals than individual i . We abstract from simple direct volume reduction effects from collusive price increases of consumption goods that generate negative (production) externalities, so that the public interest is measured entirely by G and

¹⁸European Commission (2004), recital 85.

¹⁹European Commission (2004), recital 87.

²⁰Case T-131/99, *Shaw*, 21 March 2002, recital 163.

²¹Case C-238/05, *Asnef-Equifax*, 23 November 2006, recitals 68-70.

volume effects from the cartel price increase do not themselves serve a public interest.²²

Individual i 's preferences are represented by utility function $U_i(x_i, y_i, G)$, which is twice continuously differentiable and increasing in each argument, with marginal utilities of consumption being positive and decreasing in each argument, so that all individuals consume a positive amount of all goods.²³ We assume a minimal degree of substitutability between the three goods in the economy. Pricing are normalized as $(p_x, 1, p_g)$, in which p_g can be thought of as the cost of producing the public good from contributions. Individual i decides on how to optimally allocate his wealth endowment w_i over private consumption and contributing to the public good as follows:

$$\max_{g_i, x_i, y_i} U_i(x_i, y_i, G),$$

$$s.t. p_x x_i + y_i + p_g g_i \leq w_i,$$

$$g_i \geq 0.$$

Note that if left unconstrained, the optimal individual contribution to the public good may well be zero or negative, in particular when there is already a high initial provision of the public good by nature. If the air was pure and pollution-free, it would be unlikely that people invested into making it even cleaner. Similarly, low wealth endowments or a low preference for the public good can prevent individuals from spending their own resources on it. However, substantial individual diminutions of the public good are not natural to our concerns. While, for example, individual consumers may, in the knowledge that others invest in clean air, relax their own emissions, such compensations do not convert obviously into cash.

The socially optimal total level of public good satisfies the Samuelson condition, which relative to the privately produced good x is that

$$\sum_{i=1}^n \frac{\partial U_i(\cdot)}{\partial G} / \frac{\partial U_i(\cdot)}{\partial x_i} = \frac{p_g}{p_x}. \quad (2)$$

It is denoted by G^S .

²²Note that it may as well be that the production of substitutes to the cartelized good, i.e. of products in y_i , has offsetting negative externalities that we also ignore with this assumption.

²³For analytical convenience, it is assumed that U_i satisfies: $\lim_{z \rightarrow 0+} \frac{\partial U_i}{\partial z_i} = \infty$ and $\lim_{z \rightarrow \infty} \frac{\partial U_i}{\partial z_i} = 0$ for all $z \in \{G, x, y\}$. Note that while these assumptions on preferences ensure that $x_i > 0$ and $y_i > 0$ in the optimum, it may still be optimal for the consumer to want to purchase negative amounts of the public good if his total public goods consumption remains positive thanks to contributions from other sources. For this reason, it is assumed that $g_i \geq 0$. It is often binding amounting to important corner solutions.

3.1 Competitive Equilibrium

In the competitive benchmark equilibrium, a large number of identical firms produce the private good x at zero economic profits. Naturally $g_F = 0$, as the firms will not voluntarily contribute. Let individual i 's optimal purchase bundle be (x_i^*, y_i^*, g_i^*) , and so $G^* = \sum_{i=1}^n g_i^* + g_N$. Note that while individuals are price takers, they do react to each others' behavior through the public good. When $g_i^* > 0$, individual i is a contributor. Otherwise, he is a non-contributor with $g_i^* = 0$. Someone is more likely to be a contributor if his wealth is sufficiently high, public good contributions from other sources are low, if he values the public good more compared to the other goods, or if the prices of the other goods are high.

Assuming that all the goods are normal goods and that there is a single-valued demand function for the public good, everybody taking the contributions of others as given, there exists a competitive Nash equilibrium with a unique quantity of the public good and unique sets of contributors and non-contributors.²⁴ The structure of the utility functions assures that if $g_N = 0$ and there is no provision by firms either, at least some consumers will purchase the public good. In fact, if $G = 0$, every consumer has an incentive to contribute. For positive initial levels of g_N it can be that no individual privately contributes. In competitive equilibrium there is classic under-provision of the public good.²⁵

Individual i 's indirect utility is

$$V_i^*(p_x, p_g, W, g_N) = U_i \left(\frac{w_i - y_i^*(\cdot) - p_g g_i^*(\cdot)}{p_x}, y_i^*(\cdot), g_i^*(\cdot) + G_{-i}^*(\cdot) + g_N \right),$$

in which W is a vector of the wealths of all consumers, which are all relevant through the determination of G^* .

3.2 Collusive Provision of the Public Good

The public-interest justification for a cartel offense amounts to allowing the industry a price increase $p_x^c > p_x$, in exchange for the industry contributing to the public good, $g_F > 0$.²⁶ Each policy option

²⁴The equilibrium existence and uniqueness proof is analogous to that in Bergstrom *et al.* (1986), with the only additional aspect being the composite commodity y_i , which does not affect the proof materially. Apart from the inequality constraint for private contributions to the public good, each consumer's optimization problem is a standard demand problem with income $w_i + G_{-i}$. Denoting $f_i(w)$ individual i 's demand function for the public good and assuming it is single-valued, individual i 's contribution becomes $g_i = \max\{f_i(w_i + G_{-i}) - G_{-i}, 0\}$, by the inequality constraint. This is a continuous function from a compact and convex set on itself, so that existence of a Nash equilibrium follows from Brouwer's Fixed Point Theorem. The proof of uniqueness is more complex and follows Bergstrom *et al.* (1986) verbatim, with an additional sufficient assumption that the marginal propensity to consume the public good is a differentiable function of wealth satisfying $0 < f_i'(w) < 1$ for all $i = 1, \dots, n$. In the model in Section 4, existence and uniqueness of equilibrium is proven by construction directly, allowing also for a higher marginal propensity to consume the public good.

²⁵See Bergstrom *et al.* (1986).

²⁶Note that if the cartel would apply nonlinear pricing, the fixed price components would be comparable to lump sum taxation, while also demanding compensation as a cartel damage. Since the neutrality result of Bergstrom *et al.* (1986)

has a unique Nash equilibrium: $(p_x, g_F = 0)$ versus $(p_x^c > p_x, g_F > 0)$. Partial equilibrium comparative statics captures the main effects at play in the public interest-defense. With respect to the composite commodity and the cost of producing the public good, ignoring general equilibrium price effects can be interpreted as the market for the private good being small relative to the rest of the economy. For the relevant market of the private good, it is less innocuous. In particular would the decrease in the demand for the private good resulting from the cartel price increase in general equilibrium decrease p_x , so that it depends on the model specifications whether the net effect on the price of the private good will indeed be positive, and compensation be required. This demand effect is second-order, however, and counteracted by the crowding-out effect.

Typically, a cartel will raise prices above competitive levels, with various effects identified below. As we seek to characterize a consumer welfare status quo, we need not account for any surplus cartel profit net of compensation. Also note that the agreement would be legal if exempted, so that it is contractable with side-payments and we can ignore issues of cartel stability.

In principle, cartel provision of the public good has the potential to improve upon the under-provision in competitive equilibrium and compensate the price increase. The extent to which it can depends on the interplay of several effects. In response to the cartel price increase of x , three things will happen. First, consumers will substitute away from the cartelized private good, either to the composite commodity or by making a larger public good donation, or both. These substitution effects mitigate their individual harm from the price increase directly, and larger contributions to the public good also benefit others. Second, the increase in p_x has negative real income effects, which reduce the consumption of x , y and g , which are all assumed to be normal goods.

Third, there may be crowding out effects with contributors, as increases in G_{-i} may induce lower own contributions, including to stop contributing at all. Non-contributors enjoy the increased level of public good provided, and in border cases can be induced by the increase in p_x to start purchasing the public good. Generally, however, the substitution effect towards the public good are at least partially offset by the income and crowding out effects. In addition, the industry's compensation contribution $g_F > 0$ will further crowd out private contributions to the public good and increase the demand for the private and composite commodity in the collusive equilibrium.

Figure 1 illustrates the concept of ‘compensating public good’, which essentially is a compensating variation delivered in the form of a public good, in (x_i, G) -space. Individual i consumes at (x_i^0, G^0) in competitive equilibrium, contributing to the public good. The price rise from p_x to p_x^c turns the budget equation, making the individual worse off at (x_i^1, G^1) . With the wealth transfer g_F , he is brought back to his original utility level at (x_i^2, G^2) under the collusive price. $G^2 - G^1$ being smaller than g_F reflects partial crowding-out.

applies to the fixed fee part, so that compensation is ever more expensive, it is unlikely that a cartel would opt for nonlinear cartel pricing in the context of a public interest-defense.

