Prices versus Quantities
with Morally Concerned Consumers[†]

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April 14, 2021

Abstract: It is widely believed that an environmental tax (price regulation) and cap-and-trade (quantity regulation) are equally efficient in controlling pollution when there is no uncertainty. We show that this is not the case if some consumers (firms, local governments) are morally concerned about pollution and the pollution price is constrained to be inefficiently low. Emissions are lower and material welfare is higher with price regulation. Furthermore, quantity regulation gives rise to dysfunctional incentive and distribution effects. It shifts the burden of adjustment to the poor and discourages voluntary efforts to reduce pollution, while price regulation makes these efforts effective.

JEL classification numbers: D62; H23; Q52; Q58.

Keywords: Emissions Trading; Carbon Tax; Climate Change; Prices versus Quantities; Behavioral Industrial Organization.

[†] We are grateful to Stephan Klasen whose "Farewell Lecture" in Göttingen inspired this paper. We would also like to thank Friedrich Breyer, Paul Heidhues, Frikk Nesje, Grischa Perino, Jean Tirole and seminar participants in Berlin, Munich, Bayreuth, Hamburg, the Bavarian Micro Day, and the CESifo Conference on Energy and Climate Economics for comments and suggestions. Financial support by Deutsche Forschungsgemeinschaft through CRC-TRR 190 (project number 280092119) is gratefully acknowledged.

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1 Introduction

There is unanimous agreement among economists that the most efficient way to mitigate climate change is to "put a price on carbon". There is some controversy on whether to do this with a carbon tax or an emissions market (cap-and-trade). Usually, this debate focuses on the nature of the underlying uncertainty. With a carbon tax the price of emissions is fixed, but there is uncertainty regarding the emission reduction. With an emissions market the quantity of emissions is fixed, but there is uncertainty about the resulting price. The trade-off between price and quantity regulation depends on the relative costs associated with these uncertainties (Weitzman, 1974).

In this paper we explore the implications of another - orthogonal - difference between price and quantity regulation. Cap-and-trade discourages all other abatement efforts that environmentally concerned consumers, firms, or governments are willing to engage in. If some market participants voluntarily reduce their emissions, e.g. by investing in a solar panel, by buying energy-efficient appliances, or by using the train rather than a short-distance flight, they cannot affect the total amount of emissions. Their behavior reduces the demand for emission rights while the supply is fixed (determined by the number of emission permits). This causes the permit price to fall until other consumers or producers buy more emission rights, fully offsetting the initial reduction.[1] With price regulation this is not the case. If there is a fixed carbon tax, any additional climate action is effective in reducing CO_2 emissions. Thus, price regulation may be preferable because it complements the many voluntary contributions that environmentally concerned citizens, firms and local governments are prepared to engage in, while quantity regulation makes them ineffective.

We assume that some consumers are morally concerned consequentialists (e.g. Utilitarians), who are willing to reduce their consumption of the polluting good if their behavior affects the total level of emissions. Furthermore, we assume that there is a political constraint on the emission price. No matter whether this price is a carbon tax or a permit price determined by cap-and-trade, it cannot be higher than an upper bound because a higher price would disadvantage domestic carbon-intensive industries or cause political unrest. We show that

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[1] This effect is well known in the cap-and-trade literature (see e.g. Böhringer and Rosendahl (2010)) and has been called the "waterbed effect".

under these two assumptions price regulation yields lower emissions than quantity regulation because only price regulation induces morally concerned consumers to consume less of the polluting good. These lower emissions translate into higher material social welfare. But there is also a downside to price regulation. Morally concerned consumers suffer from violating a social norm. This is not the case with quantity regulation. A consumer who knows that her actions cannot have any effect on total emissions need not be morally concerned about her actions. Thus, if the disutility from norm violation is taken into account, the effect on total social welfare depends on how high these moral costs are.

In Section 3 we relax the assumptions of rationality and consequentialism. Some consumers do not understand the different implications of price and quantity regulation, and some have non-consequentialist moral convictions. We look at the interaction of selfish consumers and two different types of morally concerned consumers: consequentialists ("Utilitarians") as described above and deontologists ("Kantians"), who consider it their moral duty to follow an ethical norm no matter what the consequences. Kantians behave in the same way under price and under quantity regulation. They are observationally equivalent to "naïve" Utilitarians, i.e. to consequentialists who do not understand that with an emissions market their actions cannot affect total emissions. We ask how a political (or educational) campaign that increases the share of morally concerned consumers (or reduces the share of naïve consumers) affects the utility of the different groups. With price regulation an increase of morally concerned consumers reduces emissions and benefits selfish and morally concerned consumers, so everybody is better off. With quantity regulation an increase of the share of morally concerned consumers leaves total pollution unaffected but reduces the emissions price. This benefits selfish and Utilitarian consumers, while Kantian consumers are harmed. In this case selfish consumers would like to convince other selfish consumers to become Kantians, while Kantians want other Kantians to become selfish, and nobody has an interest in explaining to naïve Utilitarians how the emissions market works.

In Section 4 we look at the distributional consequences of price and quantity regulation. We assume that there are two groups of consumers, rich and poor, and that the rich have a lower marginal utility of money (income) than the poor. With quantity regulation consumers only care about the price of the polluting good, because they cannot affect total emissions.

Thus, if the marginal utility of money is small for the rich, they will not reduce their consumption by much, so the poor have to bear the lion's share of the emissions reduction. With price regulation, both consumer groups are motivated in addition by moral concerns. Thus, both groups will reduce their consumption and bear the burden of emissions reductions more equally.

With cap-and-trade morally concerned consumers could buy and delete emission rights and thereby effectively compensate their CO_2 emissions. In Section 5, we allow for this possibility and show that our previous results are qualitatively unchanged. Only consumers with very strong moral convictions buy permits to compensate for their emissions, all others do not. Even compensating consumers consume more of the polluting good under quantity than price regulation.

In the formal model, we restrict attention to the consumption decisions of individual consumers. Citizens are not only consumers but also voters, employees and stakeholders. Their environmental preferences and moral concerns affect decisions by governments, firms, and many other institutions. For example, many governments respond to the demands of their voters and engage in large efforts to reduce carbon emissions in addition to carbon pricing. The Biden administration wants to spend more than one trillion US Dollars in support for renewable energy, electric vehicles, and smart electricity transmission. Similarly, the European Green Deal aims at an ambitious reduction of greenhouse gas emissions of 55 percent (compared to 1990) until 2030, which will involve many direct regulatory measures and subsidies in addition to carbon pricing. Many firms respond to the demands of their customers, employees, and shareholders by declaring to become "carbon neutral" within a few years. Our analysis has important implications for the climate action taken by governments and firms. It implies that the pressure from voters, customers, and stakeholders on (local) governments and firms to reduce their carbon footprint by additional measures (besides carbon pricing) is higher with a price regulation than a quantity regulation. The reason is that these additional efforts are wasted under quantity regulation, but can yield a significant contribution to mitigate climate change with price regulation. We elaborate on these effects in the final Section 6. All proofs are relegated to the Appendix A.

Our paper is related to three strands of the literature: First, there is a large literature on the efficient regulation of negative externalities (Baumol and Oates, 1988). This literature goes back to Pigou (1920) who first proposed a tax (price regulation) to internalize the externality. The idea of quantity regulation through cap-and-trade is implicit in Coase (1960) and spelled out formally by Montgomery (1972). In a seminal paper Weitzman (1974) compares price and quantity regulation in a model with uncertainty regarding the costs and benefits of abatement.[2] His analysis has been extended in many directions, e.g. to stock pollutants (Hoel and Karp, 2002), commitment and flexibility (Requate, 2005), and political economy issues (Helm, 2005). Surveys on this literature are offered by Hepburn (2006) and Goulder and Schein (2013).[3] The novelty of our paper is that it shows how the presence of morally concerned consumers affects this trade-off.

Second, there is a literature discussing the interaction of different policy instruments (Fankhauser, Hepburn, and Park, 2010; Goulder, Jacobsen, and van Benthem, 2012). This literature shows that different policy measures can be (perfect) substitutes, so adding one instrument to another may have very little or no effect. For example, if a pollution tax is imposed on a good that is already covered by cap-and-trade regulation, than the tax will be fully offset by a reduction of the permit price and does not have any additional effect on aggregate emissions (Goulder, 2013). Perino (2015) considers a general equilibrium model with two sectors, one of which is regulated by cap-and-trade. He shows that voluntary climate action may increase total emissions due to leakage to the other sector that is regulated by a tax. While this literature studies the interaction of different instruments in an inefficient policy mix, we consider the interaction of one type of regulation (either price or quantity regulation) with the moral preferences of consumers. We analyze how the intrinsic (moral) motivation of climate-conscious consumers is affected by the chosen policy instrument and how it affects the efficiency of the regulation.

Finally, our paper is related the behavioral and experimental economics literature. Pollution and climate change is a leading examples of a public good problem. There is an extensive literature in experimental economics showing that social preferences mitigate public good problems. Many experimental subjects are willing to give up own resources in order to help

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[2] The optimal mixture of the two instruments is analyzed, among others, by Roberts and Spence (1976), Pizer (2002), Mandell (2008), and Ambec and Coria (2013).

