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Working Paper

Morality-Induced Leakage and Decentralized Environmental Policy

CESifo Working Paper, No. 11698

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Eichner, Thomas; Runkel, Marco (2025) : Morality-Induced Leakage and Decentralized Environmental Policy, CESifo Working Paper, No. 11698, CESifo GmbH, Munich

This Version is available at:

<https://hdl.handle.net/10419/314737>

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Impressum:

CESifo Working Papers

ISSN 2364-1428 (electronic version)

Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH

The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute

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Editor: Clemens Fuest

<https://www.cesifo.org/en/wp>

An electronic version of the paper may be downloaded

- from the SSRN website: www.SSRN.com
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Abstract

Within a two-country model, this paper identifies a novel emission leakage channel that is caused by moral behavior of (atomistic) consumers. In a non-cooperative emission tax game between the countries, the leakage effect lowers the governments' marginal benefit of emission taxation, so equilibrium emission tax rates are even lower and the emission levels even higher than in the business-as-usual without moral consumers. The detrimental effect of consumer morality may remain, if governments behave morally, too, and may even be exacerbated under country asymmetries. It disappears, if governments choose emission caps, since the caps fix national emissions and avoid morality-induced leakage.

JEL-Codes: H230, H710, Q580.

Keywords: moral behaviour, emissions, tax, cap, leakage.

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February 17, 2025

Eichner gratefully acknowledges financial support by the German Research Foundation (DFG) grant number EI 847/2-1.

1 Introduction

The Paris Agreement was signed in 2015 with the goal to keep the global mean temperature rise below 1.5°C above pre-industrial levels. For that purpose, countries commit to nationally determined contributions to reduce their greenhouse gas emissions. Many economists such as Carraro (2016) and Tol (2019) consider the Paris Agreement as a non-cooperative (decentralized) approach to mitigate climate change. But there are doubts that a decentralized framework will reach its goal. For instance, the recent Emissions Gap Report already estimates a global temperature rise of $2.6 - 3.1^{\circ}\text{C}$ (UNEP, 2024). Next to the countries well-known free riding incentive, one central reason for the ineffectivity of decentralized climate policy is emission leakage, according to which a unilateral emission reduction in one country is at least partially offset by an emission increase in other countries. Typical leakage channels are, e.g., reduced international fossil fuel prices that increase fossil fuel demand and emissions abroad and the reallocation of firms into countries with laxer climate policies.

This paper identifies a novel and, to the best of our knowledge, so far unknown leakage effect that, surprisingly, is caused by moral behavior of consumers. In global problems like climate change, each consumer is atomistic, since her contribution to worldwide emissions is negligible. As rational individual, she takes as given the climate damage and ignores that the damage also depends on emissions and climate policies in other countries. We therefore should not expect a leakage effect that works through the climate damage itself. Our analysis shows, however, that this picture changes, if consumers have moral concerns. If the individual consumer follows the categorical imperative of Kant (1785), she counterfactually assumes that her emission level is chosen also by other consumers and thereby has an impact on climate damage. Realistically, however, this Kantian universalization is only partial, i.e. the individual consumer can only hope that her emission level is chosen by a part of other consumers, while the remaining consumers stick to their own emission levels. The counterfactual non-negligible impact of the domestic consumer on climate damage together with the deviating behavior of some foreign consumers establishes a strategic substitution link, i.e. if domestic consumers reduce (increase) emissions, foreign consumers increase (reduce) theirs, even though all consumers are still atomistic. Accordingly, it turns out that domestic environmental policy that reduces emissions by domestic consumers causes morality-induced leakage to foreign consumers and worsens the outcome of decentralized environmental policy.

Our results are brought forward in a stylized two-country model in which governments decentrally choose their environmental policy and atomistic consumers decide on their demand for a clean and a dirty consumption good. The dirty good causes transboundary

pollution and environmental damages in both countries. Consumers are modeled as *homo moralis* individuals, a concept introduced to the economic literature by Alger and Weibull (2013, 2016, 2017, 2020). Accordingly, the *homo moralis* consumer applies Kantian universalization and wants a certain share of the other consumers to choose the same dirty consumption and emission level as she does. This share reflects the consumer’s degree of morality. Under full (no) universalization, the share is one (zero) and we obtain the polar case of a *homo kantiansis* (*homo oeconomicus*) consumer who universalizes her behavior to all (none of the) other consumers. Most plausible, however, is the intermediate case with partial universalization where the *homo moralis* consumer counterfactually assumes that only a part of other consumers behave as she does. The *homo moralis* approach appears to be realistic since, e.g., many consumers voluntarily buy carbon offsets when flying or eat plant-based diet for climate protection reasons. Moreover, experimental evidence is provided by Capraro and Rand (2018) and Van Leeuwen and Alger (2024), who estimate the degree of morality between 0.1 and 0.2 on average, making the case for partial universalization.¹

We start with the non-cooperative emission tax game and first investigate the consumers’ behavior for given emission tax rates of the governments. Introducing morality by the *homo moralis* approach makes the consumers’ choice of dirty good consumption and, thereby, emissions dependent on other consumers’ dirty good consumption and emissions. Emissions turn out to be strategic substitutes for consumers, i.e. when consumers of one country increase emissions, then consumers of the other country react by decreasing emissions and *vice versa*. The strategic interdependency among consumers is remarkable since consumers are atomistic. It is caused by partial Kantian universalization according to which, on the one hand, the individual consumer thinks that her emissions have an impact on the environmental damage and, on the other hand, there are still consumers who choose different emission levels. From this intuition, it is also clear that the strategic interdependency

¹The Alger-Weibull *homo moralis* approach has been applied in games with public goods or externalities (Alger and Weibull, 2017, 2020; Eichner and Pethig, 2021), voting games (Alger and Laslier, 2022, Dierks et al., 2024) and Nash bargaining games (Juan-Bartroli and Karagözoğlu, 2024). Eichner and Runkel (2024) present an extension and characterize the behavior of heterogenous *homo moralis* individuals as well as the implications of heterogenous morality in public good games. An alternative approach to model Kant’s categorical imperative is the so-called Kantian optimization protocol, which has been developed by Roemer (2010, 2015) and applied to, for example, negative and positive externalities (Roemer, 2015), climate change mitigation (Grafton et al., 2017) and Nash bargaining games (Dizdharlar and Karagözoğlu 2023). Finally, Bilodeau and Gravel (2004) model Kantian behavior by introducing an equivalence relation, that allows to identify morally equivalent strategies, and the principle of universalized rationality, that selects the morally equivalent strategy which maximizes the individual payoff of each individual player.

between consumers disappears in the two polar cases of *homo oeconomicus* consumers, who do not universalize at all and proceed on the assumption that their emissions do not influence global emissions, and *homo kantiansis* consumers, who fully universalize so that their decision no longer depends on emissions of other consumers.

Next, we investigate the decentralized choice of emission tax rates by the governments of two identical countries. We find that the strategic interaction between the *homo moralis* consumers of the two countries establishes a morality-induced leakage effect: if one country reduces emissions of its consumers by increasing its emission tax rate, this reduction is partially offset by the emission increase of the consumers in the other country. The morality-induced leakage may have counterintuitive implications for the non-cooperative equilibrium of the policy game between the two countries. As benchmark, we consider the business-as-usual equilibrium in which neither consumers nor governments apply Kantian universalization. Morality-induced leakage is then absent (because consumers are not moral) and each country internalizes only its own marginal damage, implying inefficiently low emission tax rates and inefficiently high emissions. Starting from the business-as-usual equilibrium and introducing *homo moralis* consumers, while governments are still assumed to not behave morally, leads to an equilibrium of the non-cooperative policy game that shows even *lower* emission taxes and *higher* emissions than the business-as-usual, with a negative impact on welfare of the two countries. The reason for this counterintuitive result is that morality-induced leakage lowers the governments' marginal benefit of emission taxation. Morality of consumers thus exerts an unintended negative effect on climate and welfare.

In a further step, we allow governments to follow the Alger-Weibull *homo moralis* paradigm as well, where the governments' degree of morality may or may not deviate from the consumers' degree of morality. *Homo moralis* governments face opposing incentives. On the one hand, morality induces the individual government to internalize not only its own damage, but also a part of the other country's damage and, thus, to increase its emission tax. On the other hand, however, morality-induced leakage is still present and induces the government to reduce its emissions tax. If the former effect is stronger than the latter, then equilibrium emissions are lower and welfare higher than in the business-as-usual. However, if morality-induced leakage is stronger than the morality-induced increase in the government's internalization incentive, then equilibrium emissions are still higher and welfare levels still lower than in the business-as-usual. These results remain qualitatively unchanged, if we introduce small asymmetries between the countries. Large asymmetries with respect to the population size of the countries mitigate leakage and its detrimental effect on the outcome of decentralized environmental policy, while large asymmetries in the consumers' or

governments' degree of morality may even exacerbate it.

Finally, we re-examine our results for the case that governments choose emission caps instead of emission taxes. The strategic interaction between the (atomistic) consumers of the two countries then still prevails, but it now merely leads to changes in the national permit prices. Aggregate emissions in a country, in contrast, are fixed by the country's emission cap such that morality-induced emission leakage cannot arise. The non-cooperative equilibrium of the policy game between the two countries is therefore independent of the consumers' morality. It coincides with the business-as-usual in the one polar case of *homo oeconomicus* governments without morality, improves if governments become *homo moralis* with a positive degree of morality and eventually achieves the social optimum in the other polar case of *homo kantiansis* governments with full morality. Moreover, for given degree of consumer and government morality, emissions caps are always superior to emission taxes and, thereby, we make a novel argument in favor of emission caps over emission taxes.

Our paper contributes to three strands of the literature on decentralized environmental policy making. The first strand analyzes non-cooperative equilibria in decentralized policy games and their (in)efficiency properties. For example, in Hoel's (1991) and Barrett's (1994a) simple models with transboundary pollution, the non-cooperative equilibrium is characterized by inefficiently large emissions.² Additional inefficiencies and distortions may be caused by, e.g., international trade (Cremer and Gahvari, 2004; Hoel, 2005), imperfect competition (Barrett, 1994b; Kennedy, 1994) or firm mobility (Richter et al., 2021). Surprisingly, decentralized policy making can be efficient, if the population or capital is mobile (Hoel and Shapiro, 2003; Ogawa and Wildasin, 2009; Eichner and Runkel, 2012). Anyhow, none of these studies takes into account consumer or governmental morality. An exception is Eichner and Pethig (2021) who also consider a two-country model with moral consumers and governments. However, they focus on strategic delegation and, in contrast to our analysis, assume a linear damage function. As consequence, morality-induced leakage and its detrimental implications for decentralized policy are not present in their model.

The second related strand of literature investigates emission leakage, i.e. the effect that unilaterally reducing emissions in one country increases emissions in other countries. Leakage can arise, for example, through the reduction of international fossil fuel prices which increases fossil fuel demand and emissions in other countries (Bohm, 1993; Kiyono and Ishikawa, 2013), through the reallocation of mobile firms (Markusen et al., 1995; Ishikawa

²Strictly speaking, Barrett (1994a) has formulated his model in terms of abatement. Rubio and Ulph (2006) have shown that the abatement model can be transformed into an isomorph emission model.

and Okubo, 2017) or through a change in the countries' comparative advantages (Copeland and Taylor, 2005). Interestingly, even negative leakage is possible, if intermediate inputs are internationally traded (Baylis et al., 2013). To the best of our knowledge, there is no study in the leakage literature that considers moral consumers and governments and that derives the morality-induced leakage effect, which is the focus of our analysis.

The third related strand of literature compares emission taxes and emission caps in multi-jurisdictional settings. In Ulph's (1996) model with imperfect competition and international trade, strategic behavior is more intense with emission taxes than with emission caps. Kiyono and Ishikawa (2013) endogenize the policy choice in a two-country model with perfect competition and international trade. Two different subgame perfect equilibria exist in their framework. Either both countries choose emission caps or one country chooses emission taxes whereas the other country chooses emission caps. Mideksa and Weitzman (2021) show that emission caps and emission taxes are no longer isomorph when cost functions are uncertain, and in the model of Eichner and Pethig (2019) with capital mobility and capital taxation, emission caps are Pareto superior to emission taxes. Our analysis complements these studies by identifying the detrimental effects of morality-induced leakage under emission taxes as further argument in favor of emission caps.

The remaining analysis is organized as follows. In Section 2, we present the two-country model and characterize the efficient allocation. Section 3 investigates decentralized policy making, when countries use emission taxes and are symmetric. Section 4 turns to emission taxes with asymmetric countries. In Section 5, we analyze decentralized policy making with emission caps, and Section 6 provides some concluding remarks.

2 Model and social optimum

Consider an economy consisting of two countries indexed by $i, j = 1, 2$ with $i \neq j$. Country i is populated by $n_i > 0$ identical and atomistic consumers, where $n = n_i + n_j > 0$ is the total mass of consumers in both countries. If the mass of consumers is normalized to one, n_i and n_j give the population share of country i and country j , respectively. For the largest part of the analysis we focus on symmetric countries with equal population shares $n_i = n_j = n/2$. The only exception is Section 4, where the impact of country asymmetries is analyzed.