Figure 1: Compensating public good.

On balance, the net utility change for individual i from allowing a public-interest cartel is

$$\Delta U_i = V_i^*(p_x^c, p_g, W, g_N + g_F) - V_i^*(p_x, p_g, W, g_N), \quad (3)$$

which increases in g_F .

Interpreting the compensation requirement to mean that the consumers of the private good are to be compensated on average, and assuming a cardinal comparison possible by the weighted sum of individual utilities, using weight α_i for the utility of individual i - or its type - as a welfare function, the cartel is to ensure that

$$\Delta SW = \sum_{i=1}^n \alpha_i \Delta U_i \geq 0. \quad (4)$$

Obviously, different weights and different utility functions amount to interchangeable variations in social welfare. In linear approximation, condition (4) is

$$-(p_x^c - p_x) \sum_{i=1}^n \alpha_i \frac{\partial U_i(x_i^*(.), y_i^*(.), G^*(.))}{\partial p_x} \leq g_F \sum_{i=1}^n \alpha_i \frac{\partial U_i(x_i^*(.), y_i^*(.), G^*(.))}{\partial g_F}, \quad (5)$$

since all consumers consume a positive amount of the cartellized good.²⁷

Firms have no incentive to contribute more than minimally required and so seek to establish condition (4)–(5) with equality, if at all. Let the minimally required compensating level of firm public good contribution be $\hat{g}_F$. The competition authority should only accept the public interest-defense if the level of the public good actually provided by the cartel is at least $\hat{g}_F$. To make this kind of complex assessment requires of lot of the competition authority, including perfect information of preferences and perfect monitoring of firm behavior.

In the remainder of this section we study to what extent the policy can contribute to welfare, which turns out to depend crucially on whether or not there are private contributions to the public good. In Section 3.2.1 we analyze an economy with no private contributors to the public good. In Section 3.2.2 we consider economies in which at least one individual is a contributor. For analytical convenience, we assume that the set of contributors is invariant across the policies.

3.2.1 An Economy with No Contributors

If g_N is sufficiently high, no individual contributes to the public good in either of the periods and $g_i^*(\cdot) = \frac{\partial g_i^*(\cdot)}{\partial p_x} = \frac{\partial G_{-i}^*(\cdot)}{\partial p_x} = 0$. The equilibrium purchases of each consumer depend only on own wealth and prices of the private good and the composite commodity. The indirect utility function becomes $V_i^*(p_x, p_g, w_i, g_N + g_F)$, since only nature and the firms provide the public good. The collusive increase in p_x causes individual i a marginal harm of

$$\frac{\partial U_i(x_i^*(\cdot), y_i^*(\cdot), G^*(\cdot))}{\partial p_x} = -\frac{\partial U_i(x_i, y_i, G)}{\partial x_i} \frac{\left(\frac{\partial y_i^*(\cdot)}{\partial p_x} p_x + w_i - y_i^*(\cdot)\right)}{p_x^2} + \frac{\partial U_i(x_i, y_i, G)}{\partial y_i} \frac{\partial y_i^*(\cdot)}{\partial p_x}. \quad (6)$$

The cartel damage is expressed in the first right-hand term, through the consumption of x , mitigated by consumption of y and further substitution towards the composite commodity in the second term. The utility losses will be distributed unevenly. Unsurprisingly, those who like the private good the most will suffer the highest utility decline. Also wealthy consumers are hurt more.

Compensation condition approximation (5) for a discrete price change for which all individuals remain non-contributors becomes

$$(p_x^c - p_x) \sum_{i=1}^n \alpha_i \left(\frac{\partial U_i(x_i, y_i, G)}{\partial x_i} \frac{\left(\frac{\partial y_i^*(\cdot)}{\partial p_x} p_x + w_i - y_i^*(\cdot)\right)}{p_x^2} - \frac{\partial U_i(x_i, y_i, G)}{\partial y_i} \frac{\partial y_i^*(\cdot)}{\partial p_x} \right)$$

²⁷Note that while the term $\frac{\partial U_i(x_i^*(\cdot), y_i^*(\cdot), G^*(\cdot))}{\partial p_x}$ in (5) generally will be negative, it may be positive for individuals who care little for the private consumption good, yet benefit from other people's substitution effects toward the public good.

$$\leq g_F \sum_{i=1}^n \alpha_i \frac{\partial U_i(x_i, y_i, G)}{\partial G}, \quad (7)$$

which holding with equality implicitly defines $\hat{g}_F > 0$.

Note that while it may appear that in an economy with only non-contributors there is no willingness to pay for more public good than the status quo, this need not be so. There is under-provision in the competitive no-contributors equilibrium that may well be improved upon by coordination. If a sufficiently large proportion of individuals has a high enough willingness to pay for the public good, even though too low to privately contribute, consumers can be compensated on average. However, a private cartel is not well incentivized to provide public goods optimally, as the following result illustrates.

Proposition 1. *In a no-contributors economy, $\hat{g}_F$ decreases in $\frac{\partial U_i(\cdot)}{\partial G}$ for all $i = 1, \dots, n$.*

Proof. By assumption, marginal utility of the public good $\frac{\partial U_i(x_i^*(\cdot), y_i^*(\cdot), G^*(\cdot))}{\partial g_F} = \frac{\partial U_i(x_i, y_i, G)}{\partial G}$ is decreasing for each individual. In a no private contributors economy, there are no substitution effects of the firms' provision of the public good. As a result, an increase in an individual marginal willingness to pay for G on the full range of U_i amounts to higher utility gain from each additional unit of g_F provided by the firms, thus lowering the compensating level of public good for individual i and the average compensation $\hat{g}_F$. ■

The policy goes against the Samuelson condition: rather than increasing the level of the public good when there is a higher marginal willingness to pay for it, a cartel will only need to invest less in compensating public good. The reason is that for the same price rise, consumers are compensated on average with a lower amount of public good if one or more of them value the public good more. The cartel will only produce the bare minimum of compensation required.

It nevertheless may be possible to find social welfare weights $(\alpha_1, \dots, \alpha_n)$ such that $\hat{g}_F$ by compensation requirement (7) implements the Samuelson condition (2) for a given price increase p_x^c . Such weights exist by the fundamental theorem of algebra, and in real non-negative numbers for a subset of utility functions. Government can therefore make the policy work for no-contributors economies by a suitable choice of welfare function, provided it has perfect information.

3.2.2 An Economy with Contributors

In an economy with at least one contributor, a willingness to pay for the public good is revealed. The change in a contributing consumer i 's equilibrium utility brought about by a small increment in p_x then becomes

$$\begin{aligned} \frac{\partial U_i(x_i^*(.), y_i^*(.), G^*(.))}{\partial p_x} &= \frac{\partial U_i(x_i, y_i, G)}{\partial x_i} \frac{-1}{p_x^2} \left(\left(\frac{\partial y_i^*(.)}{\partial p_x} + p_g \frac{\partial g_i^*(.)}{\partial p_x} \right) p_x + w_i - y_i^*(.) - p_g g_i^*(.) \right) + \\ &\quad \frac{\partial U_i(x_i, y_i, G)}{\partial y_i} * \frac{\partial y_i^*(.)}{\partial p_x} + \frac{\partial U_i(x_i, y_i, G)}{\partial G} \left(\frac{\partial g_i^*(.)}{\partial p_x} + \frac{\partial G_{-i}^*(.)}{\partial p_x} \right). \end{aligned} \quad (8)$$

Individual i 's marginal equilibrium utility gain from firm provision of the public good is

$$\begin{aligned} \frac{\partial U_i(x_i^*(.), y_i^*(.), G^*(.))}{\partial g_F} &= \frac{\partial U_i(x_i, y_i, G)}{\partial G} \left(\frac{\partial g_i^*(.)}{\partial g_F} + \frac{\partial G_{-i}^*(.)}{\partial g_F} \right) + \\ &+ \frac{\partial U_i(x_i, y_i, G)}{\partial x_i} \frac{1}{p_x} \left(-\frac{\partial y_i^*(.)}{\partial g_F} - p_g \frac{\partial g_i^*(.)}{\partial g_F} \right) + \frac{\partial U_i(x_i, y_i, G)}{\partial y_i} * \frac{\partial y_i^*(.)}{\partial g_F}, \end{aligned} \quad (9)$$

where the set of arguments $(.)$ are the terms exogenous to the individual, i.e. $(p_x, p_g, W, g_N + g_F)$. Substituting (8) and (9) into (5) holding with equality implicitly defines $\hat{g}_F > 0$.