[3] Goulder (2013), Schmalensee and Stavins (2017) and Narassimhan et al. (2018) provide overviews and evaluations of real world cap-and-trade systems.

others.[4] This literature also shows that some informal and formal institutions can increase and sustain cooperation (Ostrom, 1990; Fehr and Gächter, 2000). Our paper shows that price regulation induces higher contributions to climate change mitigation than cap-and-trade. In our model consumers have moral concerns about the environment and suffer if their own consumption departs from a social norm. Thus, our work is closely related to the economic literature on how social norms affect behavior (Benabou and Tirole, 2006; Krupka and Weber, 2013; Bénabou, Falk, and Tirole, 2018). In particular, several empirical papers of that literature show that social norms have an important impact on decisions affecting the environment (Nyborg, Howarth, and Brekke, 2006; Allcott and Rogers, 2014; Schwirplies and Ziegler, 2016; Jakob et al., 2017). In a lab experiment, Ockenfels, Werner, and Edenhofer (2019) directly investigate whether an emissions tax performs better than a cap-and-trade system for reducing carbon emissions. They find that an emissions tax yields more abatement than cap-and-trade, which confirms our theoretical results. Several papers show that the framing of carbon prices is important. A carbon "tax" is less popular than an "emission price" that is less visible (Carattini, Kallbekken, and Orlov, 2019). Framing effects are clearly important, but for conciseness we chose to ignore them in our model. Finally, there is a discussion on whether markets erode social responsibility and moral concerns (Sandel, 2012; Falk and Szech, 2013; Bartling, Weber, and Yao, 2015; Sutter et al., 2020; Dewatripont and Tirole, 2020). In our paper, it is not the market per se that affects moral behavior but the type of market mechanism. We consider two market instruments, price and quantity regulation, and show that price regulation fosters moral behavior, while quantity regulation renders it irrelevant.

2 The Basic Model

Consider an economy with two goods, good X which pollutes the environment and good Y which involves no externalities. The government wants to mitigate the negative externalities of X and can either impose a consumption tax (price regulation) or introduce an emissions market where a fixed number of emission permits is traded (quantity regulation). We abstract away from any uncertainty, so the regulator can perfectly predict the effects of both policies. Thus, in a standard model price and quantity regulation are equivalent.

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[4] For surveys of this literature see Ledyard (1995) and Chaudhuri (2011).

We deviate from the standard model by introducing two assumptions. First, we assume that there is a constraint on the emission price. No matter whether the emission price is determined by a tax or by an emissions market, it cannot exceed an upper bound $\bar{p}$. In the real world, emission prices are constrained for several reasons. One important constraint is political. Emission prices directly affects the prices of highly visible goods such as gasoline, electricity, and heating, and they may disproportionately affect the poor. Thus, they often trigger political unrest and instability.[5] Furthermore, they impose additional costs on domestic firms, which results in a competitive disadvantage in international trade.[6] We do not model these reasons explicitly, but impose an exogenously given upper bound $\bar{p}$.

Second, we assume that consumers have moral concerns about pollution. They incur a moral cost if their emissions harm the environment and are willing to voluntarily reduce their consumption of good X. In the basic model, we assume that all consumers are "moral consequentialists" (e.g. Utilitarians) who base the moral judgment of an action on its consequences.

As we will show, with these two assumptions, there is a difference between price and quantity regulation. With price regulation a morally concerned consumer can reduce overall pollution by consuming less than what she would consume without moral concerns.[7] With quantity regulation this is not the case. On an emissions market the total quantity of emissions is fixed by the number of pollution permits. If some consumers reduce their consumption, the demand for emission permits is reduced and the permit price falls until other consumers consume more, exactly offsetting the initial reduction. A rational ("sophisticated") consumer understands this and knows that a reduction of her consumption has no impact on overall pollution. Thus, an emissions market renders her moral concerns irrelevant. Therefore, she will consume exactly the same amount that she would have consumed if she did not have any moral concerns.

We model this as follows. There is a continuum of consumers of mass one. Good X is

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[5] The opposition to higher gas taxes in the US and the "yellow vests movement" in France are prominent examples.

[6] For this reason some countries are considering border adjustment taxes, but this gives rise to new challenges. It is difficult to measure emissions of production abroad, and border adjustment taxes may violate WTO law.

[7] Even with price regulation the reduction of total emissions need not be one-to-one if there is indirect leakage; see e.g. Sinn (2008). This effect is ignored in the following.

produced on a perfectly competitive market at constant marginal cost $c > 0$. The quantity of good X is measured such that one unit of consumption yields one unit of pollution. In addition, there is a pollution price p per unit of the good that is either imposed by the government through a tax or through an emissions market that gives rise to an emission price. Thus, the total price of good X is $c + p$. The price of the numeraire good Y is normalized to 1. Let x and y denote the quantities consumed of goods X and Y, respectively, and m the income of the representative consumer. Revenues from pollution pricing $p\bar{x}$ are redistributed lumpsum, so her budget constraint implies that $y = m + p\bar{x} - (c + p)x$. Her (quasi-linear) utility function is

$$U = v(x) + m + p\bar{x} - (c + p)x - D(\bar{x}) - \beta^R[x - x^o]^+ \ , \tag{1}$$

where $v'(x) > 0$ and $v''(x) < 0$.[8]

A consumer suffers from the environmental damage $D(\cdot)$ that is caused by aggregate consumption $\bar{x} = \int_0^1 x(i)di$, with $D'(\cdot) > 0$ and $D''(\cdot) > 0$. Let $v'(0) > c + D'(0)$.

The consumer also suffers a moral cost if she consumes more than the social norm x^0 prescribes, i.e. her utility is reduced by $\beta^R[x - x^o]^+$, where $[x - x^o]^+ = \max\{x - x^o, 0\}$ and $R \in \{P, Q\}$. With price regulation the consumer affects total pollution, so $\beta^R = \beta > 0$, while with quantity regulation she cannot affect total pollution, so $\beta^Q = 0$. Note that there is a continuum of consumers. Thus, each consumer ignores the effect of her consumption on her own utility via $\bar{x}$ and the environmental damage $D(\bar{x})$. However, the aggregate utility loss of all consumers is given by $D'(\bar{x}) > 0$ which is not negligible. To illustrate: If a consumer emits one additional ton of CO_2, then she will ignore how this additional consumption affects her own utility via its effect on climate change. However, the utility loss aggregated over all people in the world cannot be ignored and is equal to the social cost of carbon. Thus, a moral consequentialist feels responsible for the environmental damage that she imposes on all other consumers (while ignoring the effect on herself).[9] For simplicity we assume that the agent's utility loss is a piecewise linear function of the norm violation.

Define $\hat{x}(z)$ implicitly by $v'(\hat{x}) \equiv z$ for all $z \geq 0$. Thus, $\hat{x}(z)$ with $\hat{x}'(z) < 0$ denotes a consumer's demand as a function of the perceived cost of consuming X, which may incorporate,

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[8] In an Online Appendix we show that the main results continue to hold for more general utility functions.

[9] For additional surportive philosophical arguments see Tiefensee (2019) .

next to the price, also the moral cost of consumption. Moreover, we assume that the wealth m is sufficiently high so that consumption of the numeraire good Y is always strictly positive. This implies that m is a constant shift parameter in the utility function, which we will ignore in the following.

The social norm x^o is determined endogenously. We assume that it is a weighted average of the morally appropriate consumption level x^* (defined below) and the average actual consumption level $\bar{x}$, i.e.,

$$x^o = \alpha x^* + (1 - \alpha)\bar{x} \ . \tag{2}$$

If $\alpha = 1$ the norm is fully injunctive and says that everybody should consume the socially efficient quantity x^* that maximizes material social welfare

$$W^M = v(\bar{x}) - c\bar{x} - D(\bar{x}) \ . \tag{3}$$

So x^* is uniquely defined by

$$v'(x^*) = c + D'(x^*) \ . \tag{4}$$

If $\alpha = 0$ the norm is purely descriptive, i.e. the consumer suffers if she consumes more of X than everybody else does. It seems natural that actual social norms are somewhere in between.

The social planner (regulator) wants to maximize social welfare by imposing an emission price p. The revenues of emission pricing are redistributed lumpsum to consumers. It could be debated whether social welfare is just material social welfare as defined in (3) or whether it should also include the feelings of utility losses due to norm violations. We will see that this does not make a difference in a first best world, but it is important if the first best cannot be implemented. We will always discuss the effects on both, material and total social welfare, where the latter is defined by

$$\begin{aligned} W &= v(\bar{x}) - (c+p)\bar{x} - D(\bar{x}) + p\bar{x} - \beta^R[\bar{x} - x^o]^+ \\ &= W^M(\bar{x}) - \alpha\beta^R[\bar{x} - x^*]^+ \ . \end{aligned} \tag{5}$$

First Best

The consumption level x^* maximizes material welfare and also minimizes the disutility from norm violation.

Lemma 1. *Total social welfare (5) and material social welfare (3) are both maximized by consumption level* x^**.*

If the carbon price is not constrained, both regulations can implement the first best. The result readily follows from the maximization of U and the definition of x^*.

