Kantian Norms and their Effect on Public Good Allocation

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1. Introduction

The cooperation dilemma is an ongoing topic in economics: A utility maximizing homo oeconomicus voluntarily does not contribute enough to a cooperative venture (e.g. producing in teams, using a common property resource as fishing grounds or pastures, providing a public good, …)

→ An efficient Pareto optimal outcome is not attained.

This divergence between individual and collective rationality is reflected by the prisoners' dilemma.

Economists (as, e.g., Rabin, 1993, Fehr & Schmidt, 1999, Bolton & Ockenfels, 2000, Brekke, Kverndokk & Nyborg, 2003) have gone beyond the narrowly defined homo oeconomicus

→ They have started to emphasize the role of other-regarding and moral motivations of various kinds for overcoming the cooperation dilemma:

- Individual preferences are assumed to have an additional ethical component, i.e. concerns for reciprocity, equal distribution or social responsibility.

- Given these extended preferences agents are still optimizing according to the Nash hypothesis.

But: Moral behavior can also be captured by a conceptually different approach

- by keeping standard preferences
- but changing the mode of optimizing behavior.

This alternative route has been taken by Roemer (2010, 2015, 2019), Long (2015, 2017, 2019) and Eichner & Pethig (2019)

- by assuming non-Nash optimization behavior according to Kant's categorical imperative **KCI** (building on ideas by Laffont, 1975, and Sugden, 1984).
- in different types of models ($\rightarrow$ static and dynamic games with discrete and continuous choice parameters and pure and mixed strategies)
- with different applications ($\rightarrow$ protection of the commons, choice of tax schedules, tax competition).

The **objectives of my presentation** are twofold:

- to discuss the normative underpinnings of the Kantian approach more closely
- to apply the Kantian approach to the standard model of private public good provision (Cornes & Sandler, 1984, 1986, or Bergstrom, Blume & Varian, 1986) using the Aggregative Game Approach **AGA** (e.g. Cornes & Hartley, 2007).

The **AGA** will be shown to be helpful for understanding

- the basic mechanisms underlying the effects of Kantian optimization in a public good economy.
- the similarities and differences as compared to other devices for promoting cooperation on public good provision.

1. The Normative Basis of Kantian Optimization

In its recent economic applications the **KCI** is presented as follows:

"*Take those and only those actions that are universalizable* …" (Roemer, 2015 p. 32) or *"(w)hat is the strategy I would like …* (*all*, WB) *of us to play*?" (Roemer, 2019, p. 12).

"*Act only on the maxim by which you could at the same time will that it should become a universal law*." (Long, 2019, p. 4).

More specifically: Applying the Kantian optimization method and pursuing the universalizability norm an agent asks herself whether she should "*deviate from a contemplated action … if I would have all others deviate in a like manner*?" (Roemer, 2015, p. 46).

Similarly, a Kantian agent is said to consider “Kantian counterfactuals”:

“*If I were to deviate, what payoff would I get, assuming that all other agents would also deviate likewise*?” (Long et al., 2017, p. 32)

But: These interpretations of the **KCI** (only) express wishes or expectations about the behavior of the potential cooperators $\rightarrow$ They do *not* refer directly to more specific ethical norms, i.e. to the question: “What kind of behavior can be deemed morally right or wrong in a cooperative setting?”

An **approach for closing this normative gap** could look like this:

A Kantian agent considers a reduction of her contribution to a common project, i.e. a deviation from some allocation (as in the interpretations mentioned above) while observing a **F**airness **N**orm **FNR** on tolerable **R**eductions of contributions:

FNR: *"If I reduce my contribution I must concede to the other agents that they likewise reduce their contributions."*

This ethical maxim can be related to norms of reciprocity and equality of distribution which are fundamental for the ethical basis of economics:

- "If the others cooperate I am obliged to cooperate too and thus to act reciprocally. Therefore, I cannot have the privilege to benefit from the contributions of the others and thus to be a free-rider by unilaterally cutting back my contribution. It is ethically incorrect to demand or accept a preferential treatment for myself" $\rightarrow$ Equal rights for all!
- "If I accepted to cut my contributions unilaterally I would not accept the principle of equitable burden-sharing among all agents involved."