It should be more easy to compensate individuals that are already contributing to the public good. In fact, some individuals may actually gain utility when p_x increases, from increases in the public good contributions by others as they substitute away from x . This is reflected in the term $\frac{\partial G_{-i}^*(.)}{\partial p_x}$ in (8), which is non-negative and effectively represents a mitigation of consumers' harm. Since the increase in $p_x^c > p_x$ and $\hat{g}_F > 0$ occur simultaneously, some individuals may benefit from both.

However, there will always be contributing consumers in the economy harmed by the price increase as well. In addition, among contributors the term $\frac{\partial G_{-i}^*(.)}{\partial g_F}$ in (9) is non-positive, so that there is crowding out of their private contributions by the cartel provision. Some contributors may become non-contributors in response to the cartel's contribution. The crowding out need not be complete, however, and the marginal benefit from the cartel's public good provision is always positive.

With at least one individual contributing privately to the public good, the policy need no longer always be contrary to the Samuelson condition. It may be that $\hat{g}_F$ increases in one or more individuals' marginal willingness to pay for the public good. Suppose for example that a contributor's willingness to pay for the public good goes up, which makes her contribute more, thus increasing G . This will generally lower the marginal utility of the public good to others, who will therefore substitute towards the private goods and thus may require more compensating public good for any cartel price increase. The policy can, however, never be socially optimal, as the following result reveals.

Proposition 2. *In an economy with at least one contributor, the public interest-defense policy can never implement G^S .*

Proof. For contributor j , the first-order conditions require that

$$\frac{\partial U_j(.)}{\partial G} / \frac{\partial U_j(.)}{\partial x_j} = \frac{p_g}{p_x},$$

be satisfied with equality, since the contribution condition $g_j \geq 0$ is not binding. Since $\frac{\partial U_i(.)}{\partial G} / \frac{\partial U_i(.)}{\partial x_i} \neq 0$ for every $i = 1, \dots, n$, the presence of only one contributor in the economy already implies that the Samuelson condition (2) is violated. ■

The public-interest defense cannot implement the Samuelson condition in economies with contributors, because of private substitution effects. Even though the overall level of public good in the economy is increasing in g_F , no matter how high $\hat{g}_F$ is, a contributor will always substitute away from the public good in a manner that prevents achieving the first-best. To contributors, the firms' provision is a mere wealth injection, which moves out the social optimum and makes it unattainable by collusion. The highest possible improvement of welfare in a contributor economy is attained by requiring the cartel to spend all of its cartel profits (or more) on the public good, yet there is no guarantee that this is sufficient to compensate consumers. Government can still engineer a socially optimal cartel by first increasing g_N to push the economy into no-contributors equilibrium, and subsequently set welfare weights that require the cartel to contribute up to G^S .

3.3 Sustainability of a Compensating Cartel

While it may be possible to compensate consumers for a cartel price rise through public good provision, it is not obvious that the required compensation can be paid for out of the cartel proceeds. Note that the individuals that are hardest to compensate with public good need not be the ones who suffered the most harm by the price increase. There may well be consumers that derive too little utility from G to be compensated effectively, even if they have not suffered much damage from the price increase at all. In this respect, public good compensation is very different from monetary compensation, which will never need to go beyond making the old bundle affordable again. On compensation via a public interest, there is no effective upper limit. The public interest compensation scheme thus proves to be potentially costly, quite possibly too costly to be financed from the cartel price overcharge on the private good.

In order for the compensation scheme to be incentive compatible for the cartel, each firm's costs of contributing to the public good cannot exceed the extra profits it yields by the higher price. Assuming that the colluding firms have efficient means of splitting the cost of producing $\hat{g}_F$, the industry's sustainability condition is

$$p_g \hat{g}_F \leq \Pi(p_x^c, p_y, W, g_N + \hat{g}_F) - \Pi(p_x, p_y, W, g_N), \quad (10)$$

where $\Pi(.)$ are the joint profits of firms engaged in the collusive agreement and paying for the public

good.²⁸ The cartel prefers condition (10) to hold with the strictest possible inequality, but cartel profits may be constrained by residual competition.²⁹

For a public interest defense to be possible, conditions (4) and (10) need to be satisfied simultaneously. The following characteristic of the policy works against sustainability.

Proposition 3. *In equilibrium, $\frac{\partial U_i(\cdot)}{\partial G}$ is nonincreasing in x_i for all $i = 1, \dots, n$.*

Proof. Rewriting individual utility as

$$U_i(x_i, y_i, G) = U_i\left(\frac{w_i - y_i - p_g g_i}{p_x}, y_i, g_i + G_{-i} + g_N\right),$$

the first-order condition readily becomes

$$\frac{\partial U_i(\cdot)}{\partial G} \left(1 + \frac{dG_{-i}^e}{dg_i}\right) - \frac{\partial U_i(\cdot)}{\partial x_i} \frac{p_g}{p_x} = 0,$$

in which conjectural variation $\frac{dG_{-i}^e}{dg_i}$ is individual i 's expectation about the change in the contribution to the public good purchases by other sources as a consequence of the change in the size of his own contribution. In a Nash equilibrium, $\frac{dG_{-i}^e}{dg_i} = 0$ for all $i = 1, \dots, n$, so that the second first-order condition reduces to

$$\frac{\partial U_i(\cdot)}{\partial G} = \frac{\partial U_i(\cdot)}{\partial x_i} \frac{p_g}{p_x}$$

for nonzero levels of individual's public good contributions, irrespective of the level of p_x . Marginal utility $\frac{\partial U_i(\cdot)}{\partial x_i}$ is positive and decreasing x_i and therefore so is $\frac{\partial U_i(\cdot)}{\partial G}$, the marginal willingness to pay for the public good, for given prices. If an individual's marginal willingness to pay for the public good is nonpositive in equilibrium, so that he is a non-contributor, small changes in his consumption of x will not make it positive. ■

The policy is orthogonal to Lindahl-pricing: rather than individuals contributing to the public good according to their willingness to pay, those who have a low marginal willingness to pay for the public

²⁸Alternatively, we may ask if the cartel is able to pay for the required public good provision out of its price overcharge, that is whether $p_g \hat{g}_F \leq (p_x^c - p_x) \sum_{i=1}^n x_i^c$, in which x_i^c is the level of consumption of the private good under the cartel regime. This is equivalent to condition (10) in the case of perfect competition at constant marginal costs considered in Section 4. Holding with equality, this formulation is analogous to the balanced budget requirement in the taxation literature.

²⁹As explained in Section 2, sufficient residual competition in the market remaining is formally a requirement for obtaining a cartel exemption, but in practice it appears not to have been required directly on the cartellized product market. Due to the partial equilibrium nature of the analysis, we ignore welfare effects from any surplus cartel profits net of compensation that would be distributed over individuals in the economy. As long as this reallocation does not change the total wealth of contributors, as it does not in no-contributors and all-contributors economies, by Bergstrom *et al.* (1986) surplus cartel profits do not affect the total level of public goods in equilibrium. Obviously, deadweight losses increase with cartel profits.

good are targeted to pay most. The reason is that the public good is financed through raising the price of the private good x , which is consumed most by individuals with a relatively low willingness to pay for G . In *Chicken of Tomorrow*, the consumers of cheap chicken meat have already revealed not to care much for chicken welfare. It is vegetarians who are most likely to have the highest willingness to pay for more animal friendly broiling. In the matter of the coal burning electricity plants, households that already purposely buy wind or solar power are particularly willing to pay for a reduction in CO₂ emissions, not grey electricity users. The cartel thus has to compensate those individuals with the lowest willingness to pay most, which is expensive.

In addition, a relative preference for the private good over the public good manifests itself in a lot of private good consumption and little private contribution to the public good. Those individuals who consume a large amount of the private good thus have a large exposure to damage from even a small cartel price increase. They value the public good relatively little and also have low mitigating substitution towards the rest of the economy. To the extent that they did contribute to the public good in the competitive equilibrium, they will respond with relatively large reductions, crowding out the compensation.

Note also that in no-contributors economies $\hat{g}_F$ generally increases in g_N . A higher level of the initial provision of the public good implies a lower marginal willingness to pay for the public goods for each individual, as consumers cannot substitute away from it. Utility loss from the cartel price increase, however, is unaffected by the level of g_N . As a result, each unit of g_F provided by the firms compensates consumers less than it would with less g_N in the economy, so that more compensation is required.