Lemma 2. *If the emission price is unconstrained, the first best can be implemented by*

(a) either price regulation that sets the emission price to $p^* \in [D'(x^*) - \beta,\ D'(x^*)]$*,*

(b) or quantity regulation that restricts the number of emission permits to $\bar{E} = x^*$*.*

Thus, without a constraint on carbon prices, a carbon tax and cap-and-trade are equivalent.

Second Best

Now, suppose that there is a political constraint on the emission price.

Assumption 1. *The social planner is constrained to implement an emission price* $p \leq \bar{p} < D'(x^*) - \beta$*.*

As discussed in the introduction, this assumption is motivated by the fact that the introduction of carbon prices is politically challenging. Many countries experienced fierce resistance against the introduction or the increase of carbon prices.[10] If positive carbon prices have been introduced they tend to be far lower than the estimated social cost of carbon. It is sometimes argued that resistance against a "tax" is stronger than the resistance against a less visible emission price, even if both instruments affect the final price in the same way. However, here we assume that consumers are perfectly rational, so the upper bound is the same for a carbon tax and an emission price.

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[10] For a survey see Carattini, Carvalho, and Fankhauser (2018).

In this second best world the social planner will choose $p = \bar{p}$ if he opts for price regulation, and he will set $\bar{E}$ such that the endogenous price on the emissions market $p(\bar{E}) = \bar{p}$. Importantly, even though the emission price is the same, total emissions are different.

Proposition 1. *Under Assumption 1, optimal price regulation implements an emission level* $x^P = \hat{x}(c + \bar{p} + \beta)$ *that is inefficiently high but strictly smaller than the level of emissions* $x^Q = \hat{x}(c + \bar{p})$ *under optimal quantity regulation, i.e.*

$$x^* < x^P < x^Q \ . \tag{6}$$

Because the emissions price is constrained to be smaller than $\bar{p}$, emissions will always be too high. However, with price regulation consumers can affect the total level of emissions and are motivated by their moral concerns to reduce their consumption. This is not the case with quantity regulation where total emissions are fixed. The social planner foresees this and chooses an emissions cap higher than the emissions under price regulation to keep p below $\bar{p}$.

Proposition 1 implies that material social welfare is unambiguously higher with price regulation than with quantity regulation. But, price regulation also yields moral costs which are absent with quantity regulation which has to be taken into account in the assessment of total welfare.

Proposition 2. *Material social welfare (3) is unambiguously higher with price regulation than with quantity regulation, i.e.*

$$W^M(x^P) > W^M(x^Q) \ . \tag{7}$$

The difference in material welfare is strictly increasing in β*,*

$$\frac{d(W^M(x^P) - W^M(x^Q))}{d\beta} > 0. \tag{8}$$

Total social welfare (5) is higher with price than with quantity regulation if and only if

$$W^M(x^P) - W^M(x^Q) > \alpha\beta[x^P - x^*] \ . \tag{9}$$

This is the case if the social norm is sufficiently descriptive (α *sufficiently small).*

The first part of the proposition follows directly from Proposition 1 and the fact that material social welfare is concave in x. Note that x^P is decreasing in β, while x^Q is unaffected, so the difference in material welfare is higher the higher β.[11] The effect on total social welfare is slightly more complicated because it not only includes the material effects of consumption but also the moral costs of consuming too much.

An important advantage of quantity regulation is that consumers do not have to be morally concerned about their actions, so there are no moral costs. With price regulation consumers suffer from the fact that their consumption affects total pollution and that it exceeds x^0. If the norm is purely descriptive ($\alpha = 0$), consumers do not suffer any moral cost, because everybody behaves as they do. The more injunctive the norm, i.e. the larger α, the more do people morally suffer from not consuming the socially optimal amount x^*. Thus, if α is sufficiently small, price regulation dominates.

The effect of β on total welfare is less clear. A decrease in β reduces the moral suffering under price regulation, but it also reduces the incentives of consumers to consume less. Thus, both sides of inequality (A.6) are reduced and the total effect is ambiguous.

3 Selfish, Kantian and Naïve Consumers

Welfare economics is based on the assumptions of rational choice and consequentialism, so it is natural to start out with a model in which all consumers are fully rational and moral consequentialists. However, in the real world many consumers are not familiar with the functioning of an emissions market and may fail to understand that their behavior cannot affect total emissions. They are “naïve” in the sense that they do not see any difference between price and quantity regulation. Furthermore, consumers who are morally concerned need not be consequentialists. Many consumers are better described as deontologists (e.g. Kantians) who aspire to follow an ethical rule or a moral duty, independently of what the consequences of this action are.[12] For example, in the public debate we often observe moral imperatives such as “You shall not fly”, but we rarely observe the statement “You may use the plane on flights within Europe, because they are covered by the EU Emissions Trading System, but you shall not fly in the US”.

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[11] Note that Assumption 1 limits β from above, which implies that individual consumption is always higher than first-best consumption. This implies that – within the allowed range – x^P is strictly decreasing in β.

[12] Kantian decision makers are also analyzed by Roemer (2010) and Alger and Weibull (2016).

In this section, we allow for different moral convictions and degrees of rationality. We assume that fraction $1-\lambda$ of consumers are selfish and have no moral concerns. They simply maximize their material utility. The remaining fraction λ consists of two types of morally concerned consumers – consequentialists as in Section 2 and deontologists – who follow an ethical norm.[13] We assume that deontologists are equally morally strict as consequentialists, so they follow the same social norm $x^o = \alpha x^* + (1-\alpha)\bar{x}$, but, to a deontologist this social norm applies no matter what the consequences. For concreteness, we will call consequentialists "Utilitarians" and deontologists "Kantians". Furthermore, there are naïve Utilitarians who do not understand the functioning of an emissions market and believe that any reduction of their emissions reduces total emissions by exactly this amount. In our model Kantian consumers and naïve Utilitarian consumers are observationally equivalent. We assume that the share of Kantians and naïve Utilitarians in the population is $\lambda^k \geq 0$ and the share of sophisticated Utilitarians is $\lambda^u \geq 0$, $\lambda^k + \lambda^u = \lambda < 1$. Let $x^s(p) = \hat{x}(c+p)$ and $x^m(p) = \hat{x}(c+p+\beta)$ be the "selfish" and the "moral" consumption, respectively.

With price regulation all morally concerned consumers behave in the same way and choose consumption level $x^m(\bar{p})$, while selfish consumers choose $x^s(\bar{p})$, with $x^m < x^s$. This gives rise to total emissions $\bar{x}^P = (1-\lambda)x^s + \lambda x^m$ and to social norm $x^o = \alpha x^* + (1-\alpha)[x^s - \lambda(x^s - x^m)]$.[14] With quantity regulation sophisticated Utilitarian consumers have no moral concerns and choose the same consumption level $x^s(p)$ as selfish consumers. Only Kantian and naïve Utilitarian consumers choose the moral consumption level $x^m(p)$. Thus, total consumption and pollution is given by $x^Q(p) = (1-\lambda^K)x^s(p) + \lambda^K x^m(p)$. The social planner will set the quantity of emission permits $\bar{E}$ such that $\bar{E} = x^Q(\bar{p})$ which gives rise to emission price $\bar{p}$. Thus, with price regulation total pollution is smaller than with quantity regulation, $x^P < x^Q$,

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[13] Other prominent models of moral behavior include social preferences (e.g. altruism) and image concerns (social and self-signaling). These (and many other) models could be used here as well. The crucial distinction is always whether or not moral concerns are consequentialist. For every consequentialist model, quantity regulation drives out moral behavior because it renders it inconsequential, while price regulation does not.

[14] This assumes that $x > x^o$ for all morally concerned consumers, which is the case if α is sufficiently large. Note that if α is very small and there are many selfish consumers it could be the case that morally concerned consumers choose a corner solution with $x = x^o$. This does not affect the qualitative nature of the following results but requires cumbersome case distinctions. Formally, we assume that

$$\alpha > \frac{\hat{x}(c+\bar{p}) - \hat{x}(c+\bar{p}+\beta)}{\hat{x}(c+\bar{p}) - x^*}.$$

and material efficiency is higher, as in Section 2.

The focus of this section is on the effects of a political or educational campaign that changes the composition of the population. For example, a new report of the IPCC or a political movement (e.g. "Fridays for Future") may raise the awareness of climate change and turn some selfish consumers into morally concerned consumers. The government could also make an effort to better explain the functioning of an emissions market to the public, thereby reducing the share of naïve consumers. Because these campaigns change the preferences of some part of the population, we cannot compare total social welfare before and after the policy change. However, we can assess how consumers who did not change their type are affected, which gives rise to important distributional effects.

Proposition 3 (Price regulation)**.** *Suppose that the share of morally concerned consumers, λ, increases. With price regulation all consumers (both selfish and moral) who did not change their type benefit from the conversion of some selfish to moral consumers.*

If a selfish consumer gets morally concerned, she consumes less and total pollution is reduced. The consumption choices of selfish and moral consumers who did not change their type are unaffected, but both types benefit from the reduction of pollution. There is also a negative effect on all consumers because tax revenues go down and less money can be redistributed. Furthermore, moral types are adversely affected because the social norm gets stricter. However, under Assumption 1, these effects are dominated by the positive effect of less pollution.