The individual consumer in country i has a given resource endowment $\omega_i > 0$ and consumes a non-polluting (clean) numeraire good in quantity x_i as well as a polluting (dirty) good in quantity y_i . Her consumption preferences are represented by the quasi-linear utility

function $B(y_i) + x_i$ with $B'' < 0 < B'$. Production technologies are linear for both goods. The price of the clean good is normalized to one, whereas the price of the dirty good equals p . Each unit of the polluting good causes one unit of emissions. Global emissions thus read

$$e = n_i y_i + n_j y_j. \quad (1)$$

Global emissions e represent a global public bad and cause an environmental damage $H(e)$ with $H' > 0$ and $H'' > 0$ that is incurred by each consumer. Materialistic utility of the individual consumer in country i equals consumption utility less environmental damage, i.e.

$$u_i = B(y_i) + x_i - H(e). \quad (2)$$

The model is closed by the worldwide resource constraint

$$n_i x_i + n_j x_j + p(n_i y_i + n_j y_j) = n_i \omega_i + n_j \omega_j. \quad (3)$$

The RHS of (3) is the global resource endowment which is required to match with the aggregate resource use in production on the LHS of (3), where $n_i x_i + n_j x_j$ and $p(n_i y_i + n_j y_j)$ represent the resource input in the production of good X and good Y , respectively.

Materialistic welfare of all consumers in country i is given by $w_i = n_i u_i$. In order to determine the social optimum, consider a social planner who maximizes global welfare $w = w_i + w_j$ subject to the resource constraint (3). Making use of (1) and (2) and replacing clean consumption $n_i x_i + n_j x_j$ with the help of (3), the social planner's objective reads

$$w = n_i B(y_i) + n_j B(y_j) + n_i \omega_i + n_j \omega_j - p(n_i y_i + n_j y_j) - nH(n_i y_i + n_j y_j). \quad (4)$$

Formally, the social planner maximizes (4) with respect to y_i and y_j . Indicating socially optimal values by a star, the first-order conditions are $B'(y_i^*) - p = nH'(n_i y_i^* + n_j y_j^*) = B'(y_j^*) - p$ and imply equal emissions $y_i^* = y_j^* =: y^*$, even if countries are asymmetric. Hence, the socially optimal emissions y^* are determined by the allocation rule

$$B'(y^*) - p = nH'(ny^*). \quad (5)$$

This allocation rule requires that the socially optimal emissions y^* are set such that the marginal consumption utility B' of one unit of the dirty good, net of the marginal production costs p , equals the worldwide marginal damage nH' .

3 Emission taxes

In this section, we investigate the consumers' consumption decision, if they behave morally and are regulated by an emission tax, as well as the governments choice of the emission tax rates, where governments may act morally as well.

***Homo moralis* consumers.** All consumers behave morally and follow the Kantian categorical imperative as formalized by Alger and Weibull (2013, 2016, 2017, 2020). Accordingly, the individual consumer in country i is a *homo moralis* and universalizes her consumption decision to other consumers. She assumes that, with probability $\kappa_i \in [0, 1]$, another consumer chooses the same dirty good consumption y_i as she does herself and, with probability $1 - \kappa_i$, the other consumer chooses her own dirty good consumption, i.e. \bar{y}_i if the consumer is from country i and y_j if the consumer is from country j . The probability κ_i is interpreted as the degree of morality of a consumer from country i . For $\kappa_i = 0$ and $\kappa_i = 1$ we obtain the two polar cases of the *homo oeconomicus* consumer, who does not universalize her dirty good consumption at all, and the *homo kantiansis* consumer, who universalize her dirty good consumption to all other individuals in both countries. The *homo moralis* concept, however, is more general than these two polar cases as it allows for interior morality levels $\kappa_i \in]0, 1[$ and, thereby, also for partial Kantian universalization.

Since all consumers are assumed to be atomistic, the law of large numbers applies and turns the probabilities into relative shares. Hence, the atomistic consumer from country i assumes that a share κ_i of all other consumers selects the same quantity y_i as she does, whereas a share $1 - \kappa_i$ of country i consumers chooses the quantity \bar{y}_i and a share $1 - \kappa_i$ of country j consumers chooses the quantity y_j .³ From the point of view of the individual *homo moralis* consumer in country i , global pollution equals

$$E^i(y_i, \bar{y}_i, y_j) = n\kappa_i y_i + (1 - \kappa_i)n_i \bar{y}_i + (1 - \kappa_i)n_j y_j. \quad (6)$$

Equation (6) does not reflect actual emissions, but counterfactual emissions which the *homo moralis* consumer from country i assumes in her consumption decision.

If the government of country i imposes an emission tax at rate t_i , the budget constraint of the consumer in country i is given by $x_i + (p + t_i)y_i = \omega_i$. Using the budget constraint in order to eliminate x_i in (2) and replacing actual emissions (1) by counterfactual emissions (6), the objective function of the *homo moralis* consumer in country i reads

$$u_i^m = B(y_i) + \omega_i - (p + t_i)y_i - H[E^i(y_i, \bar{y}_i, y_j)]. \quad (7)$$

The *homo moralis* consumer in country i maximizes the objective (7) with respect to her emissions y_i , taking as given her government's tax rate t_i as well as emissions \bar{y}_i and y_j of the other consumers. Consequently, for given tax rates t_i and t_j , we obtain a non-cooperative

³For this kind of modeling of *homo moralis* behavior in large economies with atomistic individuals see, for instance, the recent studies of Alger and Laslier (2022) and Dierks et al. (2024).

game in emissions among consumers. Differentiating (7) with respect to y_i and taking into account (6) gives the first-order condition of country i 's consumer⁴

$$\frac{du_i^m}{dy_i} = B'(y_i) - p - t_i - n\kappa_i H'[E^i(y_i, \bar{y}_i, y_j)] = 0. \quad (8)$$

In view of (8), the *homo moralis* consumer in country i equates the net marginal consumption benefit, $B' - p - t_i$, to the share κ_i of the global marginal damage nH' . Introducing morality induces the consumer to take into account at least a part κ_i of the global marginal damage.

In general, the first-order condition (8) for consumer i 's emissions y_i depends on emissions \bar{y}_i and y_j of the other consumers. The non-cooperative emission game between the consumers therefore establishes a strategic interdependency among consumers. In order to characterize the nature of this interdependency, notice that in equilibrium we have $y_i = \bar{y}_i$, since all consumers in country i are alike. Counterfactual emissions from (6) then simplify to $E^i(y_i, y_i, y_j) = (n_i + n_j\kappa_i)y_i + (1 - \kappa_i)n_jy_j$ and the first-order condition (8) determines a 'country-specific' reaction function $y_i = R^i(y_j, t_i)$. This reaction function determines emissions y_i of country i 's consumers as function of emissions y_j of country j 's consumers and country i 's tax rate t_i , presupposed all consumers in country i choose the same emissions y_i .⁵ Totally differentiating (8) and taking into account $E^i(y_i, \bar{y}_i, y_j) = E^i(y_i, y_i, y_j) = (n_i + n_j\kappa_i)y_i + (1 - \kappa_i)n_jy_j$, the partial derivatives of $y_i = R^i(y_j, t_i)$ are

$$R_{y_j}^i = \frac{n\kappa_i(1 - \kappa_i)n_jH''}{B'' - n\kappa_i(n_i + n_j\kappa_i)H''} \leq 0, \quad R_{t_i}^i = \frac{1}{B'' - n\kappa_i(n_i + n_j\kappa_i)H''} < 0, \quad (9)$$

where we have suppressed the arguments of the functions for simplicity. According to the first expression in (9), interior morality $\kappa_i \in]0, 1[$ implies a downward sloping reaction curve ($R_{y_j}^i < 0$), such that domestic and foreign emissions are strategic substitutes. If the *homo moralis* consumers of country j increase their emissions, the *homo moralis* consumers of country i react by decreasing their emissions and *vice versa*. This strategic substitutability disappears ($R_{y_j}^i = 0$) only in the two polar cases of *homo oeconomicus* consumers ($\kappa_i = 0$), who take the marginal damage as given, and *homo kantianses* consumers ($\kappa_i = 1$), who universalize their emissions to all other consumers and ignore actual emissions of the others. Due to the second expression in (9), increases in country i 's tax rate t_i shift the reaction curve R^i downwards and, for given emissions y_j of country j consumers, induce the consumers of

⁴The second-order condition $B''(y_i) - n^2\kappa_i^2H''[E^i(y_i, \bar{y}_i, y_j)] < 0$ is satisfied due to $B'' < 0$ and $H'' > 0$.

⁵The characterization of the strategic interdependency does qualitatively not change, if we consider the 'consumer-specific' reaction function $y_i = \tilde{R}^i(\bar{y}_i, y_j, t_i)$, which follows from (8) without setting $y_i = \bar{y}_i$. The only difference is that, next to the strategic relation between y_i and y_j , the use of $\tilde{R}^i(\cdot)$ also reveals a strategic relation between y_i and \bar{y}_i , which is not of interest in our subsequent analysis.

country i to reduce their emissions. In the subsequent analysis, we refer to $R_{y_j}^i < 0$ as the emission substitution channel and to $R_{t_i}^i < 0$ as the tax rate channel.

Equilibrium emissions (y_i, y_j) of the emission game between consumers simultaneously satisfy both reaction functions $y_i = R^i(y_j, t_i)$ and $y_j = R^j(y_i, t_j)$ for $j \neq i$ or, equivalently, the country i consumer's first-order condition (8) and the associated first-order condition of the consumer from country $j \neq i$. In the remainder of this section, we restrict our attention on symmetric countries with equal population sizes $n_i = n_j = n/2$ and equal degrees of morality $\kappa_i = \kappa_j =: \kappa$. The first-order condition (8) and the associated first-order condition of country $j \neq i$ can then be rewritten as

$$B'(y_i) - p - t_i - n\kappa H' \left[\frac{n(1+\kappa)}{2} y_i + \frac{n(1-\kappa)}{2} y_j \right] = 0, \quad (10)$$

$$B'(y_j) - p - t_j - n\kappa H' \left[\frac{n(1+\kappa)}{2} y_i + \frac{n(1-\kappa)}{2} y_j \right] = 0. \quad (11)$$

These conditions determine the individual equilibrium emissions in country i and country j as functions of the emission tax rates, i.e. $y_i = Y^i(t_i, t_j)$ and $y_j = Y^j(t_i, t_j)$, respectively. In the appendix, we perform a comparative static analysis of the tax rate t_i on the emission levels y_i and y_j . Evaluated at a symmetric equilibrium with identical tax rates $t_i = t_j =: t$, which imply $y_i = y_j =: y$ and $E^i(y, y, y) = ny$, we obtain

$$Y_{t_i}^i = \frac{1}{\Delta} \left\{ B'' - \frac{n^2 \kappa (1+\kappa)}{2} H'' \right\} < 0, \quad Y_{t_i}^j = \frac{1}{\Delta} \frac{n^2 \kappa (1-\kappa)}{2} H'' \geq 0, \quad (12)$$

where $\Delta > 0$ is the Jacobian determinant of (10) and (11), and where we again suppress the arguments of the functions for simplicity. The own-country tax effect $Y_{t_i}^i < 0$ shows that an increase in country i 's tax rate t_i reduces the consumers' equilibrium emissions in country i . Intuitively, it is based on the tax rate channel, which shifts the reaction curve of consumers from country i downwards and, thereby, lowers equilibrium emissions y_i . The expression $Y_{t_i}^j \geq 0$ is the cross-country effect of the tax rate in country i on equilibrium emissions in country j . It is based on the emission substitution channel. Consequently, for the polar cases of no morality $\kappa = 0$ or full morality $\kappa = 1$, the cross-country effect $Y_{t_i}^j$ becomes zero. But for all interior morality levels $\kappa \in]0, 1[$, the emission substitution channel is non-zero and we obtain $Y_{t_i}^j > 0$. Morality then causes a novel emission leakage effect: an increase in country i 's tax rate t_i increases equilibrium emissions y_j in country j . This leakage effect is inverted u-shaped in morality, increasing from zero at $\kappa = 0$ to a maximum at some intermediate morality and then decreasing to zero again if morality reaches $\kappa = 1$.

Inserting $y_i = Y^i(t_i, t_j)$ and $y_j = Y^j(t_i, t_j)$ into (1) gives global actual emissions as function of the two countries' tax rates, i.e. $e = n_i Y^i(t_i, t_j) + n_j Y^j(t_i, t_j) =: E(t_i, t_j)$. Taking

the derivative, afterwards assuming symmetry and using (12), we get

$$E_{t_i} = \frac{n(B'' - n^2\kappa^2 H'')}{2\Delta} < 0. \quad (13)$$

An increase in the emission tax t_i of country i reduces global equilibrium emissions e . Hence, emission leakage is less than 100 % and a green paradox does not occur, i.e. the negative own-country tax effect $Y_{t_i}^i < 0$ overcompensates the non-negative leakage effect $Y_{t_i}^j \geq 0$.