These policy characteristics together make that the industry may not be able to afford the required compensation: if the cartel attempted to increase revenues in order to pay for its compensation requirement with higher prices, an even larger compensating contribution would be required. Whether or not the public interest-defense can nevertheless be sustainable turns out to be case specific. In the next section we analyze a common preference structure and show that while there exist economies in which sustainable public interest defenses exist, they are a small and special subset of all economies.

4 Sustainable Public Interest-Defenses

Suppose preferences can be represented by well-behaved constant elasticity of substitution utility functions, that is, let the preferences of individual i be represented by

$$U_i = a_i \frac{G^{1-\theta}}{1-\theta} + b_i \frac{x_i^{1-\theta}}{1-\theta} + c_i \frac{y_i^{1-\theta}}{1-\theta}, \quad (11)$$

in which (a_i, b_i, c_i) are positive parameters expressing relative preferences for the public good, the private good x_i and the composite commodity y_i , and $\theta = 1/\rho \in (0, 1)$, satisfying the general

conditions imposed in the previous section. All individuals are consumers in the relevant market. Consumer i is a contributor to be public good if and only if

$$w_i > \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right) (G_{-i} + g_N), \quad (12)$$

and $g_i = 0$ otherwise. Note that a wealthy enough individual will contribute to the public good, and at lower wealth levels if a_i is high and g_N is low.

The optimal level of public good for this economy is

$$G^S = \left(\frac{p_x^c}{p_g} \sum_{i=1}^n \frac{a_i}{b_i} \left(\frac{w_i}{p_x^c + \left(\frac{c_i p_x^c}{b_i} \right)^\rho} \right)^\theta \right)^\rho, \quad (13)$$

which increases in each individuals' marginal willingness to pay for the public good a_i .

Firms produce good x at constant marginal costs c , so that $p_x = c$. Denoting market demand for good x at price p_x as $D_x(p_x)$, under the weighted average compensation requirement to produce $\hat{g}_F$, collusion is profitable for the industry only if

$$\Pi = (p_x^c - c) D_x(p_x^c, \hat{g}_F) - p_g \hat{g}_F(p_x^c, c) \geq 0, \quad (14)$$

where the demand at price p_x^c naturally depends also on $\hat{g}_F$ as it enters the consumer's optimization problem.

Figure 2 illustrates the problem of sustainability with the public interest-defense policy when there are two types of individuals.³⁰ On the horizontal axis increases the cartel price from the competitive level $p_x = c = 1$. The vertical axis displays public good contributions, as well as cartel profits. The triangulated lines show both types' private contributions to the public good in the absence of compensation, the circled lines when the cartel compensates. The upper two lines belong to type 1, who values both the private and the public good more than individual type 2 does, with a relatively larger increased valuation of the private good. When the price of the private good increases, individual type 1 substitutes towards public good contributions to such an extent that he induces type 2's to lower their contributions somewhat.

The dashed line shows $\hat{g}_F$ for each cartel price increase. Allowing a cartel with a compensation requirement leads both types to reduce their own voluntary contributions in response, on the balance of a substitution effect from the private good to the public good and the composite commodity, and a negative income effect from the cartel price rise, plus a crowding out effect from the cartel provided public good contribution. While both types just remain net contributors for the cartel prices displayed, they each reduce their private contributions steeply, in particular individual type 2 that likes the private

³⁰Parameter values are: $\alpha_1 = \alpha_2 = 1$; $(a_1, b_1, c_1) = (8, 10, 1)$; $(a_2, b_2, c_2) = (1, 1, 1)$; $\theta = \frac{1}{3}$; $(w_1, w_2) = (10, 10)$; $g_N = 2$; $(p_x = c, p_y, p_g) = (1, 1, 1)$.

Figure 2: No sustainable public interest-defense.

good more. Eventually, types 2 will become non-contributors. Industry profit is given by the lower solid line: no price rise exists for which the cartel can actually afford the compensating public good level required. Even though all consumers have a revealed willingness to pay for the public good, no sustainable public interest-defense can be mounted.

The example captures that the policy targets consumers with a high consumption of the private good, whom are damaged a lot by the cartel price rise, to pay for the public good, for which they have a relatively low preference, while the cartel provision crowds out private contributions in addition. Yet, there are specifications for which the cartel profit is positive for some price range and identifies, since Π is concave for constant elasticity of substitution-type demands, a unique viable optimal cartel strategy under the compensation requirement.³¹ In the following, we study the set of parameters for which a sustainable public interest-defense is possible. Section 4.1 considers the case without private contributions to the public good. In Section 4.2 there are private contributions.

4.1 No-contributors Economy

Suppose condition (12) is not satisfied for any individual i , so that $g_i = 0$ for all i and only $G = g_N + g_F$ enters into every individual's utility. The compensating amount of public good $\hat{g}_F$ for this economy

³¹In the example in Figure 2, if we lower $g_N = 0.2$ and $b_1 = 8.5$, there is just a positive profit maximum at price $p_x = 1.034$ - while both types stay contributors.

decreases in consumers' relative preference for the public good (a_i), in accordance with Proposition 1.³² With both $D_x(p_x^c, \hat{g}_F)$ and $p_g \hat{g}_F$ fully characterized, using the fact that locally $p_g \hat{g}_F|_{p_x^c=p_x} = 0$, we find that $\frac{\partial \Pi}{\partial p_x^c} \Big|_{p_x^c=c} \geq 0$ for infinitesimal cartel price rises if and only if

$$\sum_{i=1}^n \alpha_i a_i \sum_{i=1}^n \frac{w_i}{c + (\frac{c_i c}{b_i})^\rho} \geq \frac{p_g g_N}{c} \sum_{i=1}^n \alpha_i b_i \left(\frac{w_i}{c + (\frac{c_i c}{b_i})^\rho} \right)^{1-\theta}. \quad (15)$$

If a large proportion of consumers has a strong preference for the public good, that is if a_i is large for sufficiently many (or heavily weighted) individuals, the left hand-side of (15) increases, making compensation more sustainable. The right hand-side increases analogously in b_i . Note also that the right hand-side of (15) increases in both p_g , as producing the public good is more expensive, and g_N , reflecting that the willingness to pay for additional public goods provision decreases in the existing public good level. In fact, if g_N is low enough, it will become possible to sustainably collude and compensate - yet it will also induce individuals to contribute privately for lower wealth levels. In addition, the closer θ is to 0, the less constraining (12) is, reflecting that utility becomes near linear in all goods.

Figure 3 shows the space for a sustainable public-interest defense for a no-contributors economy with two types.³³ Type 1's preferences for the public and the private good are varied, relative to a fixed non-contributing type 2, at I2. The cartel marginally increases the price from $p_x = c$. The dashed line marks the preferences for which type 1 will remain a non-contributor too. The solid line depicts sustainability condition (15). Together, the two lines mark a bandwidth in which the ratio of a_1 to b_1 should stay for a public-interest defense to be sustainable in this economy. That is, type 1's preference weights for the public and the private good should jointly increase and not diverge much. While possibilities for compensation requires a sufficiently high value of a_1 , relative to b_1 , a_1 should not become too high, or type 1 becomes a contributor. If, on the other hand, b_1 increases above the solid line, type 1 likes the private good so much, the cartel cannot profitably compensate him.

The specific shape and location of the space of $\frac{a_1}{b_1}$ values for which a public interest-defense is sustainable depends on all other parameters of the economy. The higher g_N , for example, the more both the sustainability and the type 1 contributor boundary move to the right, leaving more or less the same space for aligned preferences. The example is non-specific however: generally the relative preferences for the private and public good should stay within narrow bounds.

As noted, the policy could be socially engineered in this economy to be first-best by choosing the individual welfare weights appropriately. For example, with preferences of both types in the sustainable public interest-defense space, for a discrete price increase from one to two, the cartel is made to compensate to the socially optimal public good level if individual type 1 has a weight roughly

³²The expression for $\hat{g}_F$ is equation (19) in the appendix, which also serves as an illustration of Proposition 1.

³³Parameter values are: $\alpha_1 = \alpha_2$; $c_1 = 1$; $(a_2, b_2, c_2) = (1, 1, 1)$; $\theta = \frac{1}{3}$; $(w_1, w_2) = (10, 10)$; $g_N = 10$; $(p_x, p_y, p_g) = (1, 1, 1)$.