Consider now the case of quantity regulation and assume that the number of emission rights $\bar{E}$ is fixed.[15]

Proposition 4 (Quantity regulation)**.** *Suppose that the share of Kantian consumers, λ^k, increases . With quantity regulation total pollution is unaffected, but the pollution price goes down. Selfish consumers unambiguously benefit from the price decrease, while Kantian consumers are strictly worse off.*

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[15] An increase of the number of Kantian consumers reduces the emission price. Thus, the regulator could respond by reducing the number of emission rights. Many existing emissions markets fixed the number of emission rights for many years. For example, in the European Emissions Trading System the amount is fixed until 2030.

With a fixed cap, an increase of the share of Kantian consumers cannot affect total pollution, but it does affect the permit price p. A decrease in p has three effects: It reduces the amount px that consumers have to pay for their consumption x, it reduces the lumpsum redistribution $p\bar{x}$ that each consumer gets, and it affects the individual consumption decisions. At the margin, the last effect is positive but second order due to the envelope theorem. Because selfish (and sophisticated Utilitarian) consumers consume more than $\bar{x}$, they benefit from the price reduction, while Kantian consumers consume less than $\bar{x}$ and therefore lose out.

These propositions show that with price regulation total emissions are reduced and everybody benefits if the population gets more climate conscious. With quantity regulation selfish consumers benefit, Kantian consumers lose out, and there is no effect on total emissions. Furthermore, quantity regulation gives rise to perverse incentive effects. Kantian consumers have no material interest to convince selfish consumers to behave more morally and selfish consumers do not want to educate naïve Utilitarians about the functioning of the emissions market.

4 Distributional Effects

We distinguish two types of consumers, called rich (r) and poor (p), who are all moral consequentialists. The utility functions are

$$U_i = v(x) - \delta_i (c + \bar{p})x - D(\bar{x}) - \beta [x - x^o]^+ + \delta_i \bar{p}\bar{x} \ , \tag{10}$$

with $i \in \{r, p\}$ and $\delta := \delta_r < \delta_p := 1$. The rich have a lower marginal utility of money than the poor. [16] This reflects the common observation that many wealthy people do not seem to react much to the prices of the goods they consume. They do not care whether a plastic bag in the supermarket costs an additional 50 cent, they drive an SUV even if fuel consumption is more expensive, and they do not give up on vacations to far away destinations just because the flight costs a few hundred Dollars more. However, some of these rich consumers react quite sensitively to moral concerns. They do not use plastic bags to protect the environment, they buy an electric car even though it is more expensive than a car with a combustion engine, and

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[16] Alternatively, we could have assumed that the rich have a higher marginal utility from consuming good X and higher moral concerns β.

they cut back on air travel because they suffer from “flight shame”.

Let the consumption of type $i \in \{r, p\}$ under regime $j \in \{P, Q\}$ be x_i^j. With price regulation optimal consumption of the poor and the rich is $x_p^P = \hat{x}(c + p + \beta)$ and $x_r^P = \hat{x}(\delta(c + p) + \beta)$, respectively, while with quantity regulation the poor and rich consume $x_p^Q = \hat{x}(c + p)$ and $x_r^Q = \hat{x}(\delta(c + p))$, respectively. Fraction μ of the population is poor and fraction $1 - \mu$ is rich, so that the average consumption in regime $j \in \{P, Q\}$ is $\bar{x}^j = \mu x_p^j + (1 - \mu)x_r^j$. Moreover, we assume that the norm is sufficiently injunctive (α sufficiently large) so that $x_p^P > x^o = \alpha x^* + (1 - \alpha)\bar{x}^j$, implying that $x^o < x_p^j < x_r^j$. Here, $x^* \equiv \mu x_p^* + (1 - \mu)x_r^*$, where $v'(x_i^*) = \delta_i c + D'(x^*)$.

Comparing the consumption levels of the poor and the rich under price and quantity regulation we get the familiar result that $x_p^P(\bar{p}) < x_p^Q(\bar{p})$ and $x_r^P(\bar{p}) < x_r^Q(\bar{p})$, so total pollution is again smaller with price regulation than with quantity regulation:

$$x^P(\bar{p}) = \mu x_p^P(\bar{p}) + (1 - \mu)x_r^P(\bar{p}) < \mu x_p^Q(\bar{p}) + (1 - \mu)x_r^Q(\bar{p}) = x^Q(\bar{p}). \tag{11}$$

More importantly, we claim that with quantity regulation the rich reduce their consumption very little and“buy their way out” by paying the emission price, while with price regulation they do this to a lesser extent.

To analyze which group, the poor or the rich, contributes more to the reduction of emissions we compare their consumption levels to those from the *status quo ante*: to the consumption in a situation in which consumers are unaware of the environmental damage and in which there is no regulation, i.e. $\beta = 0$ and $p = 0$. These consumption levels are $x_p^a = \hat{x}(c)$ and $x_r^a = \hat{x}(\delta c)$, respectively. We define the “excess contribution of the poor” as

$$\Delta^j = [x_p^a - x_p^j] - [x_r^a - x_r^j]. \tag{12}$$

If $\Delta^j > 0$ the poor reduce consumption more than the rich in regime $j \in \{P, Q\}$ compared to the status quo ante.

Proposition 5.

(a) *With quantity regulation, the poor contribute more to the reduction of pollution than the rich,*

$$\Delta^Q(\bar{p}) > 0\ , \tag{13}$$

if

$$-\frac{z\hat{x}''(z)}{\hat{x}'(z)} < 1 \ . \tag{14}$$

(b) The excess contribution of the poor is larger with quantity regulation than with price regulation,

$$\Delta^Q(\bar{p}) > \Delta^P(\bar{p}) \ , \tag{15}$$

if the demand function is convex, i.e. $\hat{x}''(z) > 0$.

Part (a) of Proposition 5 shows that with quantity regulation poor consumers contribute more to the reduction of pollution than rich consumers under a weak condition on demand. Condition (14) is satisfied if demand is not too convex (e.g. concave or linear). The excess contribution of the poor is smaller with price than with quantity regulation if demand is convex. In fact, with price regulation it is possible that the excess contribution of the poor becomes negative, i.e. the rich contribute more than the poor. Thus, if it is desirable that the poor do not contribute much more than the rich in order to increase political support, price regulation tends to be better than quantity regulation.

An extreme example illustrating Proposition 5 is the following. Suppose there is an upper limit on the consumption of good X, $x \leq x^{max}$, and that $\min\{c+p,\ \delta(c+\bar{p})+\beta\} > v'(x^{max}) > \delta(c+p)$. This is the case if δ is small and β is large.

(i) With quantity regulation the rich do not adjust their consumption of X compared to the status quo ante at all, so all the adjustment has to be done by the poor.

(ii) With price regulation the rich will reduce their consumption of X (even if they do not care about the pollution price $\bar{p}$) because of their moral concerns. In this case, both the rich and the poor contribute to the reduction of emissions.

These findings have some important implications. The limit on the pollution price $\bar{p}$ is usually determined by poor consumers who suffer more from higher prices than the rich. With quantity regulation the rich will continue to consume (almost) as much as they did in the status quo ante, so the total quantity of emission rights $\bar{E} = x^Q(\bar{p})$ may have to be very high to make sure that $p \leq \bar{p}$. Furthermore, the larger the fraction of the rich, the larger $\bar{E}$ has to be.

Thus, if for political reasons it is desirable that both, the rich and the poor, contribute to reducing emissions, price regulation tends to be preferable to quantity regulation. Sometimes it is argued that rich consumers have a higher β than poor consumers (because morality is a normal good). If this is the case, rich consumers may consume less than poor consumers with price regulation, but they will not do so with quantity regulation. This argument provides additional support for price regulation.

5 Deleting Emission Rights

If there is an emissions market, a morally concerned consumer could compensate for the emissions caused by her consumption by buying and deleting emission permits, which effectively reduces total emissions. Thus, (sophisticated) Utilitarians may have moral concerns also under a quantity regulation.[17] One might conjecture that if Utilitarian consumers can use this strategy, the difference between quantity and price regulation disappears. In this section we show that this is not the case.

Let $e \geq 0$ denote the number of emission rights that a consumer buys and deletes. This reduces her utility loss from violating the norm x^o to $\beta[x - e - x^o]^+$. A Utilitarian consumer understands that she can reduce emissions by purchasing and deleting emission rights, but not by reducing consumption. We model this as a two stage decision process. At stage two, for a given x, she maximizes her utility via the amount of permits e purchased. At stage one, she chooses her consumption x taking into account how this affects her purchase of permits. The first decision is independent of moral concerns, while for the second decision norm violation affects utility. The marginal benefit of buying emission rights is β and the marginal cost is $\bar{p}$. Thus, if β is smaller than $\bar{p}$, a morally concerned consumer will not buy any emissions rights and consumes x^s. If β is larger than $\bar{p}$, she buys as many permits so as to fully comply with the social norm, $e = x - x^0$. The consumer foresees that for every unit consumed she will buy one emission right, which increases the marginal cost of consumption to $c + 2\bar{p}$.

