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**From Lindahl's Garden to Global Warming: How Useful is
the Lindahl Approach in the Context of Global Public Goods?**

by

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Abstract

In what sense is the Lindahl approach useful for analyzing global public goods? After introducing the positive and normative parts of the Lindahl approach we look at the relation to the Nash-Cournot model of voluntary provision. An integration of both blurs the subtle difference between an explicit bargain about the cost sharing and the implicit bargain by providing individual quantities of the collective good. We take a closer look on the possible relevance of this difference in relation to problems of global public goods that are usually seen more in line with a private provision process not envisaged by Lindahl.

Keywords: Public Goods, Voluntary Provision, Lindahl

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From Lindahl's Garden to Global Warming: How Useful is the Lindahl Approach in the Context of Global Public Goods?

1 Introduction

The Lindahl model has an ambivalent reputation in public finance. On the one hand it can be seen as a corner stone of the house of public finance. It extends the fundamental model of markets to the public sector, puts the relationship between individuals and the state on an altogether other footing, declares the benefit principle as the basic principle of taxation and pictures a voluntary system of simultaneous taxation and expenditure. On the other hand the model has on several grounds been dismissed as unconvincing. In the early phase of reception the whole individualistic approach was much apart from the then held "organic" views of the public sector. A rediscovering of the model in the 1950s led to the fundamental Samuelson pseudo-market critique. Later approaches tinkered with the Lindahl model by offering different kinds of interpretations of the Lindahl approach, for example by augmenting the Lindahl diagram with all-or-nothing demand curves or indifference curves or by incorporating different voting schemes.

The 1980s witnessed a change of the centre of gravity concerning the theory of public goods. Topics like "charity giving" that used to stay more on the edge of public finance gained more attention and weight. Samuelson's seminal "Pure Theory of Public Expenditures" lost its place as the standard approach which was taken over by the Nash-Cournot model of public goods provision. For example, Cornes and Sandler (1986, 1996) start discussing the theory of public goods with the Nash-Cournot equilibrium in their book on "Externalities, Public Goods and Club Goods". This approach is also known as private or voluntary provision of public goods. Especially the phrase

“voluntary provision” seems to lead directly back to the Lindahl approach because one of the first papers written in English analyzing the Lindahl approach was Musgrave’s “The Voluntary Exchange Theory of Public Economy” in 1938.

Now there is again a growing interest in public goods theory based on models of voluntary provision. This time it is not “charity giving” but “global public goods” that are in the centre of interest. For example, the recent Stern report (2006 p. xxii) speaks of climate change mitigation as „the classic problem of the provision of a global public good. It shares key characteristics with other environmental challenges that require the international management of common resources to avoid free riding“. And Kaul and Conceicao (2006, p.1) from the UN Office of Development Studies speak of world leaders that „are increasingly concerned about the lengthening agenda of global challenges like climate change, disruptions in the supply of energy, the spread of communicable diseases, persisting poverty, macroeconomic imbalances that may hinder world economic growth, financial crises and their contagion effects, counterfeiting, and international terrorism.” All these issues are seen as cases of global public goods. And again it is the Lindahl model that is discussed in this new context, cf. for example Buchholz and Peters (2005) and Buchholz, Cornes and Peters (2004).

So the Lindahl model has come an impressive long way from a “strange” Swedish school of public finance to a much discussed model for the provision of global public goods in a new era of a fragile world that is tempted by global problems of resource allocation and distribution. This paper tries to answer the question in what sense the Lindahl approach might be really useful for analyzing today’s problems of global public goods. In Section 2 we discuss the positive and normative parts of the Lindahl approach. The relation to the Nash-Cournot model is discussed in Section 3. Afterwards we take

in Section 4 a closer look on the problems of global public goods and how they can be dealt with in a Lindahl model.