Note: Roemer and Long use a potential equilibrium with positive contributions as the initial state (and not the situation with no contributions!) and consider deviations from that $\rightarrow$ Invoking **FNR** becomes especially appealing for motivating their approaches.

FNR only deals with downward deviations

$\rightarrow$ What about deviations upwards, i.e. increases of contributions?

An oversupply of the common good can be prevented by the following ethical maxim **RMD** that provides a **R**estriction of the **M**oral **D**uty to contribute:

RMD: *"I am not obliged to increase my own contribution further if that does not benefit me even when the other agents increase their contributions likewise*."

RMD can be motivated by the following reasoning:

From an ethical perspective there is the moral postulate for agents to increase their contributions over those voluntarily chosen: This increase however has to stop at the point at which agents start to lose from additional joint contributions $\rightarrow$ "Enough is enough!" – Each moral obligation must have its limits!

Which non-Nash equilibria will emerge in a public-good economy when **FNR** and **RMD** are imposed? This crucially depends on what "deviating likewise" is to mean exactly $\rightarrow$ Topic of the next section.

2. Kantian Optimization in a Public Good Economy

The standard assumptions on a public good economy are:

- There is a group N of agents $i = 1,...,n$ with twice differentiable and strictly monotone increasing utility functions $u^i(x_i, G)$: x_i is agent i's private consumption, w_i her private good endowment, G is public good supply.
- Both goods are strictly non-inferior for each agent.
- The public good is produced by a summation technology for which the marginal rate of transformation between the public good and the private good is equal to one for all agents, i.e. $mrt = 1$.
- $x_i = e_i(G, \pi_i)$ denotes the expansion path along which agent i's marginal rate of substitution $mrs_i = m_i(x_i, G)$ between the public and the private good is π_i

$\rightarrow$ Potential equilibrium positions of a contributing agent i if her perceived mrt (= her transformation parameter or reciprocal of the personal public good price) is π_i.

According to the **AGA** (e.g., Cornes & Hartley, 2007) public good supply $\hat{G}$ in a corresponding transformation parameter equilibrium **TNE** is characterized by

(1) $$\hat{G} + \sum_{i=1}^{n} e_i(\hat{G}, \pi_i) = \sum_{i=1}^{n} w_i =: W.$$

Private consumption of agent i in an **TNE** is $\hat{x}_i = e_i(\hat{G}, \pi_i)$.

Given the standard properties of utility functions (e.g., normality $\Rightarrow$ strictly monotone increasing expansion paths) existence and uniqueness of a **TNE** is ensured.

The **TNE** are generalizations of the standard interior Nash equilibrium **SNE** with public good supply $\hat{G}^N$) where $\pi_i = 1$, i.e.

(2) $$\hat{G}^N + \sum_{i=1}^{n} e_i(\hat{G}^N, 1) = W.$$

Kantian optimization by agent i can now be easily described

$\rightarrow$ Specific transformation parameters $\pi_i \neq 1$ of agent i express different types of “likewise deviations” attributed to the others.

Two versions stand out (Roemer 2010, 2015, 2019):

Starting from a certain allocation $(x_1,...,x_n,G)$ (with individual public good contributions $g_j = w_j - x_j$ for $j=1,...,n$) some agent i's Kantian optimization either refers to

- equal additive deviations by the others $\rightarrow$ Agent i seeks to maximize $u^i(w_i - g_i + z, \sum_{j=1}^{n}(g_j + z)) = u^i(w_i - g_i + z, G + nz)$ by choosing $z \in \mathbb{R}$ $\rightarrow$ This gives the $mrt_i = \pi_i = \frac{1}{n}$ for agent i.