Proposition 6. *Suppose that morally concerned consumers can buy and delete emission rights at price $\bar{p}$. If $\bar{p} > \beta$, a Utilitarian consumer chooses x^s and does not delete any emission rights.*

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[17] There are organizations offering to compensate CO_2 emissions by buying and deleting emissions rights (e.g. Carbonkiller (`carbonkiller.org/en`). See also Gerlagh and Heijmans (2019).

If $\bar{p} < \beta$*, she buys* $x^e = \hat{x}(c + 2\bar{p})$ *and deletes* $e = x^e - x^o$*. Note that* $x^* < x^m < x^e < x^s$ *for* $\beta > \bar{p}$*.*

For heterogeneous consumers that differ in their degree of morality β, the above proposition shows that for all consumers i with $\beta_i < \bar{p}$ the analysis of the previous sections is unaffected. Consumers with $\beta_i > \bar{p}$ will make use of the option to buy emission rights. Importantly, these consumers still consume more under quantity regulation than price regulation.

6 Conclusions

Many consumers are morally concerned about their carbon footprint and prepared to voluntarily reduce emissions by saving energy, investing in renewables, or changing their consumption patterns. With quantity regulation these efforts to reduce consumption do not affect total pollution and are discouraged. Under price regulation climate action by morally concerned consumers reduces total emissions. This leads to an important difference between price and quantity regulation if there is a political constraint on the pollution price.

Our analysis applies not only to consumption decisions. Many firms are pressured by their customers, employees, and shareholders to make substantial efforts to reduce carbon emissions. For example, Forbes (2019) lists 101 multinational companies that are committed to become carbon neutral in the near future. Similarly, many (regional) governments are pressured by voters to make significant efforts to reduce CO_2 emissions. We mentioned the European Green Deal and the climate action of the Biden administration in the introduction. In addition, many US states impose clean energy standards to reduce non-renewable energy consumption and to increase the production of renewable energy. In the EU, several countries heavily subsidize the production of solar and wind energy. Germany alone has spent about 300 billion Euros since 2001 to subsidize renewable energy, and it wants to spend another 40 billion Euros to shut down all coal-fired power stations until 2038. These initiatives are often on top of cap-and-trade systems, such as the Regional Greenhouse Gas Initiative (RGGI) and the Western Climate Initiative (WCI) in North America or the Emissions Trading System (ETS) in the EU, and so have little or no effect on total emissions. As long as the carbon price is too low, additional carbon action is urgently needed to mitigate climate change and to achieve the two-degree-goal. With cap-and-trade, these additional efforts are not only largely wasted, they are also discouraged. With price regulation these measures would be more effective and, as we show, voters would have a stronger incentive to push for them.

Furthermore, quantity regulation gives rise to dysfunctional incentive and distribution effects. There are no incentives for Kantian consumers to convince selfish consumers to become morally concerned and for selfish consumers to educate "naïve" consumers about the functioning of cap-and-trade. It gives little incentives to the rich to curb their emissions, so most of the burden of adjustment has to be born by the poor. Climate action of morally concerned agents lowers the carbon price and thereby subsidizes consumption of those who are less environmentally conscious. In contrast, with price regulation everybody benefits if agents are motivated to take climate action. Additionally, rich and poor households have similar incentives to reduce their carbon emissions. These are powerful arguments in favor of price regulation that policy makers should take into account.

A Appendix

Proof of Lemma 1. For $\bar{x} = x^*$, $W^M(\cdot)$ is maximized and $\alpha\beta^R[\bar{x} - x^*]$ is minimized. Thus, x^* maximizes $W(\cdot)$. □

Proof of Lemma 2.

Part (a): Consider price regulation with $p \in [D'(x^*) - \beta,\ D'(x^*)]$. The consumer maximizes

$$\begin{aligned} U &= v(x) - (c+p)x - \beta[x - x^o]^+ - D(\bar{x}) + p\bar{x} \\ &= v(x) - (c+p)x - \beta[x - \alpha x^* - (1-\alpha)\bar{x}]^+ - D(\bar{x}) + p\bar{x}\ . \end{aligned} \tag{A.1}$$

Because of the kink in the consumer's utility function we have to distinguish two cases. First, if the consumer consumes $x > \alpha x^* + (1-\alpha)\bar{x}$, the FOC for her optimal consumption $\tilde{x}$ is given by

$$v'(\tilde{x}) - c - p - \beta = 0 \quad \Leftrightarrow \quad v'(\tilde{x}) = c + \beta + p \geq c + D'(x^*) \tag{A.2}$$

Because of the concavity of $v(\cdot)$ we have $\tilde{x} \leq x^*$. In equilibrium, all consumers choose the same $\tilde{x}$, so $\tilde{x} = \bar{x}$, which implies $\alpha x^* + (1-\alpha)\tilde{x} \geq \tilde{x}$, a contradiction to our assumption that $\tilde{x} > \alpha x^* + (1-\alpha)\bar{x}$.

Second, if the consumer consumes $x \leq \alpha x^* + (1-\alpha)\bar{x}$, the FOC for the optimal consumption decision $\tilde{x}$ is given by

$$v'(\tilde{x}) - c - p = 0 \quad \Leftrightarrow \quad v'(\tilde{x}) = c + p \leq c + D'(x^*)\ . \tag{A.3}$$

This equation is solved for $\tilde{x} \geq x^*$. Again, in equilibrium we have $\tilde{x} = \bar{x}$ and thus $\alpha x^* + (1-\alpha)\bar{x} > \bar{x} = \tilde{x}$, a contradiction. Hence, $x = x^*$ is indeed optimal.

Part (b): Consider quantity regulation where the government restricts the quantity of emission permits to $\bar{E} = x^*$. This implements the efficient emission level. Note that moral concerns do not play a role here. Thus, demand equals supply on the emissions market if $v'(x^*) = c + p$, which endogenously induces $p = D'(x^*)$. □

Proof of Proposition 1. A consumer demands $\hat{x}$ defined by

$$v'(\hat{x}) = c + \bar{p} + \beta^R < c + D'(x^*). \tag{A.4}$$

Thus, $x^* < x^P = \hat{x}(c+\bar{p}+\beta) < x^Q = \hat{x}(c+\bar{p})$ because of the concavity of $v(\cdot)$. Under quantity regulation the planer sets $\bar{E} = \hat{x}(c+\bar{p})$. □

Proof of Proposition 2. By Proposition 1, $x^Q > x^P > x^*$ which implies $W^M(x^Q) < W^M(x^P) < W^M(x^*)$. Moreover,

$$\frac{d(W^M(x^P) - W^M(x^Q))}{d\beta} = \underbrace{\hat{x}'(c+\bar{p}+\beta)}_{<0}\underbrace{[v'(x^P) - c - D'(x^P)]}_{<0} > 0. \tag{A.5}$$

By (5) total social welfare is higher under price than quantity regulation iff

$$\begin{aligned} W(x^P) = W^M(x^P) - \alpha\beta[x^P - x^*] &> W(x^Q) = W^M(x^Q) \\ \Leftrightarrow \quad W^M(x^P) - W^M(x^Q) &> \alpha\beta[x^P - x^*]. \end{aligned} \tag{A.6}$$

Note that x^P and x^Q are independent of α. Thus, if $\alpha \to 0$ inequality (A.6) holds. □

Proof of Proposition 3. An increase of λ reduces the consumption of those selfish consumers that have been turned into moral consumers. It does not affect the consumption decisions of consumers who did not change type. The effect on aggregate consumption is:

$$\frac{\partial \bar{x}^P}{\partial \lambda} = -[x^s - x^m] < 0.$$

The effect on utility of selfish and moral consumers is:

$$\frac{\partial U_S}{\partial \lambda} = \underbrace{[-D'(\bar{x}) + \bar{p}]}_{<0 \text{ by Ass. 1}}\underbrace{\frac{\partial \bar{x}^P}{\partial \lambda}}_{<0} = -[-D'(\bar{x}) + \bar{p}][x^s - x^m] > 0, \tag{A.7}$$

$$\frac{\partial U_K}{\partial \lambda} = \underbrace{[-D'(\bar{x}) + \beta(1-\alpha) + \bar{p}]}_{<0 \text{ by Ass. 1}}\underbrace{\frac{\partial \bar{x}^P}{\partial \lambda}}_{<0} = -[-D'(\bar{x}) + \beta(1-\alpha) + \bar{p}][x^s - x^m] > 0. \tag{A.8}$$