***Homo moralis* governments.** We now turn to the choice of tax rates by the governments of the two countries. It is assumed that, in setting the emission tax rates, governments may follow the *homo moralis* paradigm as well. This assumption may be motivated by the fact that governments are elected by and represent consumers who have morality concerns. In order to account for political friction, however, we suppose that the government of country i has a degree of morality $\mu_i \in [0, 1]$, which may or may not be equal to the consumers' morality κ_i in country i . A justification for $\mu_i \neq \kappa_i$ could be that, when making the consumption decision on y_i , the consumer in country i applies morality κ_i , while as a member of the government, she applies a possible different morality μ_i , because choosing the tax rate is different from choosing consumption. However, our analysis also allows for the case $\mu_i = \kappa_i$ in which the consumers' and government's moralities are identical.

In contrast to consumers, the governments are not atomistic, since there are only two countries.⁶ Hence, the degree of morality μ_i cannot be interpreted as relative share, but gives the probability that country j chooses the same tax rate t_i as country i . Taking into account equilibrium emissions of the emission game among consumers, formally $y_i = Y^i(t_i, t_j)$, $y_j = Y^j(t_i, t_j)$ and $e = E(t_i, t_j)$, and that the tax revenues $t_i Y^i(t_i, t_j)$ in country i are redistributed back to consumers in country i by a lump sum transfer, the objective function of the *homo moralis* government in country i is given by

$$\begin{aligned} W^i(t_i, t_j) = & n_i \left\{ (1 - \mu_i) \left[B[Y^i(t_i, t_j)] + w_i - pY^i(t_i, t_j) - H[E(t_i, t_j)] \right] \right. \\ & \left. + \mu_i \left[B[Y^i(t_i, t_i)] + w_i - pY^i(t_i, t_i) - H[E(t_i, t_i)] \right] \right\}. \quad (14) \end{aligned}$$

The objective $W^i(t_i, t_j)$ in (14) is the expected moral welfare in country i . This expected welfare equals the sum of materialistic welfare of consumers in country i , if country j sticks to its own tax rate t_j , which happens with probability $1 - \mu_i$, and the materialistic welfare

⁶All our subsequent results in the symmetric case also hold for more than two countries as long as the countries are not atomistic, which seems to be a plausible assumption.

of consumers in country i , if country j chooses the same tax rate t_i as country i does, which happens with probability μ_i . The government of country i maximizes (14) with respect to its tax rate t_i , taking as given the tax rate t_j chosen by the government of country j . Hence, the governments of the two countries play a non-cooperative game in emission tax rates.

The equilibrium of the emission tax game is determined by the first-order conditions $W_{t_i}^i(t_i, t_j) = 0 = W_{t_i}^j(t_i, t_j)$. Country i 's first-order condition $W_{t_i}^i(t_i, t_j) = 0$ is equivalent to⁷

$$(1 - \mu_i) \left\{ \left[B' [Y^i(t_i, t_j)] - p \right] Y_{t_i}^i(t_i, t_j) - H' [E(t_i, t_j)] E_{t_i}(t_i, t_j) \right\} \\ + \mu_i \left\{ \left[B' [Y^i(t_i, t_i)] - p \right] \left[Y_{t_i}^i(t_i, t_i) + Y_{t_j}^i(t_i, t_i) \right] \right. \\ \left. - H' [E(t_i, t_i)] \left[E_{t_i}(t_i, t_i) + E_{t_j}(t_i, t_i) \right] \right\} = 0, \quad (15)$$

where the arguments of the functions have been included in order to be aware that the functions may, in general, be evaluated at different sets of tax rates. In this section, however, we focus on symmetry with $n_i = n_j = n/2$, $\kappa_i = \kappa_j = \kappa$ and $\mu_i = \mu_j =: \mu$. It is then plausible to focus on a symmetric equilibrium with equal tax rates $t_i = t_j = t$ which implies $Y^i(t_i, t_j) = Y^i(t_i, t_i) = Y^i(t, t) = y_i$, $Y_{t_i}^i(t_i, t_j) = Y_{t_i}^i(t_i, t_i) = Y_{t_i}^i(t, t) =: Y_{t_i}^i$, $Y_{t_i}^j(t_i, t_j) = Y_{t_i}^j(t_i, t_i) = Y_{t_i}^j(t, t) =: Y_{t_i}^j$, $E(t_i, t_j) = E(t_i, t_i) = E(t, t) = e$ and $E_{t_i}(t_i, t_j) = E_{t_i}(t_i, t_i) = E_{t_i}(t, t) = E_{t_i}$ as well as $y_i = y_j = y$ and $e = ny$. Making use of this information in (15) and indicating the equilibrium of the emission tax game among governments with morality μ when consumers have morality κ by the double superscript $\mu\kappa$, we obtain

$$B'(y^{\mu\kappa}) - p = \frac{(1 + \mu)(Y_{t_i}^i + Y_{t_i}^j)}{Y_{t_i}^i + \mu Y_{t_i}^j} \frac{n}{2} H'(ny^{\mu\kappa}), \quad (16)$$

where we have used $E_{t_i} = n(Y_{t_i}^i + Y_{t_i}^j)/2$ and where $Y_{t_i}^i$ and $Y_{t_i}^j$ are given by (12). Solving (8) for the equilibrium tax rate $t_i = t_j =: t^{\mu\kappa}$ and inserting (16) implies

$$t^{\mu\kappa} = \frac{(1 + \mu - 2\kappa)Y_{t_i}^i + (1 + \mu - 2\mu\kappa)Y_{t_i}^j}{Y_{t_i}^i + \mu Y_{t_i}^j} \frac{n}{2} H'(ny^{\mu\kappa}). \quad (17)$$

Equation (16) is the allocation rule for the individual consumer's equilibrium emissions $y^{\mu\kappa}$, when governments non-cooperatively set emissions tax rates and morality of the governments

⁷The second-order condition $W_{t_i t_i}^i(t_i, t_j) < 0$ also depends on the signs of the second derivatives of $Y^i(\cdot)$ and $E(\cdot)$ which can hardly be determined, in general. In the following, we focus solely on such model specifications where $W_{t_i t_i}^i(t_i, t_j) < 0$ is satisfied and welfare maximization of the *homo moralis* government is well-defined. An example is the quadratic model specification which we consider below and which implies that $Y^i(\cdot)$ and $E(\cdot)$ are linear in the tax rates and have zero second derivatives. The second-order condition $W_{t_i t_i}^i(t_i, t_j) < 0$ can then be shown to be satisfied due to $B'' < 0$ and $H'' > 0$.

and consumers is given by μ and κ , respectively. Equilibrium global emissions equal $e^{\mu\kappa} := ny^{\mu\kappa}$. The equilibrium tax rate $t^{\mu\kappa}$ from (17) implements equilibrium emissions $y^{\mu\kappa}$.

Efficiency properties of the emission tax equilibrium. In order to evaluate the efficiency properties of the emission tax equilibrium, we compare the allocation rule (16) with the socially optimal allocation rule (5) and the equilibrium emission tax rate $t^{\mu\kappa}$ from (17) with the Pigouvian tax rate $t^* = nH'(ny^*)$. In a decentralized economy without moral consumers and governments, the Pigouvian tax would implement the social optimum, since it reflects the global marginal damage of all consumers.

As benchmark, we first focus on this case in which neither consumers nor governments are of the *homo moralis* type and instead show *homo oeconomicus* behavior, i.e. $\mu = \kappa = 0$. Emissions and emission tax rates in this scenario are denoted by y^{oo} and t^{oo} , respectively. Taking into account $Y_{t_i}^j = 0$ from (12), (16) and (17) simplify to

$$B'(y^{oo}) - p = \frac{n}{2} H'(ny^{oo}), \quad t^{oo} = \frac{n}{2} H'(ny^{oo}). \quad (18)$$

The appendix proofs

Proposition 1. *Suppose $\mu = \kappa = 0$. Then, $y^{oo} > y^*$ and $0 < t^{oo} < t^*$.*

Proposition 1 replicates the result for the business-as-usual scenario in decentralized environmental policy making, first investigated by Hoel (1991) and Barrett (1994a). Accordingly, in the absence of any morality, consumers completely ignore the marginal damage and governments internalize only the part of the marginal damage that emerges in their own country, ignoring the marginal damage that emissions impose on the consumers of other countries. As consequence, in the equilibrium of the emission tax game, each government sets a tax rate that is positive but smaller than its Pigouvian level, i.e. $0 < t^{oo} < t^*$, and thereby provides consumers an incentive to consume an inefficiently high quantity of the dirty good and to cause inefficiently high emissions $y^{oo} > y^*$. The second equation in (18) also shows that the business-as-usual tax rate t^{oo} equals half the global marginal damage and, thus, reflects only the marginal damage arising in each single country.

Against this benchmark, we now investigate the implications of introducing morality, starting with the case that consumers are *homo moralis* with $\kappa > 0$, whereas governments remain immoral and follow the *homo oeconomicus* paradigm with $\mu = 0$. Hence, while consumers now take into account at least a part of the environmental damage, each government still chooses its emission tax rate in order to maximize only the material welfare of its

consumers, taking as given the emission tax rate of the other country. Of course, governments are aware of the moral behavior of consumers and take into account $y_i = Y^i(t_i, t_j)$, $y_j = Y^j(t_i, t_j)$ and $e = E(t_i, t_j)$ when setting their emission tax rates. Denoting equilibrium emissions and tax rates in this scenario by $y^{o\kappa}$ and $t^{o\kappa}$, respectively, (16) and (17) become

$$B'(y^{o\kappa}) - p = \frac{Y_{t_i}^i + Y_{t_i}^j}{Y_{t_i}^i} \frac{n}{2} H'(ny^{o\kappa}), \quad t^{o\kappa} = \frac{(1 - 2\kappa)Y_{t_i}^i + Y_{t_i}^j}{Y_{t_i}^i} \frac{n}{2} H'(ny^{o\kappa}). \quad (19)$$

In the appendix, we prove

Proposition 2. *Suppose $\mu = 0$ and $\kappa \in]0, 1]$.*

(i) *If $\kappa \in]0, 1[$, then $y^{o\kappa} > y^{oo}$ and $t^{o\kappa} < t^{oo}$. Moreover, $t^{o\kappa} \gtrless 0$ iff*

$$\kappa \begin{matrix} \leq \\ \gtrless \\ > \end{matrix} \frac{n^2 \kappa^2 H'' - B''}{n^2 \kappa (1 + \kappa) H'' - 2B''} =: \bar{\kappa}. \quad (20)$$

(ii) *If $\kappa = 1$, then $y^{o\kappa} = y^{oo}$ and $t^{o\kappa} = -t^{oo} < 0$.*

Proposition 2 reveals a surprising result: introducing morality of consumers does not improve the business-as-usual outcome and in most cases even worsens it. According to part (i), with interior consumer morality $\kappa \in]0, 1[$ the equilibrium tax rate $t^{o\kappa}$ is below the business-as-usual level t^{oo} . Hence, governments internalize even less of the marginal damage than in the business-as-usual and provide consumers an incentive to increase their emissions $y^{o\kappa}$ even beyond the level y^{oo} that they choose without morality. Intuitively, the reason goes back to the morality-induced leakage. For interior consumer morality $\kappa \in]0, 1[$, leakage is positive due to $Y_{t_i}^j > 0$ in (12). Each government therefore knows that every unit of emissions which it tries to avoid in its own country is partly offset by higher emissions in the other country. The government's marginal benefit from emission taxation is thus lowered by morality-induced leakage, compared to the business-as-usual, so each government underinternalizes the marginal damage in its own country and consumers pollute more than without morality. The equilibrium tax rate $t^{o\kappa}$ may even turn into a subsidy, provided consumer morality is sufficiently large, i.e. $t^{o\kappa} < 0$ if $\kappa > \bar{\kappa}$ with $\bar{\kappa} \in]0, 1[$. Put differently, from the point of view of the immoral government, moral consumers do too much of the good thing and the government corrects their moral behavior by granting a consumption subsidy.

According to part (ii) of Proposition 2, morality-induced leakage and its negative effect on equilibrium emissions disappear only in the polar case of *homo kantianses* consumers ($\kappa = 1$). We then know from (12) that $Y_{t_i}^j = 0$. On the RHS of the first equation in (19), it holds $(Y_{t_i}^i + Y_{t_i}^j)/Y_{t_i}^i = 1$ and, thus, each government again internalizes the part

$nH'/2$ of the global marginal damage. However, equilibrium emissions $y^{o\kappa}$ still stay on their inefficiently low business-as-usual level y^{oo} and do not come closer to the efficient level y^* preferred by the consumers with full morality ($\kappa = 1$). The reason is that the government does not have positive morality μ and, thus, is not willing to internalize more than half of the global marginal damage which equals the share of the marginal damage occurred in its own country. Notice also that the government implements the emission level $y^{o\kappa} = y^{oo}$ in this case by paying each consumer a subsidy $t^{o\kappa} = -t^{oo} = -nH'(ny^{oo})/2$ which reflects the share of the global marginal damage that occurs in the other country. The reason is that for $\kappa = 1$ the consumers internalize the full marginal damage in both countries, while the government wants to internalize only the marginal damage in its own country. Hence, the immoral government again corrects the too moral consumers by paying a large subsidy.