- equal proportional/multiplicative deviations by the others $\rightarrow$ Agent i seeks to maximize $u^i(w_i - \lambda g_i, \sum_{j=1}^{n} \lambda g_j) = u^i(w_i - \lambda g_i, \lambda G)$ by choosing $\lambda \in \mathbb{R}$ $\rightarrow$ This gives the $mrt_i = \pi_i = \frac{g_i}{G}$ for agent i.

The concept of "likewise deviations" can be generalized

- by modifying optimization in the additive case to $u^i(w_i - g_i + z, G + z + \alpha(n-1)z)$ with some parameter $\alpha \in \mathbb{R}$ $\rightarrow$ A higher α indicates a higher moral consciousness.
- by modifying optimization in the multiplicative case to $u^i(w_i - \lambda g_i, \lambda g_i + \alpha \sum_{j \neq i} \lambda g_j)$ with some $\alpha \in \mathbb{R}$ (Long, 2019).
- by differentiating between deviations up- and downward.
- by combining the additive and the multiplicative case, i.e. by modifying optimization to $u^i(w_i - g_i + z, z + \alpha(n-1)z + \beta \frac{g_i + z}{g_i} \sum_{j \neq i} g_j)$ (similar to Roemer 2015, 2019).

3. Kantian Equilibria

Given an allocation $(x_1,...,x_n,G)$ an additive or multiplicative Kantian agent i is in an (interior) equilibrium position if optimization yields optimal values $z_i^* = 0$ or $\lambda_i^* = 0$, respectively.

We first assume that all agents are Kantian of the same type $\rightarrow$ The Kantian equilibrium

- **KEA** in the additive case then has $z_i^* = 0$
- **KEM** in the multiplicative case has $\lambda_i^* = 0$

for all agents $i = 1,...,n$.

Interior **KEA** and **KEM** are characterized as follows:

Proposition 1: Public good supply $\hat{G}_A^K$ in an **KEA** is given by the condition

(3) $$\hat{G}_A^K + \sum_{i=1}^{n} e_i(\hat{G}_A^K, \frac{1}{n}) = W \quad ,$$

and private consumption of agent $i = 1,...,n$ is $\hat{x}_A^K = e_i(\hat{G}_A^K, \frac{1}{n})$.

Proof: Since $mrt_i = \pi_i = \frac{1}{n}$ a **KEA** is a **TNE** for the transformation parameters $\pi_i = \frac{1}{n}$ for all $i = 1,...,n$. QED

Implications

- The **KEA** exists and is unique.
- Warr neutrality holds $\rightarrow$ Redistribution of income will not change public good supply and private consumption of all agents as long its interiority is preserved.
- The **KEA** is identical with the symmetric interior matching equilibrium (see, e.g. Buchholz, Cornes & Sandler, 2011) where each agent i matches each other agent j's public good contribution with the matching rate $s_{ij} = 1$.

Proposition 2 (Roemer, 2010): The **KEM** coincides with the **TNE** with the transformation parameters $\pi_i = \frac{\hat{g}_{iM}^K}{\hat{G}_M^K}$ for each agent $i = 1,...,n$ and the Lindahl equilibrium.

Proof: (i) The coincidence with the **TNE** follows since multiplicative Kantian optimization gives that in the **KEM** $mrs_i = \pi_i = \frac{\hat{g}_{iM}^K}{\hat{G}_M^K} = \frac{w_i - \hat{x}_{iM}^K}{\hat{G}_M^K}$ must hold for each agent $i = 1,...,n$.

(ii) Each agent i would choose $\hat{G}_M^K$ as price-taker given her personalized public good price $\hat{p}_i = \frac{\hat{g}_{iM}^K}{\hat{G}_M^K}$ $\rightarrow$ The conditions that define the Lindahl equilibrium are satisfied. QED

Kantian optimization indeed helps to cure the underprovision of the public good in the **SNE**.