□

Proof of Proposition 4. If $\bar{E}$ stays fixed, an increase of λ^k reduces p – i.e., $\partial p/\partial\lambda^k < 0$, which affects the consumption choices of selfish and Kantian consumers. The effect on selfish consumers is

$$\frac{\partial U_s}{\partial \lambda} = \underbrace{[v'(x) - c - p]}_{=0 \text{ by definition of } x^s} \frac{\partial x^s}{\partial p}\frac{\partial p}{\partial \lambda^k} - (x^s(p) - \bar{x})\frac{\partial p}{\partial \lambda^k} > 0, \tag{A.9}$$

which is positive because $x^s(p) > \bar{x}$. The effect on Kantian consumers is

$$\frac{\partial U_k}{\partial \lambda} = \underbrace{[v'(x) - \beta - c - p]}_{=0 \text{ by definition of } x^m} \frac{\partial x^m}{\partial p}\frac{\partial p}{\partial \lambda^k} - (x^m(p) - \bar{x})\frac{\partial p}{\partial \lambda^k} < 0, \tag{A.10}$$

which is negative because $x^m(p) < \bar{x}$. ☐

Proof of Proposition 5. Note that

$$\Delta^Q = \hat{x}(c) - \hat{x}(c+p) - [\hat{x}(\delta c) - \hat{x}(\delta(c+p)) \tag{A.11}$$

$$\Delta^P = \hat{x}(c) - \hat{x}(c+p+\beta) - [\hat{x}(\delta c) - \hat{x}(\delta(c+p)+\beta) \tag{A.12}$$

Part (a): For $\delta = 1$ it holds that $\Delta^Q = 0$. Thus, if $d\Delta^Q/d\delta < 0$, then $\Delta^Q > 0$ for all $\delta \in [0,1)$. Note that

$$\frac{d\Delta^Q}{d\delta} = -\hat{x}'(\delta c)c + \hat{x}'(\delta(c+p))(c+p). \tag{A.13}$$

This derivative is negative iff

$$\delta c\hat{x}'(\delta c) > \delta(c+p)\hat{x}'(\delta(c+p)), \tag{A.14}$$

which is the case if $z\hat{x}'(z)$ is strictly decreasing in z for all $z \geq \delta c$. Differentiating $z\hat{x}'(z)$ with respect to z yields

$$\hat{x}'(z) + z\hat{x}''(z) < 0 \quad \Leftrightarrow \quad -\frac{z\hat{x}''(z)}{\hat{x}'(z)} < 1\ . \tag{A.15}$$

Part (b): Note that $\Delta^P = \Delta^Q$ for $\beta = 0$. Thus, $\Delta^P < \Delta^Q$ for all $\beta > 0$ if Δ^P is strictly decreasing in β. Taking the derivative of Δ^P with respect to β yields:

$$\frac{d\Delta^P}{d\beta} = -\hat{x}'(c+p+\beta) + \hat{x}'(\delta(c+p)+\beta)\ . \tag{A.16}$$

Note that $c+p+\beta > \delta(c+p)+\beta$. The derivative is strictly negative if $\hat{x}''(z) > 0$. ☐

Proof of Proposition 6. The stage 2 utility is

$$U(e;x) = v(x) + m + \bar{p}(\bar{x} + \bar{e}) - (c + \bar{p})x - \bar{p}e - D(\bar{x}) - \beta[x - e - x^0]^+, \tag{A.17}$$

where $\bar{e}$ is the total amount of permits purchased. The costs and benefits of withdrawing emission rights are both linear in e. Thus, $e = 0$ for $\bar{p} > \beta$ and $e = x - x^=$ for $\bar{p} < \beta$. In the knife-edge case $\bar{p} = \beta$ the consumer is indifferent between all $e \in [0, x - x^0]$.

For $\bar{p} > \beta$, the stage 1 utility is

$$U(x) = v(x) + m + \bar{p}(\bar{x} + \bar{e}) - (c + \bar{p})x - D(\bar{x}). \tag{A.18}$$

This utility is maximized at $x^s = \hat{x}(c + \bar{p})$.

For $\bar{p} < \beta$, the stage 1 utility is

$$U(x) = v(x) + m + \bar{p}(\bar{x} + \bar{e}) - (c + \bar{p})x - \bar{p}(x - x^0) - D(\bar{x}). \tag{A.19}$$

The optimal consumption level is $x^e = \hat{x}(c + 2\bar{p})$. Note, since $\bar{p} < \beta$, we have $x^e > x^m = \hat{x}(c + \bar{p} + \beta)$. $\square$

References

Alger, Ingela and Jörgen W. Weibull. 2016. “Evolution and Kantian Morality.” *Games and Economic Behavior* 98:56–67.

Allcott, Hunt and Todd Rogers. 2014. “The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation.” *American Economic Review* 104 (10):3003–3037.

Ambec, Stefan and Jessica Coria. 2013. “Prices vs Quantities with Multiple Pollutants.” *Journal of Environmental Economics and Management* 66 (1):123–140.

Bartling, Björn, Roberto A. Weber, and Lan Yao. 2015. “Do Markets Erode Social Responsibility?” *The Quarterly Journal of Economics* 130 (1):219–266.

Baumol, William J. and Wallace E. Oates. 1988. *The Theory of Environmental Policy*. Cambridge: Cambridge University Press.

Bénabou, Roland, Armin Falk, and Jean Tirole. 2018. “Narratives, Imperatives, and Moral Reasoning.”

Benabou, Roland and Jean Tirole. 2006. “Incentives and Prosocial Behavior.” *American Economic Review* 96:1652–1678.

Böhringer, Christoph and Knut Einar Rosendahl. 2010. “Green promotes the dirtiest: on the interaction between black and green quotas in energy markets.” *Journal of Regulatory Economics* 37 (3):316–325.

Carattini, Stefano, Maria Carvalho, and Sam Fankhauser. 2018. “Overcoming public resistance to carbon taxes.” *Wiley interdisciplinary reviews. Climate change* 9 (5):e531.

Carattini, Stefano, Steffen Kallbekken, and Anton Orlov. 2019. “How to win public support for a global carbon tax.” *Nature* 565 (7739):289–291.

Chaudhuri, Ananish. 2011. “Sustaining Cooperation in Laboratory Public Goods Experiments: A Selective Survey of the Literature.” *Experimental Economics* 14 (1):47–83.

Coase, Ronald. 1960. “The Problem of Social Cost.” *Journal of Law and Economics* 3 (1):1–44.

Dewatripont, Mathias and Jean Tirole. 2020. “The morality of markets and the nature of competition.”

Falk, Armin and Nora Szech. 2013. “Morals and Markets.” *Science* 340 (6133):707–711.

Fankhauser, Samuel, Cameron Hepburn, and Jisung Park. 2010. “Combining Multiple Climate Policy Instruments: How Not to Do It.” *Climate Change Economics* 01 (03):209–225.

Fehr, Ernst and Simon Gächter. 2000. “Cooperation and Punishment in Public Goods Experiments.” *American Economic Review* 90 (4):980–994.

Gerlagh, Reyer and Roweno J. R. K. Heijmans. 2019. “Climate-Conscious Consumers and the Buy, Bank, Burn Program.” *Nature Climate Change* 9 (6):431–433.

Goulder, Laurence H. and Andrew R. Schein. 2013. “Carbon Taxes versus Cap and Trade: A Critical Review.” *Climate Change Economics* 4 (3):1350010.

Goulder, Lawrence H. 2013. “Markets for Pollution Allowances: What Are the (New) Lessons?” *Journal of Economic Perspectives* 27 (1):87–102.

Goulder, Lawrence H., Mark R. Jacobsen, and Arthur A. van Benthem. 2012. “Unintended Consequences from Nested State and Federal Regulations: The Case of the Pavley Greenhouse-Gas-per-Mile Limits.” *Journal of Environmental Economics and Management* 63 (2):187–207.

Helm, Dieter. 2005. “Economic Instruments and Environmental Policy.” *Economic and Social Review* 36 (3):205–228.

Hepburn, Cameron. 2006. “Regulation by Prices, Quantities, or Both: A Review of Instrument Choice.” *Oxford Review of Economic Policy* 22 (2):226–247.

Hoel, Michael and Larry Karp. 2002. “Taxes versus Quotas for a Stock Pollutant.” *Resource and Energy Economics* 24 (4):367–384.

Jakob, Michael, Dorothea Kübler, Jan Christoph Steckel, and Roel van Veldhuizen. 2017. “Clean up Your Own Mess: An Experimental Study of Moral Responsibility and Efficiency.” *Journal of Public Economics* 155:138–146.

Krupka, Erin L. and Roberto A. Weber. 2013. “Identifying Social Norms Using Coordination Games: Why Does Dictator Game Sharing Vary?” *Journal of the European Economic Association* 11 (3):495–524.

Ledyard, John O. 1995. “Public Goods: A Survey of Experimental Research.” In *The Handbook of Experimental Economics*, edited by John H. Kagel and Alvin E. Roth. Princeton University Press, 111–194.

Mandell, Svante. 2008. “Optimal Mix of Emissions Taxes and Cap-and-Trade.” *Journal of Environmental Economics and Management* 56 (2):131–140.

Montgomery, W.David. 1972. “Markets in Licenses and Efficient Pollution Control Programs.” *Journal of Economic Theory* 5 (3):395–418.

Narassimhan, Easwaran, Kelly S. Gallagher, Stefan Koester, and Julio Rivera Alejo. 2018. “Carbon Pricing in Practice: A Review of Existing Emissions Trading Systems.” *Climate Policy* 18 (8):967–991.