As the most general scenario in this section, we now suppose that both consumers and governments behave as *homo moralis*, i.e. $\kappa \in]0, 1]$ and $\mu \in]0, 1]$. Consequently, not only consumers counterfactually universalize their consumption decision to other consumers, but likewise do the governments in choosing their tax rate. The allocation rule (16) and the equilibrium tax rate (17) then do not further simplify. We start by comparing this scenario with the previous case, where consumers act morally ($\kappa \in]0, 1]$) and governments are immoral ($\mu = 0$) and act as *homo oeconomicus*. In the appendix, we prove

Proposition 3. *Suppose $\mu \in]0, 1]$ and $\kappa \in]0, 1]$. Then, $y^{\mu\kappa} < y^{o\kappa}$ and $t^{\mu\kappa} > t^{o\kappa}$.*

In view of Proposition 3, a *homo moralis* government always chooses a higher tax rate $t^{\mu\kappa}$ and induces lower emissions $y^{\mu\kappa}$ than a *homo oeconomicus* government that chooses the tax rate $t^{o\kappa}$ and implements the emission level $y^{o\kappa}$. Intuitively, by universalizing its tax rate choice, the *homo moralis* government acts as if it internalizes not only the marginal damage in its own country, but also at least a part of the marginal damage in the other country, which strengthens its incentive to increase the emission tax rate and to lower emissions. However, this insight does not necessarily imply that the surprising insight from Proposition 2 vanishes. The equilibrium with *homo moralis* consumers and *homo moralis* governments may still be worse than the business-as-usual equilibrium without any morality. This is shown in the next proposition that is proven in the appendix.

Proposition 4. *Suppose $\mu \in]0, 1]$ and $\kappa \in]0, 1]$. Then, $y^{\mu\kappa} \begin{smallmatrix} \leq \\ \geq \end{smallmatrix} y^{oo}$ iff*

$$\mu \begin{smallmatrix} \geq \\ \leq \end{smallmatrix} \frac{n^2\kappa(1-\kappa)H''}{n^2\kappa(1+\kappa)H'' - 2B''} =: \bar{\mu}. \quad (21)$$

According to Proposition 4, the equilibrium emissions $y^{\mu\kappa}$ with *homo moralis* consumers and *homo moralis* governments may still be higher than the business-as usual emissions y^{oo} , if the morality μ of the *homo moralis* governments is sufficiently small and below the threshold $\bar{\mu}$. Intuitively, this result goes again back to the morality-induced leakage effect. In contrast to the *homo oeconomicus* government in the business-as-usual, the *homo moralis* government faces two opposing incentives in internalizing the marginal damage. On the one hand, due to the strictly positive morality μ , it acts as if it internalizes not only the marginal damage in its own country, but also at least partially the marginal damage in the other country, implying a stronger incentive to internalize (see Proposition 3). On the other hand, it still takes into account morality-induced leakage, which reduces its internalization incentives (see Proposition 2). If the government's morality μ is sufficiently small (smaller than $\bar{\mu}$), then the former effect is small and dominated by the leakage effect, so emissions implemented by the *homo moralis* government rise above the business-as-usual level.

Several remarks on this counterintuitive result are warranted. First, for $\kappa \in]0, 1[$, the threshold $\bar{\mu}$ is always between zero and one and we always find morality levels μ of the government that satisfy $\mu < \bar{\mu}$ and thereby imply $y^{\mu\kappa} > y^{oo}$. Second, also with equal morality $\mu = \kappa \in]0, 1[$ for governments and consumers we find morality levels with $\mu < \bar{\mu}$ such that $y^{\mu\kappa} > y^{oo}$. Hence, the counterintuitive result is not caused by the possible deviation of consumer and government morality. Third, for the ease of exposition, we have not characterized the equilibrium tax rate $t^{\mu\kappa}$ in Proposition 4. But from (17) and the intuition of our results, it is obvious that $t^{\mu\kappa}$ may be smaller or larger than the business-as-usual tax rate t^{oo} and also positive or negative representing a tax or subsidy. Finally, if either consumers or governments are fully moral ($\kappa = 1$ or $\mu = 1$), we always have $\mu \geq \bar{\mu}$ and emissions with fully moral consumers or fully moral governments are lower than in the business-as-usual scenario, i.e. $y^{\mu\kappa} < y^{oo}$. For $\mu = 1$ we attain efficient emissions $y^{\mu\kappa} = y^*$ that are implemented by the emission tax rate $t^{\mu\kappa} = (1 - \kappa)nH'(ny^*)$ reflecting that part of the global marginal damage that consumers do not internalize on their own.⁸ If we additionally have $\kappa = 1$, the fully moral government ($\mu = 1$) chooses $t^{\mu\kappa} = 0$, since consumers already internalize the full marginal damage on their own which are the preferred emissions by the fully moral government ($\mu = 1$) so that further taxation is not needed.

In order to illustrate and to show that all above propositions are satisfied by a non-empty set of parameter constellations, we provide an example with quadratic utility and damage functions, i.e. $B(y) = \alpha y - \beta y^2/2$ with $\alpha, \beta > 0$ and $H(e) = \gamma e + \delta e^2/2$ with

⁸Efficient emissions follow from inserting $\mu = 1$ into (16) and comparing it with the efficient allocation rule (5). The tax rate is obtained if $\mu = 1$ is plugged into (17).

$\gamma, \delta > 0$. We set $n = p = \delta = 1$, $\alpha = 4$, $\beta = 0.1$ and $\gamma = 2$ and run a numerical simulation that is briefly described in the appendix and displayed in Figure 1. The left panel illustrates individual emissions and the right panel the corresponding equilibrium tax rates. Green lines

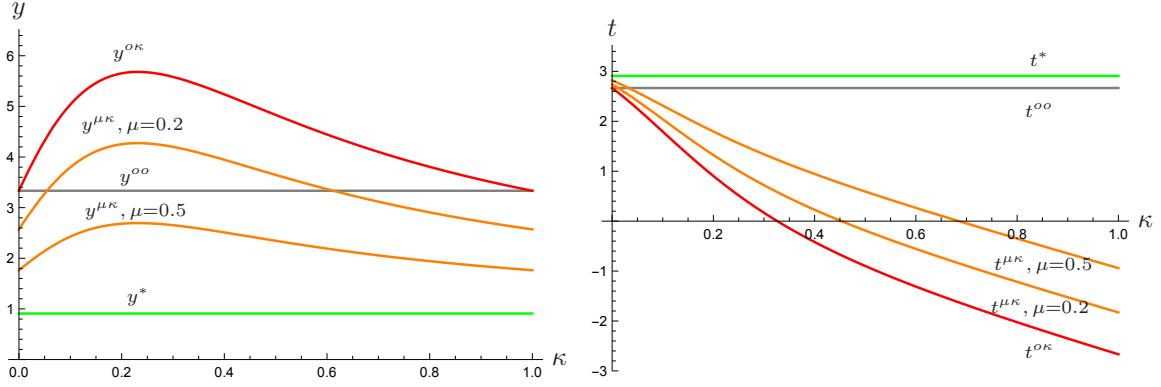


Figure 1: Equilibrium emissions and tax rate in quadratic example

indicate the social optimum (y^*, t^*) , grey lines the business-as-usual scenario (y^{oo}, t^{oo}) , red lines the scenario with *homo moralis* consumers and *homo oeconomicus* governments $(y^{o\kappa}, t^{o\kappa})$ and orange lines the case with *homo moralis* consumers and *homo moralis* governments $(y^{\mu\kappa}, t^{\mu\kappa})$ for $\mu = 0.2$ and $\mu = 0.5$. In the business-as-usual scenario, governments set inefficiently low tax rates and implement inefficiently high emissions (compare the grey and green line). Due to leakage, the inefficiency becomes more severe, if consumer morality κ is between zero and one (compare the red and grey line). Even *homo moralis* governments may worsen the business-as-usual scenario, if their morality μ is relatively low (compare orange line with $\mu = 0.2$ and the grey line), since the negative leakage effect then still dominates. Only if the governments' morality μ is sufficiently large, they will for sure reduce emissions compared to the business-as-usual scenario (compare the orange line with $\mu = 0.5$ and the grey line). Regarding tax rates, the right panel shows that consumer morality κ and the corresponding leakage may dramatically reduce the equilibrium tax rate, rendering it even negative above a threshold morality (compare the red and grey line). This effect is dampened, if governments are moral, too, but the difference to the business-as-usual tax rate remains substantial (compare the orange, red and grey line).

4 Asymmetric countries

In this section, we investigate the impact of country asymmetries on the results derived in the previous section. The focus is on the question whether country asymmetries exacerbate

or dampen the morality-induced leakage effect and its detrimental impact on the tax game equilibrium. In our setup, countries may potentially differ in three parameters, in their population size n_i and n_j , their consumer morality κ_i and κ_j and their government morality μ_i and μ_j . We distinguish between small asymmetries, where we start at the symmetric equilibrium and then characterize the impact of introducing marginal differences between the countries, and large asymmetries, where the difference between the two countries is non-marginal. All country asymmetries are modeled as a mean preserving spread (MPS), i.e. we increase the variance of the respective parameter without changing the mean.

Small asymmetries. Let $x_i \in \{n_i, \kappa_i, \mu_i\}$ be one of the three parameters that may lead to country asymmetries. For investigating small asymmetries, we run a comparative static analysis of the tax game equilibrium, compute the effects of a MPS defined by $dx_i = -dx_j =: dx$ and then evaluate the results at the symmetric equilibrium. In the appendix, we show

Proposition 5. *Let $x_i \in \{n_i, \kappa_i, \mu_i\}$ and consider a MPS with $dx_i = -dx_j =: dx$. Evaluated at the symmetric equilibrium of the emission tax game in case of identical countries, it holds*

$$\begin{aligned} (i) \quad & \frac{dy_i^{\mu\kappa}}{dx} = -\frac{dy_j^{\mu\kappa}}{dx} \begin{matrix} \geq \\ \leq \end{matrix} 0, & \frac{de^{\mu\kappa}}{dx} &= 0, \\ (ii) \quad & \frac{dw_i^{\mu\kappa}}{dx} = -\frac{dw_j^{\mu\kappa}}{dx} \begin{matrix} \geq \\ \leq \end{matrix} 0, & \frac{dw^{\mu\kappa}}{dx} &= 0. \end{aligned}$$

Proposition 5 shows that, starting at the symmetric equilibrium of the tax game, introducing small country asymmetries may change the distribution of emissions and welfare across countries, but leaves unchanged global emissions and welfare. This result holds for any source of country asymmetry, only the direction of the change in the distribution of emissions and welfare depends on the model specification under consideration and is not specified in Proposition 5. Intuitively, asymmetries change emissions in each of the two countries. For instance, a country whose government becomes more moral is expected to internalize a larger share of the environmental externality and thereby reduce emissions in its country. Because of the MPS in the model parameters, however, the government of the other country becomes less moral and increases emissions. By the nature of the MPS, the changes in both countries just cancel out each other, so global emissions and total welfare remain unchanged. Small asymmetries between the two countries therefore do not change morality-induced emission leakage and its detrimental impact on the equilibrium of the emission tax game.

Large asymmetries. Proposition 5 holds for small asymmetries and the question arises how robust it is if we consider large (discrete) asymmetries in the countries' characteristics.

Unfortunately, complexity prevents us to obtain results in the general model and we therefore restrict our attention again to the quadratic model specification $B(y) = \alpha y - \beta y^2/2$ with $\alpha, \beta > 0$ and $H(e) = \gamma e + \delta e^2/2$ with $\gamma, \delta > 0$. In the appendix, it is shown that emissions in country i are linear in tax rates and can be written as

$$y_i = Y^i(t_i, t_j) = \Gamma^{i0}(n_i, n_j, \kappa_i, \kappa_j) - \Gamma^{ii}(n_i, n_j, \kappa_i, \kappa_j)t_i + \Gamma^{ij}(n_i, n_j, \kappa_i, \kappa_j)t_j, \quad (22)$$

with $\Gamma^{ii} > 0$ and $\Gamma^{ij} > 0$. The sign of Γ^{i0} is ambiguous, but in order to have positive emissions even in the absence of taxation ($t_i = t_j = 0$), we assume that the model parameters are such that $\Gamma^{i0} > 0$. Equation (22) together with $\Gamma^{ii} > 0$ and $\Gamma^{ij} > 0$ show that individual emissions of the consumer in country i are linearly decreasing in the own country's tax rate t_i and linearly increasing in the other country's tax rate t_j , where the latter effect represents morality-induced leakage. Using (22) in (1), global emissions read

$$e = E(t_i, t_j) = \Gamma^0(n_i, n_j, \kappa_i, \kappa_j) - \Gamma^i(n_i, n_j, \kappa_i, \kappa_j)t_i - \Gamma^j(n_i, n_j, \kappa_i, \kappa_j)t_j, \quad (23)$$

with $\Gamma^0 := n_i\Gamma^{i0} + n_j\Gamma^{j0} > 0$, $\Gamma^i := n_i\Gamma^{ii} - n_j\Gamma^{ji} > 0$ and $\Gamma^j := n_j\Gamma^{jj} - n_i\Gamma^{ij} > 0$. Hence, global emissions are linearly decreasing in both countries' emissions tax rates t_i and t_j , where the coefficients Γ^i and Γ^j reflects the own-country tax effect as well as emission leakage. Inserting equations (22) and (23) as well as their derivatives into (15) for both countries and solving yields the equilibrium tax rates $t_i^{\mu\kappa}$ and $t_j^{\mu\kappa}$. Inserting the equilibrium tax rates back into (22) and (23) gives equilibrium emissions.