Figure 3: Sustainable public interest-defense space in a no-contributors economy.

two-and-a-half times that of type 2. The cartel contributes in that case almost three times the natural public goods level.³⁴

4.2 Contributor Economies

In an economy in which at least some individuals are private contributors to the public good, the crowding out effect comes into play. Suppose condition (12) is satisfied for all individuals, which is the case if they all have high enough wealth endowments. The level of public good in equilibrium then is proportional to the total value of the endowment in the economy, so that consistent with Bergstrom *et al.* (1986), lump-sum reallocation of wealth have no effect on the total level of public goods in equilibrium. However, the cartel overcharge changes consumption bundles through substitution and income effects, so that crowding out in a contributor economy is not full.

The compensating cartel contribution $\hat{g}_F$ is sustainable in an all-contributor economy for an infinitesimal cartel price rise if and only if

$$\sum_{i,j}^{i \neq j} \left(\alpha_j a_j \left(\frac{b_i}{a_i} \right)^\rho + \alpha_i a_i \left(\frac{b_j}{a_j} \right)^\rho \right) \geq p_g^{\rho-1} \sum_{i,j}^{i \neq j} \frac{\alpha_j a_j - \alpha_i a_i}{a_i^\rho a_j^\rho} ((b_j c_i)^\rho - (b_i c_j)^\rho), \quad (16)$$

³⁴Type 1 is $(a_1, b_1) = (0.5, 1)$. For $p_x^c = 2$, the social welfare weights that implements the Samuelson condition is $(\alpha_1, \alpha_2) = (1, 0.395)$. Relative to $g_N = 10$, the cartel is required to contribute a further $\hat{g}_F \approx 27$.

in which $\sum_{i,j}^{i \neq j}$ is the sum over all unique pairs of two different individuals (i, j) in the total n .³⁵ Since different levels of initial public good are essentially variations in wealth, condition (16) does not depend on g_N .

Sustainability depends critically on the relationships between preferences for the private, the public and the composite commodity. Note that it does not depend on prices, apart from p_g , the price of the public good, for which, since $\rho > 1$, it naturally holds that the more expensive it is to compensate consumers, the harder it is to do so from the cartel proceeds. Given welfare weights, since the left-hand side of (16) is positive and the right-hand side is a subtraction, it can be satisfied for a wide variety of parameter values. What matters is the ‘distance’ in preferences between pairs of individuals, in all three goods. Certainly, supposing all individuals receive the same weight (i.e. if $\alpha_i = \alpha_j$ for all (i, j)), if everybody values the public good equally (i.e. if $a_i = a_j$ for all (i, j)), it will always be possible to compensate all consumers in a contributor economy profitably. The same is true if all individuals value both the public good and the composite commodity equally (i.e. if $b_i = b_j$ and $c_i = c_j$ for all (i, j)). In both cases, the right-hand side of (16) is zero.

Around these limit identity cases is a range of different preference structures for which compensation is possible as well, as long as consumers are sufficiently homogeneous in their valuation of the three goods in society. If the values of a_i are far apart between pairs of individuals, the right-hand side of (16) will be larger and compensation not sustainable, unless the combined preferences for the private goods x and y are very close, so that the last part of the right hand-side of the condition goes to zero. The cross-multiplications of b_i and c_j reflect the fact that cartel damage is mitigated by substitution towards the composite commodity when p_x rises.

Figure 4 is an all-contributors economy with two types, induced by a lower level of g_N in otherwise the same example as above.³⁶ In the region in which both types contribute, between the dashed lines, the ratio $\frac{a_1}{b_1}$ stays relatively constant. Given that $\frac{a_2}{b_2} = 1$, if individuals are more different than quite alike in their preferences, it will not be possible to mount a sustainable public interest-defense. In the upper-left region, type 1 has insufficient liking of the public good to contribute, whereas in the lower-right region his contribution is so large that it crowds out type 2’s. Compensation is sustainable within the region between the solid lines, by which (a_1, b_1) are bounded away from zero and cannot be too high. Compensation is in principle possible close to the vertical axis, as long as type 1 is sufficiently wealthy, where the cartel would make sufficient profit on his large consumption of the private good. To the lower-right, type 1 likes the public good enough to be easy to compensate. The upper-limit on sustainability bounds the parameter space in which compensation is sustainable in an all-contributors economy, relative to the importance of the rest of the economy.

The higher g_N , the wider the bandwidth within which consumers are (non)contributors, while the sustainability bound remains the same. The location of the sustainability upper-bound depends on

³⁵The expression for $\hat{g}_F$ is equation (20) in the appendix, which also serves as an illustration of Proposition 1.

³⁶Parameter values are: $\alpha_1 = \alpha_2$; $c_1 = 1$; $(a_2, b_2, c_2) = (1, 1, 1)$; $\theta = \frac{1}{3}$; $(w_1, w_2) = (10, 10)$; $g_N = 2$; $(p_x, p_y, p_g) = (1, 1, 1)$.

Figure 4: Sustainable public interest-defense space in an all-contributors economy.

the relative importance of the composite commodity in individual preferences: if the c_i 's are sizable, compared to the private-public good trade-off, the parameter space is bounded as in Figure 4. Certain higher (a_1, b_1) combinations then cannot benefit from mitigating substitution to the composite commodity enough. If the preference for the composite commodity is small to begin with, the sustainability condition need not restrict the absolute values of (a_1, b_1) , as long as their ratio remains within bounds. Even though in an all-contributors economy compensations tend to be cheaper, still in most circumstances no sustainable compensation exists.

For intermediate economies with contributors and non-contributors, conditions are more complex, yet the main intuitions hold. Cartel provision of the public good can alleviate the problem of under-provision in competitive equilibrium and so bring an economy closer to efficient public good levels. This is the case even though consumers decrease their contributions in response to the policy. Hybrid economies in fact combine the presence of a high willingness to pay for the public good in some portion of the population, with non-contributors that aggravate the problem of under-provision. In addition, individual contributions to the public good in an economy in competition are further discouraged by free-riding when the number of individuals is larger. Together with the fact that the cartel provision benefits more people over which the cost of producing the public good can be spread, this widens the space for improvement by the policy.

The exact composition of preferences and wealth endowments, however, remains crucial for the

possibilities to mount a sustainable and effective public-interest defense. Also, the cartel provision, the accompanying increase in the price of the private good, and all responses to it will potentially turn consumers from contributor to non-contributor or vice versa. The finding remains that the existence of a critical mass of consumers who combine a low marginal utility for the public good with high purchases of the private good can easily make an effective public-interest cartel impossible.

5 Alternative Welfare Measures

The construction of a welfare function to comply with the case law that consumers in the same relevant market are compensated is cardinal, as noted. As a result, the policy does not offer an unambiguous welfare standard to guide the agency's balancing exercise. In conditions (15) and (16), the choice of weights in the welfare function α_i directly affects the sustainability condition: it can be possible to weigh certain individuals in such a way that a cartel will not be able to compensate the consumers profitably - and vice versa.³⁷

Alternative norms may allow for a more practical approach. Consumer surplus may seem an empirically viable measure, yet even as an approximation of welfare it is not well-defined, as demand for the public good does not integrate even for standard preferences. Also, while aggregate demand for the private goods is observable, that for the public good is not.

The Pareto criterion certainly is more strict, as a single individual with no willingness to pay for the public good would hold up any possibilities for a public-interest defense. At the same time, it may be easier to assess for a competition agency. Consider an all-contributors economy in which one individual h is the hardest to compensate. The linear approximation of minimal individual-specific level of public good required with general utility functions is

$$-(p_x^c - p_x) \frac{\partial U_h(x_h^*(\cdot), y_h^*(\cdot), G^*(\cdot))}{\partial p_x} = \hat{g}_{F,h} \frac{\partial U_h(x_h^*(\cdot), y_h^*(\cdot), G^*(\cdot))}{\partial g_F}. \quad (17)$$

In the case of constant elasticity of substitution utility functions, the cartel can afford the implied $\hat{g}_{F,h}$ if and only if

$$a_h^\rho \geq p_g^{\rho-1} \left(b_h^\rho \frac{\sum_{i \neq h} \left[\left(\frac{c_i}{a_i} \right)^\rho \right]}{\sum_{i \neq h} \left[\left(\frac{b_i}{a_i} \right)^\rho \right]} - c_h^\rho \right), \quad (18)$$

in which $\sum_{i \neq h}$ is the sum over all individuals other than h . While this condition is considerably simpler than condition (16) and requires no welfare function, still information is needed about the preferences of all consumers to implement it, since all individuals interact through the public good contributions.