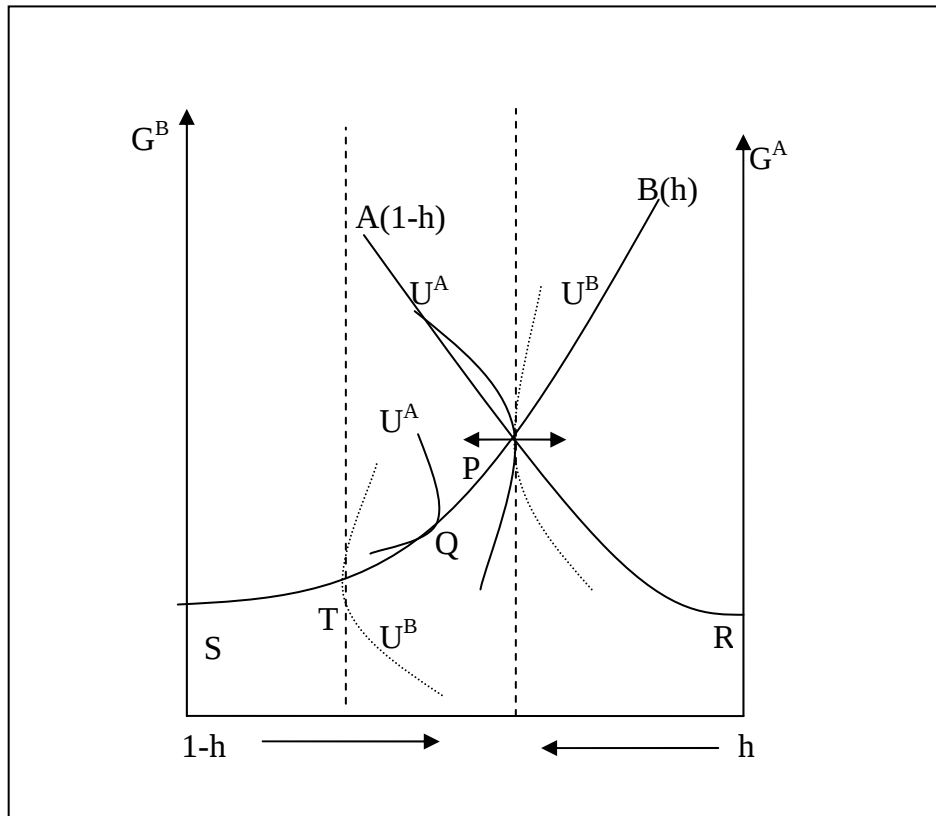
2 The Lindahl Approach

As is well known the Lindahl (1919) approach to public finance has to be seen in close relationship to the approach taken by Wicksell (1896). Both were first published in German, and the close relationship is already made clear by the very similar titles of both works, i.e. “Die Gerechtigkeit der Besteuerung” and “Ein neues Prinzip der gerechten Besteuerung”. Lindahl tries to formalize and defend in his doctoral thesis the tax principle that had been advanced by Wicksell, i.e. the benefit principle. In a more pragmatic mode Lindahl departs from Wicksell especially in not categorically demanding an unanimous consent (or a “large majority”) of all parties that decide on a tax-expenditure proposal. The veto power conceded to small minorities by Wicksell is for Lindahl unacceptable to the majority. So Lindahl allows also decisions by a simple majority. As Lindahl (1960, p. 17) puts it: “My position can be characterized as an attempt to maintain the benefit principle, while abandoning as impracticable Wicksell’s requirement of a large majority.”

In the Lindahl model used in public finance this difference is not of much importance. Here the unanimous consent of all parties is assumed for both, as is in line with the formal model presented in Lindahl (1919). The difference between both is seen in “imposing unanimity as an external rule”, Silvestre (2003, p.528), on the side of Wicksell, and stating unanimous agreement through a political bargaining process on the side of Lindahl. To illustrate this bargaining process Lindahl uses a diagrammatic exposition which shows for the case of two parties A and B the demand curves for different quantities of the public good depending on the cost share each party has to pay.

The Lindahl solution is situated where both curves intersect. Each party demands the same quantity of the public good, given the stated cost shares. So there is equivalence between marginal valuation and marginal cost of the public good for each party, each party pays according to the benefits it receives.