In order to find out the effect of large country asymmetries, we run numerical simulations starting with the symmetric benchmark where $\mu_i = \mu_j = \kappa_i = \kappa_j = 0.2$, $n_i = n_j = 0.5$, $p = \delta = 1$, $\alpha = 4$, $\beta = 0.1$ and $\gamma = 2$. Remember from our numerical example in the symmetric case that under this parameter constellation the symmetric equilibrium is Pareto-inferior to the business-as-usual scenario since $y^{\mu\kappa} > y^{oo}$ (see left panel of Figure 1). We start by introducing an asymmetry in the populations size. It is assumed that $n_i = n/2 + \varepsilon$ and $n_j = n/2 - \varepsilon$, where the difference in population sizes ε is varied within the interval $[-0.2, 0.2]$. The effects of changes in ε are illustrated in Figure 2, where orange lines represent the symmetric case and red curves the asymmetric case. The left panel shows global emissions $e^{\mu\kappa}$ in the symmetric case (solid orange line) and in the asymmetric case (solid red line) as well as the countries' emissions $ny^{\mu\kappa}/2$ in the symmetric case (dashed orange line) and the countries' emissions $n_i y_i^{\mu\kappa}$ (dashed red line) and $n_j y_j^{\mu\kappa}$ (dotted red line) in the asymmetric case. The corresponding tax rates $t^{\mu\kappa}$ in the symmetric case (solid orange line) as well as $t_i^{\mu\kappa}$ (dashed red line) and $t_j^{\mu\kappa}$ (dotted red line) in the asymmetric case are displayed in the right panel. As can be seen in the right panel, with asymmetries the large country increases its emission tax rate while the small country decreases it, compared to the symmetric

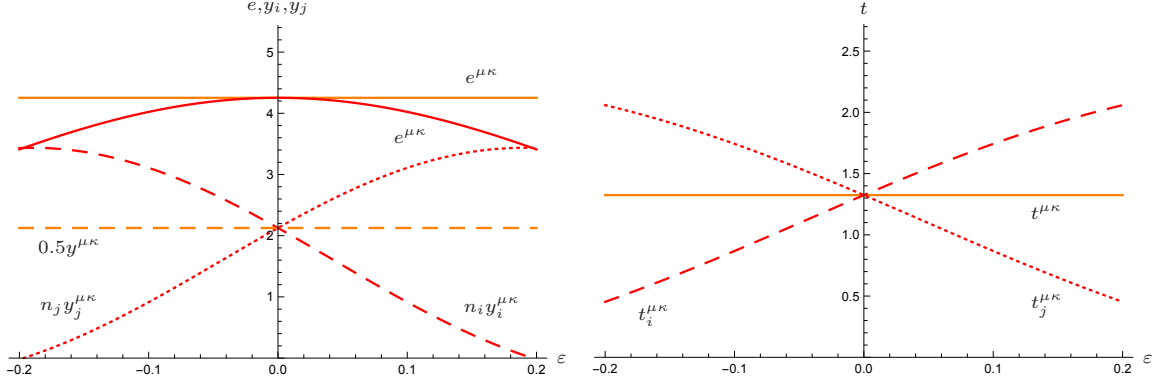


Figure 2: Equilibrium emissions and tax rates with asymmetric population sizes

case. This is a standard result in non-cooperative tax games, since the large country faces the lower tax rate elasticity of its tax base.⁹ In our framework, this property is reflected by the negative impact of the population size n_i on the own-tax effect Γ^{ii} , as formally proven in the appendix. As consequence of different tax rates under asymmetry, emissions go down in the large country and up in the small country (left panel) and consumers of the small country are better off than consumers of the large country. But for non-marginal differences in the countries' population sizes, i.e. $|\varepsilon| \gg 0$, the emission reduction in the large country overcompensates the emission increase in the small country and global emissions fall. Thus, morality-induced leakage and its detrimental impact on the efficiency of the tax equilibrium is dampened, if the countries substantially differ in their population sizes.¹⁰

Next, consider asymmetries in the governments' level of morality. We return to the assumption $n_i = n_j = n/2$ and now suppose $\mu_i = 0.2 + \varepsilon$ and $\mu_j = 0.2 - \varepsilon$ with $\varepsilon \in [-0.2, 0.2]$. The results of the numerical simulations under this specification are displayed in Figure 3, where the colors and the styles of the curves have the same assignment as in Figure 2. The right panel shows that, compared to the symmetric case, the country with the more moral government increases its emission tax rate, while the country with the less moral government reduces it. The intuition is that a higher (lower) morality induces the government to internalize a larger (smaller) share of the environmental externality. According to the left panel of Figure 3, the difference in tax rates translates into lower emissions in the high

⁹It has been first derived by Bucovetsky (1991) in the context of capital tax competition.

¹⁰Notice that the solid red line of global emissions in the asymmetric case is tangent to the orange line of global emissions in the symmetric case, confirming our result from Proposition 5 that marginal differences in populations sizes do not change global emissions. The same will be true for the subsequent numerical analysis of differences in consumer and government moralities (μ_i, μ_j) and (κ_i, κ_j) , respectively.

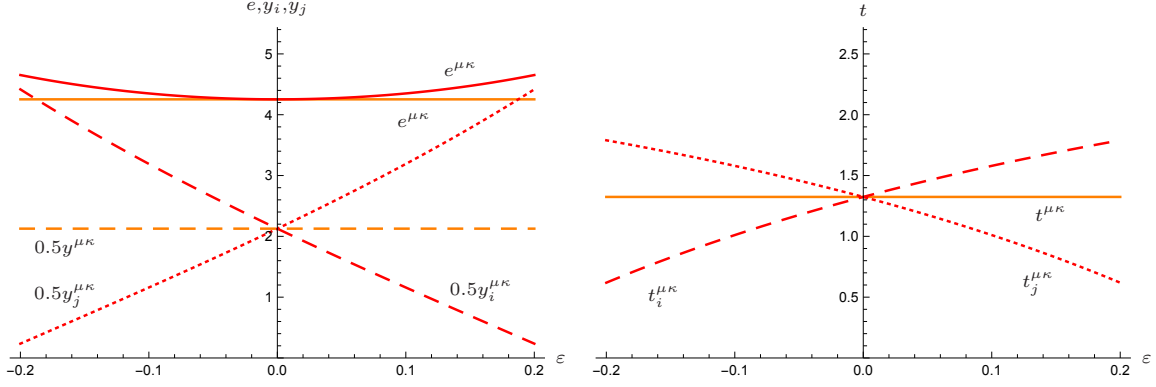


Figure 3: Equilibrium emissions and tax rates with asymmetric government morality

morality country and higher emissions in the low morality country, similar to the left panel of Figure 2. In contrast to the case with asymmetric population sizes, however, the emission reduction in the high morality country is now overcompensated by the emission increase in the low morality country such that global emissions increase if the difference in morality is not marginal, i.e. $|\varepsilon| \gg 0$. In sum, we obtain the striking result that asymmetries in the morality of governments accelerate morality-induced emission leakage and the associated detrimental effect on the efficiency of the tax game equilibrium.

The results depicted in Figures 2 and 3 are robust against changes in the model parameters. In fact, we were not successful in identifying model specifications that show other patterns than those displayed in Figures 2 and 3. This is different under asymmetries in consumer morality, since the leakage effect and its detrimental impact on the tax game equilibrium may be dampened or accelerated by asymmetries, depending on the initial value of consumer morality. In order to demonstrate this, we now choose a different benchmark and start at $\mu_i = \mu_j = 0$, where the symmetric tax equilibrium is worse than the business-as-usual as long as consumer morality takes interior values $\kappa \in]0, 1[$ (see Figure 1). We then introduce a fixed size of the asymmetry such that $\kappa_i = \kappa - 0.2$ as well as $\kappa_j = \kappa + 0.2$ and vary κ in the interval $]0.2, 0.8[$. Hence, country i consumers are always less moral than country j consumers. The results are depicted in Figure 4, where the colors and styles of the curves have again the same assignment as in Figures 2 and 3 and where in the left panel we have dropped the countries' emissions for the sake of clearness. As can be seen in the right panel, asymmetries in consumer morality split the emission tax rates. Country i with the low morality has a higher tax rate than the high morality country j . This is intuitively plausible, since we assume that the governments of both countries are not moral at all in our example and, thus, they have an incentive to correct the moral behavior of their consumers

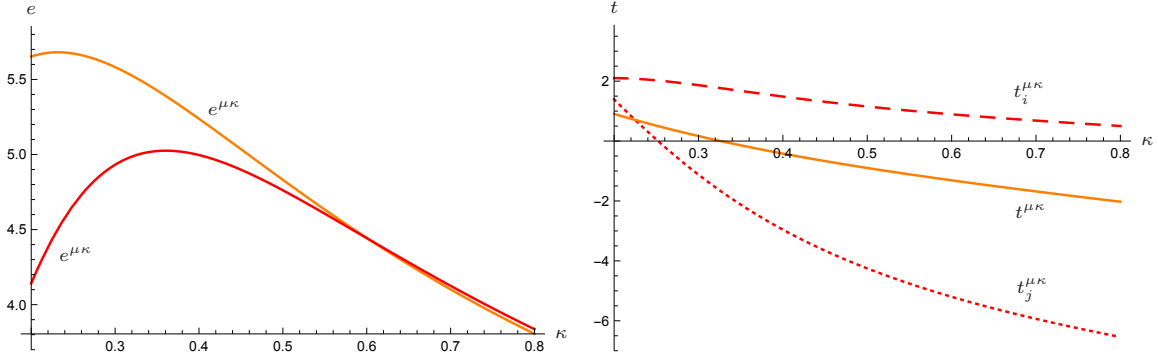


Figure 4: Equilibrium emissions and tax rates with asymmetric consumer morality

by relaxing taxation, which is weaker in the low morality country. Moreover, for low average morality levels κ , both tax rates with asymmetry lie above the tax rate under symmetry, implying lower global emissions in the left panel. With increasing average morality κ , the tax rates of both countries fall, as does the tax rate in the symmetric case. However, the tax rate of the high morality country j falls below the tax rate under symmetry and also falls much faster than the tax rate of the low morality country i . As consequence, there is a threshold $\bar{\kappa} \approx 0.6$ at which global emissions in the asymmetric case are just identical to global emissions under symmetry. For all consumer moralities $\kappa > \bar{\kappa}$, global emissions in the asymmetric case even overtake global emissions in the symmetric case. For relatively low levels of consumer morality, asymmetries in the morality therefore dampen the leakage effect and its detrimental impact on the tax game equilibrium, while for sufficiently large consumer morality, leakage and the associated inefficiency becomes even more severe. Intuitively, we can trace back these results to the impact of the consumer morality on the leakage effect represented by Γ^{ij} in (22). In the appendix, we show that Γ^{ij} is falling in morality κ_j of country j consumers, whereas it is inverted u-shaped in morality κ_i of country i consumers. Hence, if the average morality level κ is small, a reduction in κ_i and an increase in κ_j such that $\kappa_i < \kappa < \kappa_j$ will unambiguously reduce the leakage effect Γ^{ij} . In contrast, if the average morality level κ is sufficiently high, the increase in κ_j still reduces leakage Γ^{ij} , whereas the reduction in κ_i increases leakage Γ^{ij} . If the latter effect is strong enough, overall leakage increases and renders the inefficiency of the tax game equilibrium even worse.