³⁷The example of an unsustainable public interest-defense in Figure 2, in which both types have equal weight, becomes sustainable if individual 2 receives a weight in the welfare function that is at least three times higher than the weight of individual 1.

Also note that asking for potential Pareto improvements, for which those who are better off could compensate those who are worse off, as proposed in the Kaldor-Hicks-criteria, is not obvious either. This criterion is less stringent than the Pareto-criterion, but it still requires a full comparative statics analysis. Moreover, in economies with contributors any redistribution of wealth among contributors does not change individual utilities by the neutrality result in Bergstrom *et al.* (1986), and so Kaldor-Hicks compensation offers no solution. In the no-contributors economy, the information required to establish whether potential compensations exist remains staggering. It is not clear whether the relevant case law discussed in Section 2 would allow the potential Pareto criterion.

Finally, a more practical approach may be to try to measure the maximum willingness to pay for the promised cartel public good contribution by consumers of the private good and compare it to the projected cartel price increase.³⁸ In principle, if the average willingness to pay for the new equilibrium public goods level is larger than the price increase, the public-interest defense would be allowed and otherwise not. For small increases in an all-contributors economy, the approach seems straightforward: for an increase in the public good provision the average willingness to pay is equal to the current price of the public good p_g .³⁹

However, such a test is generally not strict enough, since the price increase of the private good will lead to substitution towards private contributions to the public good, which will lower the willingness to pay for further contributions by the cartel. In addition, once some compensation is given, consumer's willingness to pay for the public good will be lowered further. Therefore, even if the (average) willingness to pay for the public good would be found to be higher than the cartel price increase, i.e. $p_x^c - p_x$, it is still very well possible that consumers are damaged on average. Asking consumers to compare discretely different regimes in questionnaires may allow for including the cartel's coordination benefits as well as consumer demand substitutions, yet is potentially unreliable.

6 Concluding Remarks

The public interest-defense policy seeks to exempt horizontal agreements from the cartel law if they advance certain public interests, such as public health or the environment, enough to compensate the consumers damaged by their anti-competitive effects. The collusive provision of public goods proves cumbersome, however. A cartel could improve upon the under-provision of public goods in competitive equilibrium, yet it will contribute the minimum required, which in no-contributor economies decreases in consumers' willingness to pay, contrary to the Samuelson condition. When there is at least one

³⁸This approach was taken by the Dutch competition agency in the matter of the coal burning electricity plants and *Chicken of Tomorrow*. See ACM (2013) and ACM (2015).

³⁹For the no-contributors economy, we obtain the overall willingness to pay at a point $G = g_N$ as $p_g^{g_N} = \left(\frac{\sum_{i=1}^n w_i}{g_N \sum_{i=1}^n \left(p_x \left(\frac{b_i}{a_i p_x} \right)^\rho + \left(\frac{c_i}{a_i} \right)^\rho \right)} \right)^{\frac{1}{\rho}}$, which is not obvious to establish empirically.

private contributor to be public good in the economy, the policy can never attain first-best because of crowding out.

Moreover, public good provision by a private cartel is orthogonal to Lindahl-pricing, as those individuals who have self-selected themselves, through their private good consumption, as relatively low willingness to pay for the public good types, are targeted to pay most for the provision of a compensating public good that they value least. As a result, the cartel will often not be able to compensate profitably. Only when sufficiently many consumers have relative preferences for the cartelized private commodity and the public good that stays constant within narrow bounds, may a sustainable public interest-defense exist. The space for sustainable compensation is particularly small if the market for the cartelized private good is not too large relative to the rest of the economy.

The policies saddle competition authorities with a conflict of public interests. The conditions for sufficient compensation prove complex and the information requirements on a competition agency that is to practically implement the policy seem prohibitively large. Even if an unambiguous welfare assessment were possible - or when the Pareto criterion would be applied - to identify whether a given market satisfies the compensation condition, perfect information is needed of all consumers' preferences. While consumer choices reveal some information about their valuation of public goods, this is far from sufficient. Given the narrow set of economies and the precise sizes of compensating public good contributions required, a false assessment is quite probable. Complexity is added by allowing exemptions on future benefits as well.⁴⁰

Even if corporations had the best intentions to meet the policy criteria, the difficulty to self-assess whether their intended agreement would qualify for an exemption leaves a lot of legal uncertainty. With good or bad intentions, industries have an incentive to exaggerate their contribution. The capacity of a competition agency to effectively monitor firm contributions lacking, firms may just take advantage of the policy and provide some cosmetic public good in exchange for a free pass to collude. A cartel exempted will raise prices by as much as it possibly can, doing as little for the public interest as it can get away with.

Our model has wider application in competition policy context. It applies to companies in a position of dominance pricing excessively in return for promoting a public interest. Likewise does our analysis extend to price rises from various forms of (partial) cartels that face remaining fringe competition, or mergers that are cleared with public interest remedies, such as avoiding job losses. In the latter cases, firms' ability to raise prices and profits will be limited, which would leave an even narrower space for sustainable public interest contributions than under full collusion.

We have abstracted from public interest benefits that result directly from a reduction in the con-

⁴⁰In a revision of the Dutch policy rule referenced in footnote 6, in force since 5 October 2016, the assessment is to involve: "... quantitative and qualitative benefits for users that materialize in the long." In paragraph 3.3 on page 9 of the revised policy rule, this is explained as: "With this approach, the benefits both to the current consumer in the future, as well to future consumers of the product or service concerned are taken into account: it is about a longer term than right here, right now, and others that do not themselves consume the product."

sumption of private commodities that generate negative externalities, such as smoking or polluting production, that may result from a cartel price increase. Including them as compensating cartel benefits does not change our qualitative findings. In particular do we note that arguably those individuals who consume most of products that harm the public interest will generally care less for the public benefits, or they wouldn't generate the externalities. A cartel price overcharge in this context can be seen as a uniform Pigovian tax on those individuals that cause the negative externality by consumption. Constrained by competition case law, the cartel price rise can, however, not exceed the average of Lindahl prices in the subgroup of individuals with the lowest willingness to pay.

Also, we model all public interests in the form of a single public good that enters independently into preferences, as a substitute for spending on private consumption. In many cases, for example cars and road safety, private and public goods may be complementary, so that the demand for the private good increases as the provision of the public good rises.⁴¹ When the cartel produces the complementary public good in compensation, it can benefit from an increased demand effect that would possibly relax the sustainability constraint.

Finally, we note that public goods often have a local character. For the provision that consumers in the same relevant market are compensated, it is necessary that the cartel contributes to a compensating public good in that market, or otherwise possibly to various different local public goods that together span all consumers affected by the cartel price overcharge for compensation. The latter case would complicate enforcement accordingly. While public interest benefits may (far) exceed the relevant market, they must minimally cover it by the European Treaty provisions.

The case law requirement that consumers are to be compensated on average, rather than all, introduces a fundamental equity matter as well. The compensating public good provision that will preserve utility on average will still harm consumers with a low marginal valuation of the public good. Consumers with a low preference for the private good and a relatively high willingness to pay for the public good are effectively paying less, in terms of damage suffered by the price increase, than the consumers targeted by the policy: those who buy substantial volumes of the private good. This heterogeneity in impacts is much more pronounced than it would be in a system of (capped) monetary compensations. The Pareto criterion does not suffer from these problems, yet if indeed it cannot apply for legal reasons, the trade-offs seem for political, rather than bureaucratic decision making.

It appears to remain that public interests call for government provision and regulation, paid for by taxation - certainly if government had the information required to assess public-interest cartel defenses. By tendering the private production of public goods, it is possible to tap into superior corporate knowledge and capabilities to promote public interests most efficiently also. Sector knowledge can be involved in the drafting of regulation as well, which would vertically impose more sustainable production conditions without the need for horizontal agreements. To the extent that this raises the

⁴¹See, for example, Bradford & Hildebrandt (1977). Complementarity is noted in the commodity taxation literature as reducing the social costs of the second-best policy.

cost of production, it would do so symmetrically across all firm in the industry and thus increase consumer prices in competition by no more than necessary.