Nyborg, Karine, Richard B. Howarth, and Kjell Arne Brekke. 2006. “Green Consumers and Public Policy: On Socially Contingent Moral Motivation.” *Resource and Energy Economics* 28 (4):351–366.

Ockenfels, Axel, Peter Werner, and Ottmar Edenhofer. 2019. *Direct Pricing Accommodates Moral Behavior*. mimeo: University of Colgone.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

Perino, Grischa. 2015. “Climate campaigns, cap and trade, and carbon leakage: Why trying to reduce your carbon footprint can harm the climate.” *Journal of the Association of Environmental and Resource Economists* 2 (3):469–495.

Pigou, Arthur C. 1920. *The Economics of Welfare*. London: MacMillan and Co.

Pizer, William A. 2002. “Combining Price and Quantity Controls to Mitigate Global Climate Change.” *Journal of Public Economics* 85 (3):409–434.

Requate, Till. 2005. “Dynamic Incentives by Environmental Policy Instruments—A Survey.” *Ecological Economics* 54 (2-3):175–195.

Roberts, Marc J. and Michael Spence. 1976. “Effluent Charges and Licenses under Uncertainty.” *Journal of Public Economics* 5 (3-4):193–208.

Roemer, John E. 2010. “Kantian Equilibrium.” *Scandinavian Journal of Economics* 112 (1):1–24.

Sandel, Michael J. 2012. *What Money Can’t Buy: The Moral Limits of Markets.* New York: Farrar Straus and Giroux, 1. ed.

Schmalensee, Richard and Robert N. Stavins. 2017. “The Design of Environmental Markets: What Have We Learned from Experience with Cap and Trade?” *Oxford Review of Economic Policy* 33 (4):572–588.

Schwirplies, Claudia and Andreas Ziegler. 2016. “Offset Carbon Emissions or Pay a Price Premium for Avoiding Them? A Cross-Country Analysis of Motives for Climate Protection Activities.” *Applied Economics* 48 (9):746–758.

Sinn, Hans-Werner. 2008. “Public policies against global warming: A supply side approach.” *International Tax and Public Finance* 15 (4):360–394.

Sutter, Matthias, Jürgen Huber, Michael Kirchler, Matthias Stefan, and Markus Walzl. 2020. “Where to Look for the Morals in Markets?” *Experimental Economics* 23 (1):30–52.

Tiefensee, Christine. 2019. “Why Making No DiWhy Making No Difference Makes No Moral Difference.” In *Demokratie und Entscheidung*, edited by K. Marker, J. Sirsch, and A. Schmitt. Wiesbaden: Springer VS, 231–244.

Weitzman, Martin L. 1974. “Prices vs. Quantities.” *The Review of Economic Studies* 41 (4):477–491.

B Online Appendix: Generalized Model

B.1 The representative consumer

We consider a representative consumer with utility function

$$U = v(x, y, n) - D(\bar{x}), \tag{B.1}$$

where $n = \beta^R(x - x^0)$, $\beta^R \in \{\beta^Q, \beta^P\}$, $0 = \beta^Q < \beta^P = \beta$, denotes the norm violation.

We impose the following assumptions regarding the effects of increasing consumption of good X or numéraire good Y on utility.

Assumption B1 (Consumption utility). *For all $x \geq 0$, $y \geq 0$, and $n \geq 0$ it holds that:*

(i) $\partial_x v(x, y, n) > 0$ *and* $\partial_y v(x, y, n) > 0$*;*

(ii) $\partial^2_{xx} v(x, y, n) < 0$ *and* $\partial^2_{yy} v(x, y, n) \leq 0$*;*

(iii) $\partial^2_{xy} v(x, y, n) \geq 0$.

Parts (i) and (ii) are standard assumptions. Part (iii) ensures that – keeping n constant – utility is strictly concave – i.e., indifference curves are convex lines in a (x, y)-diagram. Moreover, we assume that first units of both goods are sufficiently valuable so that the consumer always chooses strictly positive amounts of both good, $x > 0$ and $y > 0$.

Regarding the utility from violating the social norm, we impose the following assumption.

Assumption B2 (Moral utility). *For all $x \geq 0$ and $y \geq 0$ it holds that:*

(i) $\partial_n v(x, y, n) < 0$ *for* $n \geq 0$ *and* $\partial_n v(x, y, n) = 0$ *for* $n < 0$*;*

(ii) $\lim_{n \searrow 0} v(x, y, n) = v(x, y, 0)$*;*

(iii) $\partial^2_{xn} v(x, y, n) \leq 0$ *and* $\partial^2_{yn} v(x, y, n) \geq 0$ *for* $n \geq 0$.

According to part (i), if the consumer consumes more of good X than the norm prescribes, she experiences a disutility from norm violation. This disutility is larger, the more her consumption exceeds the norm. Consuming less than what the norm prescribes does not create positive feelings. Part (ii) ensures that utility is continuous at $n = 0$.[18] Note that by part (i) $\lim_{n \searrow 0} \partial_n v(x, y, n) > 0 = \lim_{n \nearrow 0} \partial_n v(x, y, n)$, and thus $v(x, y, n)$ is not differentiable at $n = 0$. Denote the right-hand limit by $\lim_{n \searrow 0} \partial_n v(x, y, n) = \partial_n v(x, y, 0)$. According to the first inequality in part (iii), the larger the norm violation the lower the marginal consumption utility from consuming good X. Put differently, the hedonic pleasure from consuming X is – at the margin – reduced if the norm violation is higher. The larger the norm violation, the more is the consumer reminded that over-consumption of X is wrong, which reduces her additional intrinsic utility from consuming one additional unit of X. From a technical perspective, this assumption guarantees that a larger amount of X does not lead to a larger marginal utility dU/dx. The second inequality in part (iii) assumes that, if at all, there is a positive interaction of norm violation and consumption of good Y. This ensures that an increased consumption of x decreases the marginal rate of substitution between x and y. It plays the same role as Assumption B1(iii). Note that Assumption B2(iii) allows for consumption utility being independent of moral utility, $\partial^2_{xn} v(x, y, n) = 0$ and $\partial^2_{yn} v(x, y, n) = 0$.

Assumptions B1 and B2 are sufficient but not necessary conditions to guarantee that all maximization problems (utility and welfare) are strictly concave.

Finally, as in the model presented in the main text, we assume that $D'(\cdot) > 0$ and $D''(\cdot) \geq 0$. The consumer's budget constraint is given by

$$y + (c + p)x \leq m + p\bar{x}. \tag{B.2}$$

Since an increase in the consumption of Y always increases the intrinsic utility and does not cause any moral disutility, the budget constraint is binding.

The social norm x^0 is a convex combination of the first-best consumption x^* (defined below) and average consumption $\bar{x}$:

$$x^0 := \alpha x^* + (1 - \alpha)\bar{x}, \tag{B.3}$$

with $\alpha \in [0, 1]$. Note that in equilibrium $n = \beta^R(\bar{x} - x^0) = \beta^R \alpha(\bar{x} - x^*)$.

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[18] Continuity of $v(x, y, n)$ at $n = 0$ allows us to derive optimal consumption decisions by considering marginal changes. Moreover, it ensures that utility and welfare is continuous in the model parameters that affect the norm violation.

B.2 Material and total social welfare

Let $y^*(x) = m - cx$. This allows us to define welfare solely as a function of x, or more precisely, because of the representative consumer, as a function of $\bar{x}$. Material social welfare is defined as

$$W^M(\bar{x}) = v(\bar{x}, y^*(\bar{x}), 0) - D(\bar{x}). \tag{B.4}$$

Material social welfare is maximized at the socially optimal consumption level x^*. Total social welfare is given by

$$\begin{aligned} W(\bar{x}) &= v(\bar{x}, y^*(\bar{x}), \beta^R(\bar{x} - x^0)) - D(\bar{x}) \\ &= v(\bar{x}, y^*(\bar{x}), \beta^R\alpha(\bar{x} - x^*)) - D(\bar{x}). \end{aligned} \tag{B.5}$$

Lemma B1. *The socially optimal consumption x^*, implicitly characterized by*

$$\frac{\partial_x v(x^*, y^*, 0)}{\partial_y v(x^*, y^*, 0)} = c + \frac{D'(x^*)}{\partial_y v(x^*, y^*, 0)} \tag{B.6}$$

with $y^* = m - cx^*$, maximizes material and total social welfare.

Proof. First, we consider material welfare. Rearranging the first-order condition $dW^M/d\bar{x} = 0$ yields the optimality condition provided in the lemma. Furthermore, by Assumption B1

$$\frac{d^2W^M}{d\bar{x}^2} = \partial^2_{xx}v(x, y, 0) - 2c\, \partial^2_{xy}v(x, y, 0) + (-c)^2\partial^2_{yy}v(x, y, 0) - D''(\bar{x}) < 0, \tag{B.7}$$

and thus $W^M(\bar{x})$ is strictly concave. Hence, satisfying the first-order condition is necessary and sufficient for optimality.