5 Emission caps

In this section, we assume that governments set emission caps instead of emission taxes and reexamine the governments' policy game in the otherwise unchanged model. We return to

the symmetric case with $n_i = n_j = n/2$, $\kappa_i = \kappa_j = \kappa$ and $\mu_i = \mu_j = \mu$. With emission caps, a consumer in country i has to purchase an emission permit at price ρ_i for every unit of emissions. Each country has its own emission trading scheme and no trade in permits between the two countries is allowed. The permit market in country i is in equilibrium if

$$n_i y_i = \bar{e}_i, \quad (24)$$

where \bar{e}_i is the emission cap set by the government of country i . The individual *homo moralis* consumer in country i takes as given the emission cap \bar{e}_i . She maximizes exactly the same moral utility as in (7), except of replacing the emission tax rate t_i by the permit price ρ_i . Instead of (10) and (11), we obtain the first-order condition

$$B'(y_i) - p - \rho_i - n\kappa H' \left[\frac{n(1+\kappa)}{2} y_i + \frac{n(1-\kappa)}{2} y_j \right] = 0, \quad (25)$$

$$B'(y_j) - p - \rho_j - n\kappa H' \left[\frac{n(1+\kappa)}{2} y_i + \frac{n(1-\kappa)}{2} y_j \right] = 0, \quad (26)$$

where we have already taken into account $y_i = \bar{y}_i$ and $y_j = \bar{y}_j$.¹¹ The permit market equilibrium condition (24) and the corresponding condition for country j together with the first-order conditions (25) and (26) determine both the individual emissions and the permit prices as functions of the emission caps, i.e. $y_i = \bar{e}_i/n_i$, $y_j = \bar{e}_j/n_j$, $\rho_i = P^i(\bar{e}_i, \bar{e}_j)$ and $\rho_j = P^j(\bar{e}_i, \bar{e}_j)$. Hence, in contrast to the case of emission taxes, emissions in a country are now fixed by the country's emission cap and there is no longer a strategic interdependency between the consumers' emissions in the two countries. As consequence, the morality-induced leakage of the governments' policy choice disappears as well. By the permit price functions $\rho_i = P^i(\bar{e}_i, \bar{e}_j)$ and $\rho_j = P^j(\bar{e}_i, \bar{e}_j)$, the only cross-country effect of the governments' emission caps is on the permit prices paid by consumers. Since we do not need this cross-country effect in the subsequent analysis, we skip the associated comparative static analysis.

In choosing the emission cap \bar{e}_i , the government of country i takes into account individual emissions $y_i = \bar{e}_i/n_i$ and the permit price function $\rho_i = P^i(\bar{e}_i, \bar{e}_j)$. The government is again supposed to behave as *homo moralis* and counterfactually assumes the government of country j to choose the same cap \bar{e}_i with probability μ_i and its own cap \bar{e}_j with probability $1 - \mu_i$. The objective of the *homo moralis* government of country i can thus be written as

$$\begin{aligned} V^i(\bar{e}_i, \bar{e}_j) &= n_i \left\{ (1 - \mu_i) \left[B(\bar{e}_i/n_i) + w_i - p\bar{e}_i/n_i - H(\bar{e}_i + \bar{e}_j) \right] \right. \\ &\quad \left. + \mu_i \left[B(\bar{e}_i/n_i) + w_i - p\bar{e}_i/n_i - H(2\bar{e}_i) \right] \right\}, \end{aligned} \quad (27)$$

¹¹The second-order condition of individual utility maximization is exactly the same as the second-order condition listed in footnote 4 and satisfied due to our assumptions $B'' < 0$ and $H'' > 0$.

where we have replaced y_i by \bar{e}_i/n_i and where the permit price cancels out since we assume that the government's revenues from emission permits $\bar{e}_i P^i(\bar{e}_i, \bar{e}_j)$ are redistributed back lump sum to the consumers in country i . The government of country i maximizes (27) with respect to its emission cap \bar{e}_i , taking as given the emission cap \bar{e}_j of the country j . We obtain a non-cooperative game in emission caps between the two governments. The equilibrium of this game is determined by the first-order condition $V_{\bar{e}_i}^i(\bar{e}_i, \bar{e}_j) = 0$ or, equivalently,¹²

$$B'(\bar{e}_i/n_i) - p - (1 - \mu_i)n_i H'(\bar{e}_i + \bar{e}_j) - 2\mu_i n_i H'(2\bar{e}_i) = 0. \quad (28)$$

and the corresponding condition $V_{\bar{e}_j}^j(\bar{e}_i, \bar{e}_j) = 0$ for country j . We focus on the symmetric cap equilibrium with $\bar{e}_i = \bar{e}_j =: \bar{e}$. Equation (24) then implies $y_i = 2\bar{e}/n =: y^c$, where the superscript c indicates the equilibrium under the cap policy. Inserting into (28) yields

$$B'(y^c) - p = (1 + \mu) \frac{n}{2} H'(ny^c). \quad (29)$$

Equation (29) represents the allocation rule for emissions y^c in the emission cap game.

Comparing this allocation rule with the corresponding rule (5) and (16) in the social optimal and the tax game equilibrium, respectively, we prove in the appendix

Proposition 6. *Emissions y^c are independent of κ . Moreover,*

- (i) *If $\mu = 0$, then $y^c = y^{oo}$.*
- (ii) *If $\mu = 1$, then $y^c = y^*$.*
- (iii) *If $\mu \in]0, 1[$, then $y^c < y^{oo}$, $y^c < y^{o\kappa}$ and $y^c < y^{\mu\kappa}$.*

Proposition 6 shows that equilibrium emissions y^c in the emission cap game do not depend on the consumer morality κ . The reason is that the cap \bar{e}_i fixes emissions in country i and, thus, variations in consumer morality κ changes the demand for emissions, indeed, but do not change country i 's emissions which are fixed by cap. Morality κ only affects the equilibrium permit prices which, however, do not have any welfare consequences in our framework. Since κ does not influence equilibrium emissions in the cap game, it is obvious that a government with zero morality $\mu = 0$ replicates the business-us-usual, see part (i) of Proposition 6, and a government with full morality $\mu = 1$ implements the social optimum, see part (ii) of Proposition 6. The most striking insight of Proposition 6, however, is contained in part (iii). As long as the governments have interior morality $\mu \in]0, 1[$, they implement emissions

¹²The second-order condition $V_{\bar{e}_i \bar{e}_i}^i(\bar{e}_i, \bar{e}_j) < 0$ can be written as $B''(\bar{e}_i/n_i)/n_i - (1 - \mu_i)n_i H''(\bar{e}_i + \bar{e}_j) - 4\mu_i n_i H''(2\bar{e}_i) < 0$ and is satisfied due to our assumptions $B'' < 0$ and $H'' > 0$.

that are lower than in the business-as-usual and also lower than in the emission tax game. The reason is that emissions in each country are fixed by the emission caps and, thus, the cap policy avoids any emission leakage effects. Remember that in the emission tax game morality-induced leakage may occur and worsen the business-as-usual. In this sense, our analysis provides an argument in favor of emission caps over emission taxes.

6 Concluding remarks

This paper identifies a novel emission leakage effect that is caused by consumer morality and may render the decentralized choice of emission taxes by national governments even worse than in the absence of moral consumers and governments. With morality, global emissions may therefore be higher and global welfare lower than without. These counterintuitive effects of morality on decentralized policymaking with emissions taxes do not hinge on the assumption of symmetric countries. On the contrary, we show that asymmetries in moralities can even amplify the morality-induced leakage effect and the associated inefficiency of decentralized emission taxation. Because the morality-induced leakage is absent in decentralized policymaking with emission caps, our analysis additionally provides an argument in favor of emission caps instead of emission taxes as decentralized policy instruments.

In order to have a clear focus on the novel morality-induced leakage channel, our analysis proceeds on some simplifying assumptions. We abstract from other kinds of leakage, for instance, terms of trade leakage where governments manipulate international input and output prices in their favor. Moreover, we also ignore different degrees of morality among consumers in a given country, country-specific environmental damages, imperfect competition and population and firm mobility. But our morality-induced leakage effect will prevail even in a more sophisticated model and the only interesting question is how it interacts with other effects. As this question is mainly quantitative in nature, it is not addressed in our theoretical framework and instead left for more comprehensive empirical studies.

Appendix

Derivation of equation (12). Totally differentiating (10) and (11) and applying symmetry yields the matrix equation

$$\begin{bmatrix} B'' - \frac{n^2\kappa(1+\kappa)}{2}H'' & -\frac{n^2\kappa(1-\kappa)}{2}H'' \\ -\frac{n^2\kappa(1-\kappa)}{2}H'' & B'' - \frac{n^2\kappa(1+\kappa)}{2}H'' \end{bmatrix} \begin{bmatrix} dy_i \\ dy_j \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} dt_i \\ dt_j \end{bmatrix}. \quad (30)$$

The Jacobian reads

$$\Delta = (B'')^2 - n^2\kappa(1 + \kappa)B''H'' + n^4\kappa^3(H'')^2 > 0.$$

Applying Cramer's rule to (30) proves (12).

Proof of Propositions 1–4. For notational convenience, define

$$F(y) := B'(y) - p \quad \text{with} \quad F'(y) = B''(y) < 0, \quad (31)$$

$$G(y) := \frac{n}{2}H'(ny) \quad \text{with} \quad G(y) > 0, \quad G'(y) = \frac{n^2}{2}H''(ny) > 0. \quad (32)$$

For $\mu = \kappa = 0$, we have (18) from which the first equation can be rewritten as $F(y^{oo}) = G(y^{oo})$. In the social optimum, equation (5) becomes $F(y^*) = 2G(y^*)$. Since $2G(y) > G(y)$ for all y and since $F(y)$ is decreasing while $G(y)$ is increasing in y , it follows $y^{oo} > y^*$. From equation (18), $F'(y) < 0$ and $y^{oo} > y^*$ we also have $t^{oo} = G(y^{oo}) > 0$ and $t^{oo} = F(y^{oo}) < F(y^*) = t^*$, which completes the proof of Proposition 1.

In order to prove Proposition 2, rewrite the first equation in (19) as $F(y^{o\kappa}) = \Psi G(y^{o\kappa})$ where $\Psi := (Y_{t_i}^i + Y_{t_i}^j)/Y_{t_i}^i$. For $\kappa \in]0, 1[$, (12) implies $Y_{t_i}^i < 0$ and $Y_{t_i}^j > 0$, so $\Psi < 1$ and $\Psi G(y) < G(y)$ for all y . The equation $F(y^{o\kappa}) = \Psi G(y^{o\kappa})$ compared to $F(y^{oo}) = G(y^{oo})$ together with $F'(y) < 0$ and $G'(y) > 0$ then yields $y^{o\kappa} > y^{oo}$. For the tax rate we obtain from (19) that $t^{o\kappa} = F(y^{o\kappa}) - 2\kappa G(y^{o\kappa}) < F(y^{oo}) - 2\kappa G(y^{oo}) < F(y^{oo}) = t^{oo}$, since $F(y^{o\kappa}) < F(y^{oo})$ due to $y^{o\kappa} > y^{oo}$ and $F'(y) < 0$. Moreover, from (19) we have $t^{o\kappa} \geq 0$ iff $(1 - 2\kappa)Y_{t_i}^i + Y_{t_i}^j \leq 0$ or, equivalently, $\kappa \leq (Y_{t_i}^i + Y_{t_i}^j)/2Y_{t_i}^i = [n^2\kappa^2H'' - B'']/[n^2\kappa(1 + \kappa)H'' - 2B'']$, where we have used (12). This completes the proof of part (i) in Proposition 2. In order to show part (ii), notice that $\kappa = 1$ implies $Y_{t_i}^j = 0$ and, thus, $\Psi = 1$ and $F(y^{o\kappa}) = G(y^{o\kappa})$, which is the same condition as in (18) implying $y^{o\kappa} = y^{oo}$. Inserting $\kappa = 1$ and $Y_{t_i}^j = 0$ into (19), we obtain $t^{o\kappa} = -G(y^{o\kappa}) = -F(y^{o\kappa}) = -F(y^{oo}) = -G(y^{oo}) = -t^{oo}$, which completes the proof.

Next turn to the proof of Proposition 3. For $\mu \in]0, 1]$ and $\kappa \in]0, 1]$, we can rewrite (16) as $F(y^{\mu\kappa}) = \Omega G(y^{\mu\kappa})$ where $\Omega := (1 + \mu)(Y_{t_i}^i + Y_{t_i}^j)/(Y_{t_i}^i + \mu Y_{t_i}^j)$. Moreover, we know from the proof of Proposition 2 that $F(y^{o\kappa}) = \Psi G(y^{o\kappa})$ with $\Psi := (Y_{t_i}^i + Y_{t_i}^j)/Y_{t_i}^i$. It is straightforward that $\Omega > \Psi$, since $\mu \in]0, 1]$, $Y_{t_i}^i + \mu Y_{t_i}^j < Y_{t_i}^i + Y_{t_i}^j < 0$ and $Y_{t_i}^i < 0 < Y_{t_i}^j$. It follows $y^{\mu\kappa} < y^{o\kappa}$ due to $\Omega G(y) > \Psi G(y)$ for all y as well as $F'(y) < 0$ and $G'(y) > 0$. Furthermore, from (16) and (17) we obtain $t^{\mu\kappa} = F(y^{\mu\kappa}) - 2\kappa G(y^{\mu\kappa}) > F(y^{o\kappa}) - 2\kappa G(y^{o\kappa}) = t^{o\kappa}$ due to $y^{\mu\kappa} < y^{o\kappa}$ and, thus, $F(y^{\mu\kappa}) > F(y^{o\kappa})$ as well as $G(y^{\mu\kappa}) < G(y^{o\kappa})$. This completes the proof.