In some cases, jurisdictional or political barriers, effective lobbies and stubborn creative compliance may render government regulation problematic. Yet, allowing a public interest-cartel seems hardly an effective workaround for a well meaning agency operating in a intergovernmental vacuum. In the cases so far seen, the more traditional government interventions were perfectly available. Energy inefficient household appliances and coal burning electricity plants can simply be phased out by law, as cruelty to animals can be made illegal by putting minimum living conditions for chicken in place. More than a conviction that competition agencies are best placed to balance different public interests, the introduction of the public interest-defense seems to reflect a lack of political will to regulate, or, more concerning even, a politicking of antitrust.

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Appendix - Derivations of the Model in Sections 4 and 5

Consumer $i \in \{1, \dots, N\}$ has a wealth endowment w_i and a utility function

$$U_i = a_i \frac{G^{1-\theta}}{1-\theta} + b_i \frac{x_i^{1-\theta}}{1-\theta} + c_i \frac{y_i^{1-\theta}}{1-\theta}.$$

For consumer i , the budget constraint is (normalizing $p_y = 1$)

$$w_i + p_g G_{-i} - p_g G - p_x x_i - y_i = 0,$$

with $g_i \geq 0$. First-order conditions for consumer i with no bounds for g_i are

$$x_i = \left(\frac{b_i p_g}{a_i p_x} \right)^\rho G,$$

$$y_i = \left(\frac{c_i p_g}{a_i} \right)^\rho G,$$

$$g_i = \frac{w_i - \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right) (G_{-i} + g_N)}{p_g + p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho},$$

so that $g_i > 0$ iff condition (12) in the text holds.

The Samuelson Condition

$\sum_{i=1}^n MRS_i = MRT$ for an economy after the price increase, expressed relative to the private good x_i is

$$\sum_{i=1}^n \frac{a_i G^{-\theta}}{b_i x_i^{-\theta}} = \frac{p_g}{p_x^c}.$$

Substituting $x_i = \frac{w_i}{p_x^c + \left(\frac{c_i p_x}{b_i} \right)^\rho}$ yields (13) in the text. Clearly also $\frac{a_i G^{-\theta}}{b_i x_i^{-\theta}} \neq \frac{p_g}{p_x^c}$ for some i , which illustrates the result in Proposition 3 for model economy.

No-contributors Economy

If each consumer's voluntary contribution is negative both under competition and collusion, $g_1 = \dots = g_N = 0$ in both states. The public good does not enter the utility maximization, so that demands are

$$x_i = \frac{w_i}{p_x + \left(\frac{c_i p_x}{b_i} \right)^\rho},$$

$$y_i = \frac{w_i}{1 + \left(\frac{b_i}{c_i p_x}\right)^\rho p_x}.$$

Equilibrium utility is

$$U_i^* = \frac{1}{1-\theta} \left(a_i G^{1-\theta} + b_i \left(\frac{w_i}{p_x + \left(\frac{c_i p_x}{b_i}\right)^\rho} \right)^{1-\theta} + c_1 \left(\frac{w_i}{1 + \left(\frac{b_i}{c_i p_x}\right)^\rho p_x} \right)^{1-\theta} \right),$$

where $G = g_N$, as no consumer contributes to the public good. Equilibrium utility under collusion is the same, with the higher price p_x^c and $G = g_N + g_F$, including the industry's compensation. Giving consumer i a weight α_i in a welfare function, total welfare becomes

$$SW = \sum_{i=1}^n \alpha_i U_i^* = \sum_{i=1}^n \frac{\alpha_i}{1-\theta} \left(a_i G^{1-\theta} + b_i \left(\frac{w_i}{p_x + \left(\frac{c_i p_x}{b_i}\right)^\rho} \right)^{1-\theta} + c_1 \left(\frac{w_i}{1 + \left(\frac{b_i}{c_i p_x}\right)^\rho p_x} \right)^{1-\theta} \right).$$

Equating welfare in the two equilibria $(p_x, G = g_N)$ and $(p_x^c, G = g_N + g_F)$,

$$\begin{aligned} \sum_{i=1}^n \frac{\alpha_i}{1-\theta} \left(a_i g_N^{1-\theta} + b_i \left(\frac{w_i}{p_x + \left(\frac{c_i p_x}{b_i}\right)^\rho} \right)^{1-\theta} + c_1 \left(\frac{w_i}{1 + \left(\frac{b_i}{c_i p_x}\right)^\rho p_x} \right)^{1-\theta} \right) = \\ \sum_{i=1}^n \frac{\alpha_i}{1-\theta} \left(a_i (g_N + g_F)^{1-\theta} + b_i \left(\frac{w_i}{p_x^c + \left(\frac{c_i p_x^c}{b_i}\right)^\rho} \right)^{1-\theta} + c_1 \left(\frac{w_i}{1 + \left(\frac{b_i}{c_i p_x^c}\right)^\rho p_x^c} \right)^{1-\theta} \right), \end{aligned}$$

which is equivalent to

$$\begin{aligned} \sum_{i=1}^n \alpha_i a_i g_N^{1-\theta} + \sum_{i=1}^n \alpha_i \left(b_i \left(\frac{w_i}{p_x + \left(\frac{c_i p_x}{b_i}\right)^\rho} \right)^{1-\theta} + c_1 \left(\frac{w_i}{1 + \left(\frac{b_i}{c_i p_x}\right)^\rho p_x} \right)^{1-\theta} \right) = \\ \sum_{i=1}^n \alpha_i a_i (g_N + g_F)^{1-\theta} + \sum_{i=1}^n \alpha_i \left(b_i \left(\frac{w_i}{p_x^c + \left(\frac{c_i p_x^c}{b_i}\right)^\rho} \right)^{1-\theta} + c_1 \left(\frac{w_i}{1 + \left(\frac{b_i}{c_i p_x^c}\right)^\rho p_x^c} \right)^{1-\theta} \right). \end{aligned}$$

This condition yields the minimally required compensation level to keep total welfare constant

$$\hat{g}_F = \left(g_N^{1-\theta} + \frac{Z(c) - Z(p_x^c)}{\sum_{i=1}^n \alpha_i a_i} \right)^{\frac{1}{1-\theta}} - g_N, \quad (19)$$

in which

$$Z(p) = \sum_{i=1}^n \alpha_i \left(b_i \left(\frac{w_i}{(p + (\frac{c_i p}{b_i})^\rho)} \right)^{1-\theta} + c_i \left(\frac{w_i}{(1 + (\frac{b_i}{c_i p})^\rho p)} \right)^{1-\theta} \right),$$

for $p = c$ and $p = p_x^c$, respectively.

Total industry profits in perfect competition at $p_x = c$ are zero. After raising the price to p_x^c and paying compensation $\hat{g}_F$ industry profits become

$$\Pi = (p_x^c - p_x) D_x(p_x^c) - p_g \hat{g}_F(p_x^c, p_x).$$

In order to determine analytically whether $\hat{g}_F$ can be sustainably contributed by the cartel, it suffices to investigate for a marginal cartel overcharge the sign of $\left. \frac{\partial \Pi}{\partial p_x^c} \right|_{p_x^c=c}$, since if a positive deviation from the cost-price $p_x = c$ yields a positive profit, there naturally exists a price $p_x^c > p_x$ at which firms make profit and consumers are compensated, while if it does not, no sustainable compensation exists due to the concavity of the profit function. At point $p_x^c = p_x (= c)$

$$\left. \frac{\partial \Pi}{\partial p_x^c} \right|_{p_x^c=c} = \left. \frac{\partial (p_x^c - p_x) D_x(p_x^c, \hat{g}_F)}{\partial p_x^c} \right|_{p_x^c=p_x} - \left. \frac{\partial p_g \hat{g}_F}{\partial p_x^c} \right|_{p_x^c=p_x} = D_x(p_x, \hat{g}_F) - \left. \frac{\partial p_g \hat{g}_F}{\partial p_x^c} \right|_{p_x^c=p_x},$$

since

$$\begin{aligned} & \left. \frac{\partial (p_x^c - p_x) D_x(p_x^c, \hat{g}_F)}{\partial p_x^c} \right|_{p_x^c=p_x} = \\ & \left(\left. \frac{\partial (p_x^c - p_x)}{\partial p_x^c} \right|_{p_x^c=p_x} \right) D_x(p_x, \hat{g}_F) + (p_x - p_x) \left(\left. \frac{\partial D_x(p_x^c, \hat{g}_F)}{\partial p_x^c} \right|_{p_x^c=p_x} \right) = D_x(p_x, \hat{g}_F), \end{aligned}$$

as the latter part is zero. Even though in actual cases price increases will be discrete rather than infinitesimal, this approach allows for identifying where there is possibility for a sustainable public interest-defense at all.