Proposition 3: Both **KEA** and **KEM** are Pareto optimal and have a higher public good supply than in the **SNE**. (Observe interiority!)

Proof: (i) Pareto-optimality follows from the Samuelson rule:

- $\sum_{i=1}^{n} mrs_i = \sum_{i=1}^{n} \pi_i = \sum_{i=1}^{n} \frac{1}{n} = 1 = mrt$ for the **KEA.**
- $\sum_{i=1}^{n} mrs_i = \sum_{i=1}^{n} \pi_i = \sum_{i=1}^{n} \frac{\hat{g}_{iM}^{K}}{\hat{G}_{M}^{K}} = 1 = mrt$ for the **KEM**.

(ii) By a standard argument of the **AGA** we have $\hat{G}_A^K > \hat{G}^N$ and $\hat{G}_M^K > \hat{G}^N$ since $e_i(G, \pi_i) < e(G,1)$ holds if $\pi_i < 1$ for some agent i $\rightarrow$

(4) $$\hat{G}^N + \sum_{i=1}^{n} e_i(\hat{G}^N, \pi_i) \; < \; \hat{G}^N + \sum_{i=1}^{n} e_i(\hat{G}^N, 1) = W.$$

To have identity of both sides of (4) if either $\pi_i = \frac{1}{n} < 1$ or $\pi_i = \frac{\hat{g}_{iM}^{K}}{\hat{G}_{M}^{K}} < 1$ for all $i = 1, \ldots, n$ public good supply must increase. QED

Note: If all agents have the same utility function and the same income level **KEA** = **KEM** holds.

4. Mixed Kantian Equilibria in the Case of Additive Variations

It cannot be expected that all agents exhibit Kantian behavior:

"*In most real world situations there is a mixture of Kantians and Nashians*." (Long et al., 2017, p. 34)

We now determine the equilibrium outcomes in this more intricate situation

$\rightarrow$ Generalized ("mixed") Kant-Nash equilibria **KNE**

The entire set of agents $n = m + k$ is divided into two sub-groups (Long, 2017, Long et al., 2017 and Long, 2019):

- the Nash players $i = 1, ..., m$
- the Kantian players $i = m + 1, ..., m + k$.

Two types of Kantian agents have to be distinguished:

- inclusive Kantians $\rightarrow$ The variations pertain to the entire population with n agents.
- exclusive Kantians $\rightarrow$ The variations only pertain to the group of the of k Kantian agents $\rightarrow$ The Kantian agents are forming a “moral community”.

For both types of agents and the case of additive deviations the **KNE** can easily be characterized by the **AGA**:

- For inclusive Kantians public good supply $\hat{G}_{AI}^{KN}$ in an interior inclusive **KNEI** is given by

(5) $$\hat{G}_{AI}^{KN} + \sum_{i=1}^{m} e_i(\hat{G}_{AI}^{KN},1) + \sum_{i=m+1}^{m+k} e_i(\hat{G}_{AI}^{KN},\frac{1}{m+k}) = \sum_{i=1}^{m+k} w_i .$$

Private consumption of a Nashian is $\hat{x}_{iAI}^{KN} = e_i(\hat{G}_{AI}^{KN},1)$ and that of a Kantian is $\hat{x}_{iAI}^{KN} = e_i(\hat{G}_{AI}^{KN},\frac{1}{m+k})$.

- For exclusive Kantians public good supply $\hat{G}_{AE}^{KN}$ in the interior exclusive **KNEE** is given by

(6) $$\hat{G}_{AE}^{KN} + \sum_{i=1}^{m} e_i(\hat{G}_{AE}^{KN}, 1) + \sum_{i=m+1}^{m+k} e_i(\hat{G}_{AE}^{KN}, \frac{1}{k}) = \sum_{i=1}^{m+k} w_i .$$

Private consumption of a Nashian is $\hat{x}_{iAE}^{KN} = e_i(\hat{G}_{AE}^{KN}, 1)$ and that of a Kantian is $\hat{x}_{iAE}^{KN} = e_i(\hat{G}_{AE}^{KN}, \frac{1}{k})$.