Figure 1: Lindahl diagram with indifference curves



Starting from this solution concept different venues of discussion were taken up in the literature. We distinguish in the following broadly between positive and normative aspects of the Lindahl equilibrium and take up the positive issues first. Roughly one can differentiate two interpretations of the “bargaining solution” advanced by Lindahl. One takes it as a serious description of bargaining in a small number setting. And the other takes the bargaining background more as an illustrative device for a large number problem, similar to the use of the Edgeworth-box for illustrating Pareto-optimal trade in a market. As is well known both interpretations run in serious difficulties.

The formal resemblance of the Lindahl solution with a market equilibrium for private goods – where for each consumer the MRS between two goods x and y equals the MRT between y and x – is void of any significance for the individual behaviour in the context of public goods. One could imagine a kind of Walrasian auction where “the referee *pretends* the man can buy as much or as little of the public goods as he pleases”, Samuelson (1969, p.103). But this would be obviously counterfactual because everyone knows that although the prices are fixed individually the quantity of the public good will be equal for all. Accordingly Samuelson calls this a pseudo-market-equilibrium, cf. also Silvestre (2003, p. 545).

Because Lindahl explicitly took recourse to the bargaining setting this interpretation has sparked the most interest, cf. Johansen (1963), Shibata (1971), Silvestre (2003). By considering an arbitrarily taken starting point of cost-sharing, for example left of P in figure 1, Lindahl discusses movements to the final equilibrium P . In the case of point T it would be the “shorter” side of the market, i.e. the demand of group B , restricting the quantity of the public good G . Following Lindahl it would be in the interest of group A to increase its share in order to obtain an agreement with B for a higher demand of G . But as Lindahl rightly noticed when we move along the demand curve of B in direction to P we will reach a point like Q . At this point a further rise in the share of group A will lower the utility of this group. So at this point a further move along the demand curve in direction to P is foreclosed. We cannot raise by this the utility of B further without reducing the utility of A , although Q constitutes not a Pareto-optimum. So while B stays “on” the demand curve, group A is off its demand curve. As Shibata (1971, p. 16) has argued, we can interpret Lindahl here as employing the “so-called leadership and followership approach usually attributed to von Stackelberg, namely, one party [A] acts as a price maker, and the other party [B] as a

quantity adjuster.” But as Johansen (1963) argued, it is not clear why the possible outcomes should be restricted to the demand curves at all. Because starting from a point like Q there exist also Pareto-optimal allocations where both sides are off their demand curve.

Clearly, for Lindahl a position like Q (or a likewise situation with opposed roles of A and B) constitutes not the “ideal” solution. It is only at P that both parties stay simultaneously on their demand curve and agree about the quantity of the public good. Although Lindahl addresses quite clearly the problems of reaching point P he nevertheless takes P as the reference point for judging the bargaining activities of both parties. Eventually it is the assumption of equal power of both parties which leads to the unique Lindahl solution and establishes the benefit principle where each group bears at the margin costs that equal benefits. The assumption of equal power is surely not a convincing argument and works as a kind of “deus ex machina”, cf. Head (1963/64, p. 426).

In Lindahl (1928, p.224) a (public) garden is used as an example for the bargaining over public goods and is illustrated with the help of a numerical example:

„If all are to pay the same amount Group B votes only for the cheapest, the 10,000 *mark* garden. But our figures show that Group A can increase its net gain by offering to pay a little more than half, 8,000 *mark* towards a 15,000 *mark* garden. Group B accepts this proposal. It would be clearly against all economic reason to make all rate payers contribute the same amount. The ideal solution is differentiation of the payments. Which of the possible solutions will be chosen, depends upon the parties’ negotiating skill. Each party tries to get away with paying as little as possible, but each is at the same time anxious that the town should have as large a garden as possible. Some compromise is bound to be reached. If this consists in Group A contributing twice as much to the cost of the garden than Group B, then both parties have safeguarded their interests in equal measure, because only this distribution key corresponds to full agreement between both parties’ wishes regarding the size of the garden [S. 224].“