Finally, in order to show Proposition 4, remember from the above proofs that $F(y^{oo}) = G(y^{oo})$ as well as $F(y^{\mu\kappa}) = \Omega G(y^{\mu\kappa})$ with $\Omega = (1 + \mu)(Y_{t_i}^i + Y_{t_i}^j)/(Y_{t_i}^i + \mu Y_{t_i}^j)$. Due to $F'(y) < 0$

and $G'(y) > 0$, it follows $y^{\mu\kappa} \leq y^{oo}$ iff $\Omega \geq 1$ or, equivalently, $\mu \leq -Y_{t_i}^j/Y_{t_i}^i$. Using (12), the latter inequality turns into condition (21).

Proof of Propositions 5. The equilibrium $(t_i^{\mu\kappa}, t_j^{\mu\kappa})$ of the asymmetric emission tax game is determined by (15) for both countries. We only vary one of the parameters at the same time. Let $x_i \in \{n_i, \kappa_i, \mu_i\}$. In general, the equilibrium conditions (15) can then be rewritten as $W_{t_i}^i(t_i^{\mu\kappa}, t_j^{\mu\kappa}, x_i, x_j) = 0$ and $W_{t_j}^j(t_i^{\mu\kappa}, t_j^{\mu\kappa}, x_i, x_j) = 0$. Totally differentiating these conditions gives the matrix equation

$$\begin{bmatrix} W_{t_i t_i}^i & W_{t_i t_j}^i \\ W_{t_j t_i}^j & W_{t_j t_j}^j \end{bmatrix} \begin{bmatrix} dt_i^{\mu\kappa} \\ dt_j^{\mu\kappa} \end{bmatrix} = \begin{bmatrix} -W_{t_i x_i}^i & -W_{t_i x_j}^i \\ -W_{t_j x_i}^j & -W_{t_j x_j}^j \end{bmatrix} \begin{bmatrix} dx_i \\ dx_j \end{bmatrix}. \quad (33)$$

The Jacobian reads $J := W_{t_i t_i}^i W_{t_j t_j}^j - W_{t_i t_j}^i W_{t_j t_i}^j$ and has to be positive in order to ensure stability of the tax game equilibrium. Applying Cramer's rule to (33) yields

$$\frac{\partial t_i^{\mu\kappa}}{\partial x_i} = -\frac{W_{t_i x_i}^i W_{t_j t_j}^j - W_{t_j x_i}^j W_{t_i t_i}^i}{J}, \quad \frac{\partial t_i^{\mu\kappa}}{\partial x_j} = -\frac{W_{t_i x_j}^i W_{t_j t_j}^j - W_{t_j x_j}^j W_{t_i t_i}^i}{J}, \quad (34)$$

$$\frac{\partial t_j^{\mu\kappa}}{\partial x_i} = -\frac{W_{t_j x_i}^j W_{t_i t_i}^i - W_{t_i x_i}^i W_{t_j t_i}^j}{J}, \quad \frac{\partial t_j^{\mu\kappa}}{\partial x_j} = -\frac{W_{t_j x_j}^j W_{t_i t_i}^i - W_{t_i x_j}^i W_{t_j t_i}^j}{J}. \quad (35)$$

Equilibrium emissions of the individual consumer can be written as $y_i^{\mu\kappa} = Y^i(t_i^{\mu\kappa}, t_j^{\mu\kappa}, x_i, x_j)$ and $y_j^{\mu\kappa} = Y^j(t_i^{\mu\kappa}, t_j^{\mu\kappa}, x_i, x_j)$. We therefore obtain

$$\frac{\partial y_i^{\mu\kappa}}{\partial x_i} = Y_{t_i}^i \frac{\partial t_i^{\mu\kappa}}{\partial x_i} + Y_{t_j}^i \frac{\partial t_j^{\mu\kappa}}{\partial x_i} + Y_{x_i}^i, \quad \frac{\partial y_i^{\mu\kappa}}{\partial x_j} = Y_{t_i}^i \frac{\partial t_i^{\mu\kappa}}{\partial x_j} + Y_{t_j}^i \frac{\partial t_j^{\mu\kappa}}{\partial x_j} + Y_{x_j}^i, \quad (36)$$

$$\frac{\partial y_j^{\mu\kappa}}{\partial x_i} = Y_{t_j}^j \frac{\partial t_j^{\mu\kappa}}{\partial x_i} + Y_{t_i}^j \frac{\partial t_i^{\mu\kappa}}{\partial x_i} + Y_{x_i}^j, \quad \frac{\partial y_j^{\mu\kappa}}{\partial x_j} = Y_{t_j}^j \frac{\partial t_j^{\mu\kappa}}{\partial x_j} + Y_{t_i}^j \frac{\partial t_i^{\mu\kappa}}{\partial x_j} + Y_{x_j}^j. \quad (37)$$

Equilibrium global emissions are $e^{\mu\kappa} = E(t_i^{\mu\kappa}, t_j^{\mu\kappa}, x_i, x_j)$ implying

$$\frac{\partial e^{\mu\kappa}}{\partial x_i} = E_{t_i} \frac{\partial t_i^{\mu\kappa}}{\partial x_i} + E_{t_j} \frac{\partial t_j^{\mu\kappa}}{\partial x_i} + E_{x_i}, \quad \frac{\partial e^{\mu\kappa}}{\partial x_j} = E_{t_i} \frac{\partial t_i^{\mu\kappa}}{\partial x_j} + E_{t_j} \frac{\partial t_j^{\mu\kappa}}{\partial x_j} + E_{x_j}. \quad (38)$$

Equilibrium welfare is determined by $w_i^{\mu\kappa} = W^i(t_i^{\mu\kappa}, t_j^{\mu\kappa}, x_i, x_j)$ and $w_j^{\mu\kappa} = W^j(t_i^{\mu\kappa}, t_j^{\mu\kappa}, x_i, x_j)$. Taking into account the equilibrium conditions $W_{t_i}^i(\cdot) = 0$ and $W_{t_j}^j(\cdot) = 0$, we obtain

$$\frac{\partial w_i^{\mu\kappa}}{\partial x_i} = W_{t_j}^i \frac{\partial t_j^{\mu\kappa}}{\partial x_i} + W_{x_i}^i, \quad \frac{\partial w_i^{\mu\kappa}}{\partial x_j} = W_{t_j}^i \frac{\partial t_j^{\mu\kappa}}{\partial x_j} + W_{x_j}^i, \quad (39)$$

$$\frac{\partial w_j^{\mu\kappa}}{\partial x_i} = W_{t_i}^j \frac{\partial t_i^{\mu\kappa}}{\partial x_i} + W_{x_i}^j, \quad \frac{\partial w_j^{\mu\kappa}}{\partial x_j} = W_{t_i}^j \frac{\partial t_i^{\mu\kappa}}{\partial x_j} + W_{x_j}^j. \quad (40)$$

Now consider a MPS with $dx_i = -dx_j = dx$. With the help of (36) and (37), the corresponding changes in individual emissions turn out to be

$$\frac{dy_i^{\mu\kappa}}{dx} = \frac{\partial y_i^{\mu\kappa}}{\partial x_i} - \frac{\partial y_i^{\mu\kappa}}{\partial x_j} = Y_{t_i}^i \left(\frac{\partial t_i^{\mu\kappa}}{\partial x_i} - \frac{\partial t_i^{\mu\kappa}}{\partial x_j} \right) + Y_{t_j}^i \left(\frac{\partial t_j^{\mu\kappa}}{\partial x_i} - \frac{\partial t_j^{\mu\kappa}}{\partial x_j} \right) + Y_{x_i}^i - Y_{x_j}^i, \quad (41)$$

$$\frac{dy_j^{\mu\kappa}}{dx} = -\frac{\partial y_j^{\mu\kappa}}{\partial x_j} + \frac{\partial y_j^{\mu\kappa}}{\partial x_i} = -Y_{t_j}^j \left(\frac{\partial t_j^{\mu\kappa}}{\partial x_j} - \frac{\partial t_j^{\mu\kappa}}{\partial x_i} \right) - Y_{t_i}^j \left(\frac{\partial t_i^{\mu\kappa}}{\partial x_j} - \frac{\partial t_i^{\mu\kappa}}{\partial x_i} \right) - Y_{x_j}^j + Y_{x_i}^j. \quad (42)$$

The total change in global emissions is

$$\frac{de^{\mu\kappa}}{dx} = \frac{\partial e^{\mu\kappa}}{\partial x_i} - \frac{\partial e^{\mu\kappa}}{\partial x_j} = E_{t_i} \left(\frac{\partial t_i^{\mu\kappa}}{\partial x_i} - \frac{\partial t_i^{\mu\kappa}}{\partial x_j} \right) + E_{t_j} \left(\frac{\partial t_j^{\mu\kappa}}{\partial x_i} - \frac{\partial t_j^{\mu\kappa}}{\partial x_j} \right) + E_{x_i} - E_{x_j}, \quad (43)$$

where we have used (38). Employing (39) and (40), the change in the countries' welfare is

$$\frac{dw_i^{\mu\kappa}}{dx} = \frac{\partial w_i^{\mu\kappa}}{\partial x_i} - \frac{\partial w_i^{\mu\kappa}}{\partial x_j} = W_{t_j}^i \left(\frac{\partial t_j^{\mu\kappa}}{\partial x_i} - \frac{\partial t_j^{\mu\kappa}}{\partial x_j} \right) + W_{x_i}^i - W_{x_j}^i, \quad (44)$$

$$\frac{dw_j^{\mu\kappa}}{dx} = -\frac{\partial w_j^{\mu\kappa}}{\partial x_j} + \frac{\partial w_j^{\mu\kappa}}{\partial x_i} = -W_{t_i}^j \left(\frac{\partial t_i^{\mu\kappa}}{\partial x_j} - \frac{\partial t_i^{\mu\kappa}}{\partial x_i} \right) - W_{x_j}^j + W_{x_i}^j. \quad (45)$$

Next, evaluate all these derivatives at the symmetric equilibrium with $\mu_i = \mu_j = \mu$, $\kappa_i = \kappa_j = \kappa$ and $n_i = n_j = n/2$. It is then obvious that we have $W_{t_i t_i}^i = W_{t_j t_j}^j$, $W_{t_i t_j}^i = W_{t_j t_i}^j$, $W_{t_i x_i}^i = W_{t_j x_j}^j$ and $W_{t_i x_j}^i = W_{t_j x_i}^j$. From (34) and (35), we obtain

$$\frac{\partial t_i^{\mu\kappa}}{\partial x_i} = \frac{\partial t_j^{\mu\kappa}}{\partial x_j}, \quad \frac{\partial t_i^{\mu\kappa}}{\partial x_j} = \frac{\partial t_j^{\mu\kappa}}{\partial x_i}. \quad (46)$$

Moreover, symmetry also implies $Y_{t_i}^i = Y_{t_j}^j$, $Y_{t_j}^i = Y_{t_i}^j$, $Y_{x_i}^i = Y_{x_j}^j$ and $Y_{x_j}^i = Y_{x_i}^j$. Inserting together with (46) into (41) and (42) yields

$$\frac{dy_i^{\mu\kappa}}{dx} = -\frac{dy_j^{\mu\kappa}}{dx}. \quad (47)$$

Similar, symmetry implies $E_{t_i} = E_{t_j}$, $E_{x_i} = E_{x_j}$ and, by (43) and (46),

$$\frac{de^{\mu\kappa}}{dx} = 0, \quad (48)$$

which completes the proof of part (i) of Proposition 5. Finally, $W_{t_j}^i = W_{t_i}^j$, $W_{x_i}^i = W_{x_j}^j$ and $W_{x_j}^i = W_{x_i}^j$ due to symmetry. Inserting into (44) and (45), taking into account (46) gives

$$\frac{dw_i^{\mu\kappa}}{dx} = -\frac{dw_j^{\mu\kappa}}{dx}, \quad (49)$$

which also implies $dw^{\mu\kappa}/dx = dw_i^{\mu\kappa}/dx + dw_j^{\mu\kappa}/dx = 0$ and completes the proof of part (ii).

Proof of Propositions 6. For proving Proposition 6, remember the definitions and notation from the proofs of Proposition 1–4. The allocation rule (29) under the cap policy can then be written as $F(y^c) = (1 + \mu)G(y^c)$. Hence, y^c does not depend on κ . Moreover, for $\mu = 0$ and $\mu = 1$ we obtain $F(y^c) = G(y^c)$ and $F(y^c) = 2G(y^c)$ which obviously prove part (i) and part (ii), respectively. In order to show part (iii), remember $F(y^{oo}) = G(y^{oo})$ which due to $1 < 1 + \mu$ for $\mu \in]0, 1[$ implies $y^c < y^{oo}$. Similar, $F(y^{o\kappa}) = \Psi G(y^{o\kappa})$ with $\Psi = (Y_{t_i}^i + Y_{t_i}^j)/Y_{t_i}^i < 1 < 1 + \mu$ implies $y^c < y^{o\kappa}$. And, last but not least, $F(y^{\mu\kappa}) = \Omega G(y^{\mu\kappa})$ with $\Omega = (1 + \mu)(Y_{t_i}^i + Y_{t_i}^j)/(Y_{t_i}^i + \mu Y_{t_i}^j) < 1 + \mu$ implies $y^c < y^{\mu\kappa}$.