Public good supply in the various equilibria can be ranked by use of the **AGA** in a standard way:

Proposition 4: Given that all equilibria are interior we have

$$\hat{G}^{N} < \hat{G}_{AE}^{KN} < \hat{G}_{AI}^{KN} < \hat{G}_{A}^{K} .$$

Proof: In a similar way as in the proof of Proposition 3 the result follows by comparing (2), (3), (5) and (6) and observing that $e_i(G,\pi_i') < e_i(G,\pi_i)$ for all $G > 0$ and all agents $i = 1,...,n$ given $\pi_i' < \pi_i$. QED

Interpretation: A stronger moral motivation increases agents' willingness to contribute to the public good and consequently equilibrium public good supply.

Concerning utility of agents in the different equilibria there is an ambiguous picture $\rightarrow$ A clear-cut result is only obtained for the Nashians:

Proposition 5: A Nashian agent is better off

- in **KNEI** and **KNEE** than in the **SNE**.
- in the inclusive **KNEI** than in the exclusive **KNEE**.

Proof: With increased public supply each Nashian agent $i = 1,...,m$ is moving outward her expansion path $e_i(G,1)$. QED

Some welfare effects for Kantians will be explored in the subsequent section.

5. The Profitability of Forming Kantian Coalitions

When all agents are adopting Kantian behavior forming a grand Kantian coalition, this

- makes some agents better off since **KEA** and **KEM** are Pareto optimal but **SNE** is not.
- may make some agents worse off since their willingness to contribute to the public good increases.

If all agents have the same utility function **KEA** is Pareto superior to **SNE**. For **KEM** = Lindahl equilibrium (see Buchholz, Cornes & Peters, 2006) this only holds if all agents also have the same income so that **KEA** = **KEM**.

More complicated question: When does it pay for a group to become Kantians and to form a Kantian coalition of limited size when a group of stubborn Nashians is still present?

We deal with this question for a special case with inclusive Kantians and additive deviations assuming interiority of the ensuing equilibria.

Proposition 6: Let a fixed number n of agents have identical preferences with expansion paths $e(G,\pi)$. Becoming inclusive Kantians then is profitable for a group if and only if its size k exceeds some threshold level $\underline{k}$.

Proof: Public good supply $\hat{G}_{AI}^{KN}$ in an original (interior) **KNEI** with k inclusive Kantians and $m = n - k$ Nashians is characterized by

(7) $$\hat{G}_{AI}^{KN} + ke(\hat{G}_{AI}^{KN}, \frac{1}{n}) + me(\hat{G}_{AI}^{KN}, 1) = W$$

Since $e(\hat{G}_{AI}^{KN}, \frac{1}{n}) < e(\hat{G}_{AI}^{KN}, 1)$ this implies

(8) $$\hat{G}_{AI}^{KN} + (k+1)e(\hat{G}_{AI}^{KN}, \frac{1}{n}) + (m-1)e(\hat{G}_{AI}^{KN}, 1) < W$$

Hence to re-establish equilibrium public good supply $\hat{G}_{AI}^{KN}$ must increase and the Kantians (and the Nashians) must move outwards on their expansion paths $e(G, \frac{1}{n})$ and $e(G, 1)$, respectively.

Consequently: If agents have improved their utility over **SNE** in a Kantian coalition of size k they will also do better in an enlarged Kantian coalition of size $k+1$.

By an analogous argument it is shown: If forming a Kantian coalition of size k is not profitable then it is also not profitable for a coalition of size $k-1$.