Demand $D_x(p_x^c)$ has the form

$$D_x(p_x^c) = \sum_{i=1}^n x_i = \sum_{i=1}^n \frac{w_i}{p_x^c + (\frac{c_i p_x^c}{b_i})^\rho}.$$

The derivative of the costs of compensation evaluated at point $p_x^c = p_x (= c)$, using the fact that $[Z(p_x) - Z(p_x^c)]|_{p_x^c=p_x} = 0$, becomes

$$\left. \frac{\partial p_g \hat{g}_F(p_x^c, p_x)}{\partial p_x^c} \right|_{p_x^c=p_x} = \frac{p_g g_N^\theta}{(1-\theta) \sum_{i=1}^n \alpha_i a_i} \left[- \left. \frac{\partial Z(p_x^c)}{\partial p_x^c} \right|_{p_x^c=p_x} \right],$$

where

$$- \left. \frac{\partial Z(p_x^c)}{\partial p_x^c} \right|_{p_x^c=p_x} = \frac{(1-\theta)}{p_x} \sum_{i=1}^n \alpha_i b_i \left(\frac{w_i}{p_x + (\frac{c_i p_x}{b_i})^\rho} \right)^{1-\theta}.$$

We thus finally get

$$\left. \frac{\partial p_g \hat{g}_F(p_x^c, p_x)}{\partial p_x^c} \right|_{p_x^c=p_x} = \frac{p_g g_N^\theta}{p_x \sum_{i=1}^n \alpha_i a_i} \sum_{i=1}^n \alpha_i b_i \left(\frac{w_i}{p_x + (\frac{c_i p_x}{b_i})^\rho} \right)^{1-\theta},$$

so that the sustainability condition (the sign of $\left. \frac{\partial \Pi}{\partial p_x^c} \right|_{p_x^c=p_x}$) is as in equation (15) in the text.

Contributors Economies

Assuming the contributor condition is satisfied for every consumer in both states of the economy,

$$g_i = \frac{w_i - \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right) (G - i + g_N)}{p_g + p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho} \text{ and thus}$$

$$G = \sum_{i=1}^n g_i + g_N + g_F = \left(\frac{p_g (g_N + g_F) + \sum_{i=1}^n w_i}{p_g + \sum_{i=1}^n \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right)} \right),$$

with $g_F = 0$ before the price increase and $p_x = p_x^c$ after. Using $x_i = \left(\frac{b_i p_g}{a_i p_x} \right)^\rho G$ and $y_i = \left(\frac{c_i p_g}{a_i} \right)^\rho G$, equilibrium utility is

$$U_i = \frac{G^{1-\theta}}{1-\theta} \left(a_i + b_i \left(\frac{b_i p_g}{a_i p_x} \right)^{\rho(1-\theta)} + c_i \left(\frac{c_i p_g}{a_i} \right)^{\rho(1-\theta)} \right).$$

Giving consumer i a weight α_i in a welfare function, total welfare becomes

$$SW = \sum_{i=1}^n \alpha_i U_i^* = \frac{G^{1-\theta}}{1-\theta} \sum_{i=1}^n \alpha_i \left(a_i + b_i \left(\frac{b_i p_g}{a_i p_x} \right)^{\rho(1-\theta)} + c_i \left(\frac{c_i p_g}{a_i} \right)^{\rho(1-\theta)} \right).$$

Welfare in the two equilibria equal,

$$\begin{aligned} \frac{(g_N + \sum_{i=1}^n g_i)^{1-\theta}}{1-\theta} \sum_{i=1}^n \alpha_i \left(a_i + b_i \left(\frac{b_i p_g}{a_i p_x} \right)^{\rho(1-\theta)} + c_i \left(\frac{c_i p_g}{a_i} \right)^{\rho(1-\theta)} \right) = \\ \frac{(g_N + g_F + \sum_{i=1}^n g_i)^{1-\theta}}{1-\theta} \sum_{i=1}^n \alpha_i \left(a_i + b_i \left(\frac{b_i p_g}{a_i p_x^c} \right)^{\rho(1-\theta)} + c_i \left(\frac{c_i p_g}{a_i} \right)^{\rho(1-\theta)} \right), \end{aligned}$$

after expressing the equilibrium level of the public good yields the minimally required compensation

$$\begin{aligned} \hat{g}_F = \frac{\sum_{i=1}^n w_i + p_g g_N}{p_g} \times \\ \left\{ \left(\frac{p_g + \sum_{i=1}^n \left(p_x^c \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right)}{p_g + \sum_{i=1}^n \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right)} \right)^{\frac{1}{1-\theta}} \left(\frac{\sum_{i=1}^n \alpha_i \left(a_i + b_i \left(\frac{b_i p_g}{a_i p_x} \right)^{\rho(1-\theta)} + c_i \left(\frac{c_i p_g}{a_i} \right)^{\rho(1-\theta)} \right)}{\sum_{i=1}^n \alpha_i \left(a_i + b_i \left(\frac{b_i p_g}{a_i p_x^c} \right)^{\rho(1-\theta)} + c_i \left(\frac{c_i p_g}{a_i} \right)^{\rho(1-\theta)} \right)} \right)^{\frac{1}{1-\theta}} - 1 \right\}. \end{aligned} \quad (20)$$

Analogous to the no-contributors case, we have that $\left. \frac{(p_x^c - p_x) D_x(p_x^c)}{\partial p_x^c} \right|_{p_x^c = p_x} = D_x(p_x)$ where

$$D_x(p_x) = \sum_{i=1}^n x_i = G \sum_{i=1}^n \left(\frac{b_i p_g}{a_i p_x} \right)^\rho = \left(\frac{p_g g_N + \sum_{i=1}^n w_i}{p_g + \sum_{i=1}^n \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right)} \right) \sum_{i=1}^n \left(\frac{b_i p_g}{a_i p_x} \right)^\rho.$$

The derivative of the costs of compensation evaluated at point $p_x^c = p_x (= c)$ is

$$\begin{aligned} \left. \frac{\partial p_g \hat{g}_F}{\partial p_x^c} \right|_{p_x^c = p_x} = \left(p_g g_N + \sum_{i=1}^n w_i \right) \times \\ \left(\frac{(1-\rho) p_x^{-\rho} \left(\sum_{i=1}^n \left(\frac{b_i p_g}{a_i} \right)^\rho \right)}{p_g + \sum_{i=1}^n \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right)} + \frac{\rho p_x^{-\rho} \left(\sum_{i=1}^n b_i \left(\frac{b_i p_g}{a_i} \right)^{\rho-1} \right)}{\sum_{i=1}^n \left(a_i + p_x^{1-\rho} b_i \left(\frac{b_i p_g}{a_i} \right)^{\rho-1} + c_i \left(\frac{c_i p_g}{a_i p_y} \right)^{\rho-1} \right)} \right). \end{aligned}$$

Some algebra reveals that the sustainability condition $\left. \frac{(p_x^c - p_x) D_x(p_x^c)}{\partial p_x^c} \right|_{p_x^c = p_x} \geq \left. \frac{\partial p_g \hat{g}_F}{\partial p_x^c} \right|_{p_x^c = p_x}$ becomes condition (16) in the text.

The Pareto Criterion

Assume consumer h is the most difficult to compensate individual in society. In the all-contributor economy, the required compensation for consumer h is

$$\hat{g}_{F,h} = \frac{\sum_{i=1}^n w_i + p_g g_N}{p_g} \times \left[\frac{p_g + \sum_{i=1}^n \left(p_x^c \left(\frac{b_i p_g}{a_i p_x^c} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right)}{p_g + \sum_{i=1}^n \left(p_x \left(\frac{b_i p_g}{a_i p_x} \right)^\rho + \left(\frac{c_i p_g}{a_i} \right)^\rho \right)} \left(\frac{a_h + b_h \left(\frac{b_h p_g}{a_h p_x} \right)^\rho (1-\theta) + c_h \left(\frac{c_h p_g}{a_h} \right)^\rho (1-\theta)}{a_h + b_h \left(\frac{b_h p_g}{a_h p_x^c} \right)^\rho (1-\theta) + c_h \left(\frac{c_h p_g}{a_h} \right)^\rho (1-\theta)} \right)^{\frac{1}{1-\theta}} - 1 \right].$$

By similar algebra as above, $\left. \frac{\partial \Pi}{\partial p_x^c} \right|_{p_x^c = p_x} \geq 0$ iff condition (18) in the text holds.