Again the solution proposed by Lindahl is seen as special, as one that has properties that make it unique, enabling the only point of “full agreement” between both parties. But

the numerical figures given in this example are insofar interesting as they can be seen as an argument for an alternative interpretation of the bargaining process. Following this interpretation the starting point is not a given cost share, but a given quantity of the public good for both sides. Instead of the vertical line through point T a horizontal line had to be drawn through T. Each group is then asked to reveal its maximum willingness to pay for the given quantity. Not in the sense of a total (all or nothing) willingness, but in the sense of an maximum cost share one would be willing to take. In a situation like point T the cost shares would add to more than one, so the shares have to be changed and the quantity of the public good has to be raised. This continues till at a given quantity of the public good the shares add to one (the horizontal line would then run through P). In this way both parties would reach P, each on the demand curve, till both curves intersect and utility of one party cannot rise without diminishing the utility of the other.¹

Besides the problem of how to reach the Lindahl solution is there any compelling normative argument in favour of the solution itself? To answer this, let's turn now to some of the "normative aspects" of the Lindahl approach. As Silvestre (2003, p. 530) puts it in his survey: "By present-day standards, Wicksell and Lindahl fail to clearly distinguish between positive and normative analysis." This mixture of normative and positive elements is on the surface quite strong in the work of Lindahl. And it is from today's point of view sometimes hard to say what belongs on which side. But a closer look reveals that the problems are not so much normative at all.

¹ This path to the Lindahl solution seems to be what Musgrave (1938) had in mind by his interpretation of the demand curves at offer curves. Johansen (1963, p.350) rejects this interpretation but concedes that the numerical example in Lindahl (1928) gives some support to it.

The basic position of Wicksell and Lindahl is the application of a kind of methodological individualism to public finance. So for them public expenditures had to be analysed in the same line as private consumption. In a lengthy discussion of this topic Lindahl (1919) concedes that it is for the individual much more difficult to evaluate the utility that one has to expect from a public good, but in principle such an evaluation is possible. This position has clearly some normative content. It will be formative for what one believes to be a good standard for evaluating social outcomes. But it is also a basic judgement about how best to explain social outcomes and has in this way a clear positive meaning. This basic individualism leads Wicksell and Lindahl to the benefit principle of taxation. If people are interested in public goods like in private consumption and can articulate their interests in the political decision process one would expect to see some relation between taxes paid for and benefits received from public goods. As Lindahl (1960, p. 13) puts it: "Taxes could generally be considered as voluntary rather than compulsory contributions to the cost of covering public expenditure made in the taxpayers' own interest."

In line with the old welfare school Lindahl allows comparing utilities across taxpayers. But he concedes also that these comparisons are difficult and can only be made in "fairly wide margins", cf. Lindahl (1960, p.17 fn. 20). Taking this under consideration some more or less objective measurement of well-being is possible. But because people are different one would expect differential taxation in relation to goods that have to be consumed by all in equal quantity and quality. This leads to the formal model shown above where for each of the two groups a demand curve is given. As an argument for the relevance of his approach Lindahl (1928, p. 218) emphasises that:

"These individual values are not fictitious quantities devoid of real significance, but are of decisive importance for the tax system. This is shown by the fact that by and large the pattern of tax distribution does agree

with these values and that in the last resort they must underlie any actual decision on the amount of public expenditure and the total tax bill.

From today's point of view the problem with this argumentation seems not to be so much that it mixes normative and positive thinking, or that it contains too much normative thinking, but that it rests too strongly on positive statements about "facts" for which no operational way of measuring them is given (or even conceivable).

This tendency is even strengthened because Wicksell and Lindahl went beyond the traditional welfare school and took the political decision process in a democracy explicitly in consideration. This meant for Lindahl the ruling of a simple majority. He had therefore to concede that the estimation of the benefits each groups receives is in practice a judgment by the majority. "On closer examination ... we would probably find that it corresponds fairly well to the majority's understanding of just taxation" Lindahl (1960, p. 16). So this really leaves the measurement of individual values even more devoid of any operational significance.