Quadratic example. With the quadratic specification, (8) can be rewritten as

$$\alpha - p - t_i - n\gamma\kappa_i - \left[\beta + n\delta\kappa_i(n_i + \kappa_i n_j) \right] y_i - n\delta\kappa_i(1 - \kappa_i)n_j y_j = 0. \quad (50)$$

Explicitly solving (50) and the corresponding condition for country j yields (22) where

$$\begin{aligned} \Gamma^{i0}(n_i, n_j, \kappa_i, \kappa_j) = & \frac{1}{\theta} \left\{ (\alpha - p) \left\{ \beta + n\delta \left[(\kappa_j - \kappa_i)n_j + \kappa_j^2 n_i + \kappa_i^2 n_j \right] \right\} \right. \\ & \left. - n\gamma\kappa_i \left[\beta + n\delta\kappa_j(\kappa_j n_i + \kappa_i n_j) \right] \right\}, \end{aligned} \quad (51)$$

$$\Gamma^{ii}(n_i, n_j, \kappa_i, \kappa_j) = \frac{\beta + n\delta\kappa_j(n_j + \kappa_j n_i)}{\theta} > 0, \quad \Gamma^{ij}(n_i, n_j, \kappa_i, \kappa_j) = \frac{n\delta\kappa_i(1 - \kappa_i)n_j}{\theta} > 0, \quad (52)$$

with $n = n_i + n_j$ and

$$\theta := \beta^2 + \beta n\delta(\kappa_i n_i + \kappa_j n_j + \kappa_j^2 n_i + \kappa_i^2 n_j) + n^3 \delta^2 \kappa_i \kappa_j (\kappa_j n_i + \kappa_i n_j). \quad (53)$$

Differentiating Γ^{ii} with respect to n_i , taking into account $n_j = n - n_i$, we obtain

$$\Gamma_{n_i}^{ii} = - \frac{n\delta\kappa_i(1 - \kappa_i)(\beta + n^2\delta\kappa_j)(\beta + n^2\delta\kappa_j^2)}{\theta^2}. \quad (54)$$

If $\kappa_i \in]0, 1[$, $\Gamma_{n_i}^{ii} < 0$ as stated in the text. Differentiating Γ^{ij} with respect to κ_i and κ_j gives

$$\Gamma_{\kappa_i}^{ij} := - \frac{n\delta n_j \left[\beta + n\delta\kappa_j(n_j + \kappa_j n_i) \right] \left[n^2\delta\kappa_i^2 + 2\beta\kappa_i - \beta \right]}{\theta^2}, \quad (55)$$

$$\Gamma_{\kappa_j}^{ij} := - \frac{n^2\delta^2\kappa_i(1 - \kappa_i)n_j \left\{ \beta(n_j + 2\kappa_j n_i) + n^2\delta\kappa_i(\kappa_i n_j + 2\kappa_j n_i) \right\}}{\theta^2}. \quad (56)$$

Equation (56) implies $\Gamma_{\kappa_j}^{ij} < 0$ as long as $\kappa_i \in]0, 1[$, as stated in the text. Accordingly to (55), we have $\Gamma_{\kappa_i}^{ij} \geq 0$ iff $\kappa_i \leq \bar{\kappa}$ with $\bar{\kappa} := (-\beta + \sqrt{\beta^2 + \beta n^2 \delta})/(n^2 \delta) \in]0, 1/2[$. Hence,

leakage Γ^{ij} is inverted u-shaped in κ_i , as stated in the text. Finally, inserting $y_i = Y^i(t_i, t_j)$ and $y_j = Y^j(t_i, t_j)$ into (1) gives global emissions (23) with

$$\Gamma^i(n_i, n_j, \kappa_i, \kappa_j) = n_i \Gamma^{ii}(n_i, n_j, \kappa_i, \kappa_j) - n_j \Gamma^{ji}(n_i, n_j, \kappa_i, \kappa_j) = \frac{n_i(\beta + n^2 \delta \kappa_j^2)}{\theta} > 0. \quad (57)$$

The expression for $\Gamma^j(n_i, n_j, \kappa_i, \kappa_j)$ is analogous. $\Gamma^0 = n_i \Gamma^{i0} + n_j \Gamma^{j0} > 0$ follows from our assumptions $\Gamma^{i0} > 0$ and $\Gamma^{j0} > 0$.

With symmetry $\mu_i = \mu_j = \mu$, $\kappa_i = \kappa_j = \kappa$ and $n_i = n_j = n/2$, we again obtain the individual consumer's emissions (22), but the coefficients (51)–(53) simplify to

$$\Gamma^{i0} \left(\frac{n}{2}, \frac{n}{2}, \kappa, \kappa \right) = \frac{\alpha - p - n\gamma\kappa}{\beta + n^2\delta\kappa}, \quad (58)$$

$$\Gamma^{ii} \left(\frac{n}{2}, \frac{n}{2}, \kappa, \kappa \right) = \frac{2\beta + n^2\delta\kappa(1 + \kappa)}{2(\beta + n^2\delta\kappa)(\beta + n^2\delta\kappa^2)}, \quad (59)$$

$$\Gamma^{ij} \left(\frac{n}{2}, \frac{n}{2}, \kappa, \kappa \right) = \frac{n^2\delta\kappa(1 - \kappa)}{2(\beta + n^2\delta\kappa)(\beta + n^2\delta\kappa^2)}. \quad (60)$$

With these expressions we compute the consumers' emissions in the left panel of Figure 1, which by the relation $e = ny$ are proportional to the global emissions in the symmetric case. Individual emissions together with (17) are then used to compute the equilibrium tax rates in the right panel of Figure 1. The socially optimal emissions and tax rate follow from using the quadratic specification of B and H in (5) and the in Pigouvian tax $t^* = nH'(ny^*)$. All numerical simulations in the symmetric and asymmetric case are conducted with the algebra software Mathematica[®]. The Mathematica[®] notebook can be obtained upon request.

References

- Alger, I. and J.-F. Laslier (2022): Homo moralis goes to the voting booth: coordination and information aggregation. *Journal of Theoretical Politics* 34, 280-312.
- Alger, I. and J.W. Weibull (2013): Homo moralis - preference evolution under incomplete information and assortative matching, *Econometrica* 81, 2269-2302.
- Alger, I. and J.W. Weibull (2016): Evolution and Kantian morality, *Games and Economic Behavior* 98, 56-67.
- Alger, I. and J.W. Weibull (2017): Strategic behavior of moralists and altruists, *Games* 8, 38.

- Alger, I. and J.W. Weibull (2020): Morality: evolutionary foundations and economic implications, in: Basu, K., Rosenblatt, D. and C. Sepulveda (eds.), *The State of Economics, the State of the World*, Cambridge, MIT Press.
- Barrett, S. (1994a): Self-enforcing international environmental agreements, *Oxford Economic Papers* 46, 878-894.
- Barrett, S. (1994b): Strategic environmental policy and international trade, *Journal of Public Economics* 54, 325-338.
- Baylis, K., Fullerton, D. and D.H. Karney (2013): Leakage, welfare, and cost-effectiveness of carbon policy, *American Economic Review* 103, 332-337.
- Bilodeau, M. and N. Gravel (2004): Voluntary provision of a public good and individual morality, *Journal of Public Economics* 88, 645-666.
- Bohm, P. (1993): Incomplete international cooperation to reduce CO₂ emissions: Alternative policies, *Journal of Environmental Economics and Management* 24: 258-271.
- Bucovetsky, S. (1991): Asymmetric tax competition, *Journal of Urban Economics* 30, 167-181.
- Capraro, V. and D.G. Rand (2018): Do the right thing: Experimental evidence that preferences for moral behavior, rather than equity or efficiency per se, drive human prosociality, *Judgment and Decision Making* 13, 99-111.
- Carraro, C. (2016): A bottom-up, non-cooperative approach to climate change control: assessment and comparison of Nationally Determined Contributions (NDCs), *Journal of Sustainable Development* 9, 175.
- Copeland, B., and M.S. Taylor (2005): Free trade and global warming: a trade theory view of the Kyoto protocol, *Journal of Environmental Economics and Management* 49, 205-34.
- Cremer, H. and F. Gahvari (2004): Environmental taxation, tax competition, and harmonization, *Journal of Urban Economics* 55, 21-45.
- Dierks, K., Alger, I. and J.-F. Laslier (2024): Does universalization ethics justify participation in large elections? Toulouse School of economics Working Papers No. 1193.
- Dizarlar, A. and E. Karagözoğlu (2023): Kantian equilibria of a class of Nash bargaining games, *Journal of Public Economic Theory* 25, 867-891.

- Eichner, T. and R. Pethig (2019): Strategic pollution control and capital tax competition, *Journal of Environmental Economics and Management* 94, 27-53.
- Eichner, T. and R. Pethig (2021): Climate policy and moral consumers, *Scandinavian Journal of Economics*, 123, 1190-1226.
- Eichner, T. and M. Runkel (2012): Interjurisdictional spillovers, decentralized policymaking and the elasticity of capital supply, *American Economic Review* 102, 2349-2357.
- Eichner, T. and M. Runkel (2024): Homo oeconomicus as the homo moralis' party pooper: heterogeneous morality in public good games, CESifo Working Paper No. 11231.
- Grafton, R.Q., Kompas, T. and N. van Long (2017): A brave new world? Kantian-Nashian interaction and the dynamics of global climate change mitigation, *European Economic Review* 99, 31-42.
- Hoel, M. (1991): Global environmental problems: the effects of unilateral actions taken by one country, *Journal of Environmental Economics and Management* 20, 55-70.
- Hoel, M. (2005): The triple inefficiency of uncoordinated environmental policies, *Scandinavian Journal of Economics* 107, 157-173.
- Hoel, M. and P. Shapiro (2003): Population mobility and transboundary environmental problems, *Journal of Public Economics* 87, 1013-1024.
- Ishikawa, J. and T. Okubo (2017): Greenhouse-gas emission controls and firm locations in north-south trade, *Environmental and Resource Economics* 67, 637-660.
- Juan-Bartroli, P. and E. Karagözoğlu (2024): Moral preferences in bargaining, *Economic Theory*, <https://doi.org/10.1007/s00199-023-01544-7>.
- Kant, I. (1785): *Grundlegung zur Metaphysik der Sitten* (1964, Groundwork of the Metaphysics of Morals, Harper Torchbooks, New York).
- Kennedy, P.W. (1994): Equilibrium pollution taxes in open economies with imperfect competition, *Journal of Environmental Economics and Management* 27, 49-63.
- Kiyono, K. and J. Ishikawa (2013): Environmental management policy under international carbon leakage, *International Economic Review* 54, 1057-1083.
- Markusen, J.R., Morey, E.R. and N. D. Olewiler (1995): Competition in regional environmental policies when plant locations are endogenous, *Journal of Public Economics* 56, 55-77.

- Mideksa, T.K. and M.L. Weitzman (2019): Prices versus quantities across jurisdictions, *Journal of the Association of Environmental and Resource Economists* 6, 883-891.
- Ogawa, H. and D.E. Wildasin (2009): Think locally, act locally: Spillovers, spillbacks, and efficient decentralized policymaking, *American Economic Review* 99, 1206-1217.
- Richter, P.M., Runkel, M. and R.C. Schmidt (2021): Strategic environmental policy and the mobility of firms, *Journal of the Association of Environmental and Resource Economists* 8, 863-893.
- Roemer, J.E. (2010): Kantian equilibrium, *Scandinavian Journal of Economics*, 112, 1-24.
- Roemer, J.E. (2015): Kantian optimization. A microfoundation for cooperation, *Journal of Public Economics* 127, 45-57.
- Rubio, S.J. and A. Ulph (2006): Self-enforcing international environmental agreements revisited, *Oxford Economic Papers* 58, 233-263.
- Tol, R.S.J. (2019): A social cost of carbon for (almost) every country, *Energy Economics* 83, 555-566.
- Ulph, A. (1996): Environmental policy and international trade when governments and producers act strategically, *Journal of Environmental Economics and Management* 30, 265-281.
- UNEP (2024): Emissions Gap Report 2024: no more hot air ... please! With a massive gap between rhetoric and reality, countries draft new climate commitments, Nairobi, <https://doi.org/10.59117/20.500.11822/46404>.
- Van Leeuwen, B. and I. Alger (2024): Estimating social preferences and Kantian morality in strategic interactions, *Journal of Political Economy Microeconomics* 2, 665-706.