Second, we consider total social welfare. Note that $W(\cdot) = W^M(\cdot)$ for $n \leq 0$. For $n > 0$ we obtain

$$\frac{dW}{d\bar{x}} = \partial_x v(x, y, n) - c\, \partial_y v(x, y, n) + \beta^R\alpha\, \partial_n v(x, y, n) - D'(\bar{x}), \tag{B.8}$$

and

$$\begin{aligned} \frac{d^2W}{d\bar{x}^2} = {} & \partial^2_{xx}v(x, y, n) - 2c\, \partial^2_{xy}v(x, y, n) + 2\beta^R\alpha\, \partial^2_{xn}v(x, y, n) + (-c)^2\partial^2_{yy}v(x, y, n) \\ & - 2c\beta^R\alpha\, \partial^2_{yn}v(x, y, n) + (\beta^R\alpha)^2\partial^2_{nn}v(x, y, n) - D''(\bar{x}) < 0 \end{aligned} \tag{B.9}$$

where $d^2W/d\bar{x}^2 < 0$ follows from Assumptions B1 and B2. Hence, $W(\cdot)$ is a strictly concave function with potentially a kink at $x = x^*$ and thus $n = 0$. Finally, noting that for $n > 0$

$$\left.\frac{dW}{d\bar{x}}\right|_{\bar{x}=x^*} < 0 \tag{B.10}$$

implies that x^* maximizes – next to $W^M(\cdot)$ – also $W(\cdot)$. □

B.3 Consumer's behavior

The representative consumer chooses her consumption x to maximize

$$U(x) = v(x, y(x), \beta^R(x - x^0)) - D(\bar{x}), \tag{B.11}$$

where $y(x) = m + p\bar{x} - (c+p)x$. For $n > 0$, the equilibrium consumption is implicitly defined by the following optimality condition

$$\frac{\partial_x v(\hat{x}, \hat{y}, \hat{n})}{\partial_y v(\hat{x}, \hat{y}, \hat{n})} = c + p - \beta^R \frac{\partial_n v(\hat{x}, \hat{y}, \hat{n})}{\partial_y v(\hat{x}, \hat{y}, \hat{n})}, \tag{B.12}$$

with $\hat{y} = m - c\hat{x}$ and $\hat{n} = \beta^R(\hat{x} - x^0) = \alpha\beta^R(\hat{x} - x^*)$. Note that by Assumptions B1 and B2 the utility function is strictly concave; formally,

$$\begin{aligned} U''(x) &= \partial^2_{xx} v(x,y,n) - 2(c+p)\ \partial^2_{xy} v(x,y,n) + 2\beta^R\ \partial^2_{xn} v(x,y,n) \\ &\quad + [-(c+p)]^2 \partial^2_{yy} v(x,y,n) - 2(c+p)\beta^R\ \partial^2_{yn} v(x,y,n) + (\beta^R)^2 \partial^2_{nn} v(x,y,n) < 0. \end{aligned} \tag{B.13}$$

We assume that the first-best consumption is not attainable due to a political constraint.

Assumption B3 (Political constraint)**.** *The emissions tax/permit price is bounded from above:*

$$p \leq \bar{p} < \frac{D'(x^*) - \beta \partial_n v(x^*, y^*, 0)}{\partial_y v(x^*, y^*, 0)}.$$

To simplify expressions, we define

$$\mu(x) = \frac{\partial_x v(x, y(x), n(x))}{\partial_y v(x, y(x), n(x))} > 0 \tag{B.14}$$

and

$$\psi(x) = \frac{\partial_n v(x, y(x), n(x))}{\partial_y v(x, y(x), n(x))} < 0. \tag{B.15}$$

With this notation, equilibrium consumption $\hat{x} = \hat{x}(p, \beta^R)$ is implicitly defined by

$$\mu(\hat{x}) = c + p - \beta^R \psi(\hat{x}). \tag{B.16}$$

Note that $\mu'(x) < 0$ while the sign of $\psi'(x)$ is undetermined. This implies that Assumptions B1 and B2 are not sufficient to rule out that good X is a *Giffen good* (within a certain price range). The following assumption guarantees that X is an *ordinary good.*

Assumption B4. $\mu'(x) + \beta\psi'(x) < 0$ *for all* $\beta \geq 0$.

From equation (B.16) together with Assumption B4, we readily obtain that

$$\frac{d\hat{x}}{dp} = \frac{1}{\mu'(\hat{x}) - \beta^R \psi'(\hat{x})} < 0. \tag{B.17}$$

By Assumption B3 the first-best consumption is not attainable and realized consumption is always too high. Material and total social welfare are strictly concave. Thus, choosing p such that $\hat{x}$ is as low as possible is optimal. Consumption of X is decreasing in p and thus $p = \bar{p}$ is optimal. In other words, under price regulation the social planer specifies $p = \bar{p}$ and under quantity regulation he sets $\bar{E}$ such that $p(\bar{E}) = \bar{p}$.

B.4 Prices versus quantities

From the previous analysis the next result, comparing the resulting quantities, is readily obtained.

Proposition B1. $x^* < x^P = \hat{x}(\bar{p}, \beta) < \hat{x}(\bar{p}, 0) = x^Q$.

Proof. Implicit differentiation of (B.16) with respect to β^R yields

$$\frac{d\hat{x}}{d\beta^R} = \frac{-\psi(\hat{x})}{\mu'(\hat{x}) + \beta^R \psi'(\hat{x})} < 0. \tag{B.18}$$

□

Note that lower quantities improve material welfare because consumption is always inefficiently high. Moreover, the quantity implemented under price regulation is decreasing in β, while it is independent of β under quantity regulation. From these considerations the next result follows immediately.

Proposition B2.

(i) Material social welfare is unambiguously higher with price regulation than with quantity regulation, i.e.

$$W^M(x^P) > W^M(x^Q) \ . \tag{B.19}$$

(ii) The difference in material welfare is strictly increasing in β,

$$\frac{d(W^M(x^P) - W^M(x^Q))}{d\beta} > 0. \tag{B.20}$$

(iii) Total social welfare is higher with price than with quantity regulation if and only if

$$v(x^P, y^P, \alpha\beta(x^P - x^*)) - D(x^P) \geq v(x^Q, y^Q, 0) - D(x^Q) \ . \tag{B.21}$$

This is the case if the social norm is sufficiently descriptive (α sufficiently small).

Proof.

(i) Material welfare is strictly concave in $\bar{x}$ and maximized at x^*. By Proposition B1 we have $x^* < x^P < x^Q$, and thus $W^M(x^P) > W^M(x^Q)$.

(ii) Note that W^M depends on β^R only indirectly via $\hat{x}$. Additionally, x^Q is independent of β. Thus,

$$\frac{d(W^M(x^P) - W^M(x^Q))}{d\beta} = \frac{dW^M(x^P)}{d\bar{x}} \times \frac{d\hat{x}(\bar{p}, \beta)}{d\beta} > 0. \tag{B.22}$$

The first term is negative because W^M is strictly concave and $x^P > x^*$. The second term is negative as shown in (B.18).

(iii) It remains to show that (B.22) holds if $\alpha \to 0$. First, note that $W(x^Q)$ is independent of α. Welfare under price regulation, however, depends on α. A change in α changes the norm x^0 and the equilibrium consumption $\hat{x}(\alpha) = x^P$, where $\hat{x}(\alpha)$ is implicitly defined by

$$\frac{\partial_x v(\hat{x}(\alpha), \hat{y}(\alpha), \alpha\beta(\hat{x}(\alpha) - x^*))}{\partial_y v(\hat{x}(\alpha), \hat{y}(\alpha), \alpha\beta(\hat{x}(\alpha) - x^*))} = c + \bar{p} - \beta \frac{\partial_n v(\hat{x}(\alpha), \hat{y}(\alpha), \alpha\beta(\hat{x}(\alpha) - x^*))}{\partial_y v(\hat{x}(\alpha), \hat{y}(\alpha), \alpha\beta(\hat{x}(\alpha) - x^*))}, \tag{B.23}$$

with $\hat{y} = m - c\hat{x}(\alpha)$. For $\alpha \to 0$, the consumed amount is $\hat{x}(0)$ defined by

$$\frac{\partial_x v(\hat{x}(0), \hat{y}(0), 0)}{\partial_y v(\hat{x}(0), \hat{y}(0), 0)} = c + \bar{p} - \beta \frac{\partial_n v(\hat{x}(0), \hat{y}(0), 0)}{\partial_y v(\hat{x}(0), \hat{y}(0), 0)}. \tag{B.24}$$

For this $\hat{x}(0)$ – under the imposed assumptions – it still holds that $d\hat{x}/d\beta < 0$ and thus $x^P = \hat{x}(0) < x^Q$. Intuitively speaking, even if the norm is purely descriptive and thus a consumer does not suffer from a norm violation in equilibrium, at the margin she still suffers from over-consumption (norm violation) under a price regulation.

Hence,

$$\lim_{\alpha \to 0} W(x^P) = v(x^P(0), y^P(0), 0) - D(x^P(0)), \tag{B.25}$$

with $x^P(0) = \hat{x}(0)$. It follows that $\lim_{\alpha \to 0} W(x^P)$ is strictly larger that $W(x^Q)$, because $W(\cdot)$ is strictly concave and $x^* < x^P(0) < x^Q$.

□