Since forming a grand Kantian coalition is always profitable the existence of a critical coalition size $\underline{k}$ follows. QED

Part of this result also holds if the coalition members become exclusive Kantians:

Proposition 7: If all agents have the same preferences becoming exclusive Kantians is also profitable for any group of size $k \geq \underline{k}$.

Proof: All agents are better off in the **KNEE** than in the **KNEI** which follows directly from the general result in Proposition 8 and Proposition 9. QED

Proposition 8: At least one Kantian agent is worse off in the **KNEI** with coalition size k than in the **KNEE** of the same size.

Proof: Let $\hat{g}_{iAE}^{KN}$ and $\hat{g}_{iAI}^{KN}$ denote the public good contributions of a Kantian agent i in the **KNEE** and the **KNEI**, respectively. Then

$$\hat{G}_{AI}^{KN} - \hat{G}_{AE}^{KN} < \sum_{i=m+1}^{m+k} \hat{g}_{iAI}^{KN} - \sum_{i=m+1}^{m+k} \hat{g}_{iAE}^{KN} \tag{9}$$

since the increase of public good supply from $\hat{G}_{AE}^{KN}$ to $\hat{G}_{AI}^{KN}$ is accompanied by an increase of the Nashian's private consumption and hence a reduction of their public good contributions.

Hence

(10) $$\frac{\hat{g}_{jAI}^{KN} - \hat{g}_{jAE}^{KN}}{\hat{G}_{AI}^{KN} - \hat{G}_{AE}^{KN}} > \frac{1}{m}$$

at least for one Kantian agent $j = m+1,...,m+k$ $\rightarrow$ Agent j's position in the **KNEI** lies below the indifference curve through her position in the **KNEE** where $mrs = \frac{1}{m}$ holds. QED

Proposition 8 directly implies

Proposition 9: If all agents have the same preferences all Kantian agents are better off in the **KNEE** than in the **KNEI**.

If all agents are completely identical, i.e. also have the same income, the results of Propositions 6, 7 and 8 also hold for the **KNE** in the multiplicative case – as these then coincide with those of the additive case.

6. Possible Extensions

The analysis so far was focused on absolute deviations: Which results on coalition formation also hold in the multiplicative case?

What about Kant-Kant equilibria when two groups of either inclusive or exclusive Kantians meet? How can the **AGA** be applied to this situation?

What about corner solutions in which some agents make no contributions to the public good?

7. Conclusions

Kantian behavior is important for achieving voluntary collective action. A main field of application therefore is the provision of global public goods (e.g., Buchholz & Sandler, 2019).

Concerning the effects of Kantian behavior in this case a lot is already known from standard public good theory (albeit in different conceptual frameworks)

- from the properties of Lindahl equilibria.
- from the theory of Non-Nash behavior with positive conjectural variations (Buchanan, 1967, Cornes & Sandler, 1984).

The result of Proposition 3 has already been anticipated there long time ago: "… *the Pareto path corresponds to Kantian behavior, since the 'categorical imperative', whereby each acts as they want others to act, is satisfied."* (Cornes & Sandler, 1984, p. 377).
Note: Assuming Kantian behavior is conceptually less problematic for explaining Non-Nash behavior than referring to expectations about reaction of others as a kind of "magical thinking"

- from the literature on reciprocal matching (see Epperson & Reif, 2017, for an overview) which is similar to the case of exclusive Kantians.
  Kantian behavior can be perceived as "intrinsic matching".
  Note: Interiority is less a problem in the exclusive Kantian case than in the matching scenario (cf. Buchholz, Cornes & Rübbelke, 2011): In the Kantian case the set of interior solutions is larger.

- from the theory of coalition formation (e.g. Finus, 2001, and Buchholz, Cornes and Rübbelke, 2014)

The **AGA** helps to make the structural analogies between these different topics in public good theory more transparent – and to derive some new results: Especially for the case with inclusive Kantians which already formally differs from the case of matching.