A special feature of Lindahl's argument for the benefit principle is the blending of it with the ability-to-pay principle. Both are seen as the outcome of the same concept: "The general formulation of the ability principle as a norm for the distribution of taxes is that the taxes are distributed in such proportion to the citizens' economic ability as corresponds to their subjective interest in the relevant government expenditure" Lindahl (1960, p. 15). "The benefit principle is the general one, the ability principle a practical norm for meeting the cost of subjective cost advantages" Lindahl (1928, p. 228). Consequently the existing system of taxation is seen by Lindahl more or less in accordance with his proposed solution. Divergences are attributed to an uneven distribution of power, the estimation of benefits by the majority, some social (redistributive) element of taxation and other factors.

Is there any normative justification given by Lindahl for his solution concept? If one awaits a special justification for the proposed cost-sharing in terms of fairness one will be disappointed. Maybe the closest argument in that direction is linked to the following chain of arguments: By starting with the methodological individualism one comes to the benefit principle, this leads to the ability principle, this is then interpreted as the (marginal) equal sacrifice principle and leads finally to “maximum satisfaction of wants as expressed in money terms under the prevailing property order”, Lindahl (1928, p. 231). This chain of arguments looks quite conventional and is not far away from the normative content of the welfare economics in the tradition of Pigou.² Efficiency is seen as a normative goal, distribution should be given due consideration, this should be done by somehow comparing utilities. These interpersonal comparisons are seen more sceptical by Lindahl, but because of the integration of the political decision system, this problem is somehow shifted to the study of the estimations of benefits by the ruling party (than to measure utility “objectively”).

² But certainly Wicksell and Lindahl probed much deeper the topic of public expenditure and the use of the benefit principle than Pigou did in his “A Study in Public Finance”. Although even here one finds glimpses that are close to the Lindahl model: “Expenditure should be pushed in all directions up to the point at which the satisfaction obtained from the last shilling expended is equal to the satisfaction lost in respect of the last shilling called up on government service. This last, or ‘marginal’ shilling is, of course, to be regarded as made up of parts contributed by all of the separate contributors to government funds ... not as the last shilling taken from the poorest contributor” Pigou (1947, p. 31).

So taken as a whole it seems justified to speak of a positive approach like the title of the translation of part 2 of Lindahl (1919) by E. Henderson as “Just Taxation: A Positive Solution” suggests. But certainly one can look for a more modern – or so to speak more normative compelling – justification of the bargaining solution proposed by Lindahl. In this way Lindahl’s model resembles another famous bargaining approach, i.e. the one proposed by Nash. Binmore (1996, p. xiv) makes very explicit that Nash’s name wrongfully “continues to be used to lend authority to the claim that this bargaining solution is best seen as a scheme for fair arbitration, rather than an attempt to characterize cut-throat bargaining between two rational agents”. Similar to Lindahl, also Nash’s bargaining solution does lead to an efficient but not naturally fair outcome. In the next section we turn not to the cooperative bargaining solution of Nash, but instead look more closely at the relation between the non-cooperative Nash solution of voluntary provision of a public good and the Lindahl solution.

3 The Lindahl Equilibrium and the Nash-Cournot Model of Voluntary Provision

The Lindahl diagram presented above is just one of many different graphical representations in the context of public goods that can be found in the literature. Each tries to shed some light on specific aspects of the allocation of public goods. For example, with the help of a famous graphical representation Samuelson (1955) derived the conditions for a Pareto-optimal allocation of a public and a private good in a world of two (groups of) consumers in a non-technical and easy to follow way. Johansen (1963) augmented the diagram of Lindahl (after turning it like Musgrave 90° to the right) with indifference curves (as it is also done in Figure 1 above) to analyse in more detail what happens along and off the Lindahl demand curves. A similar approach with

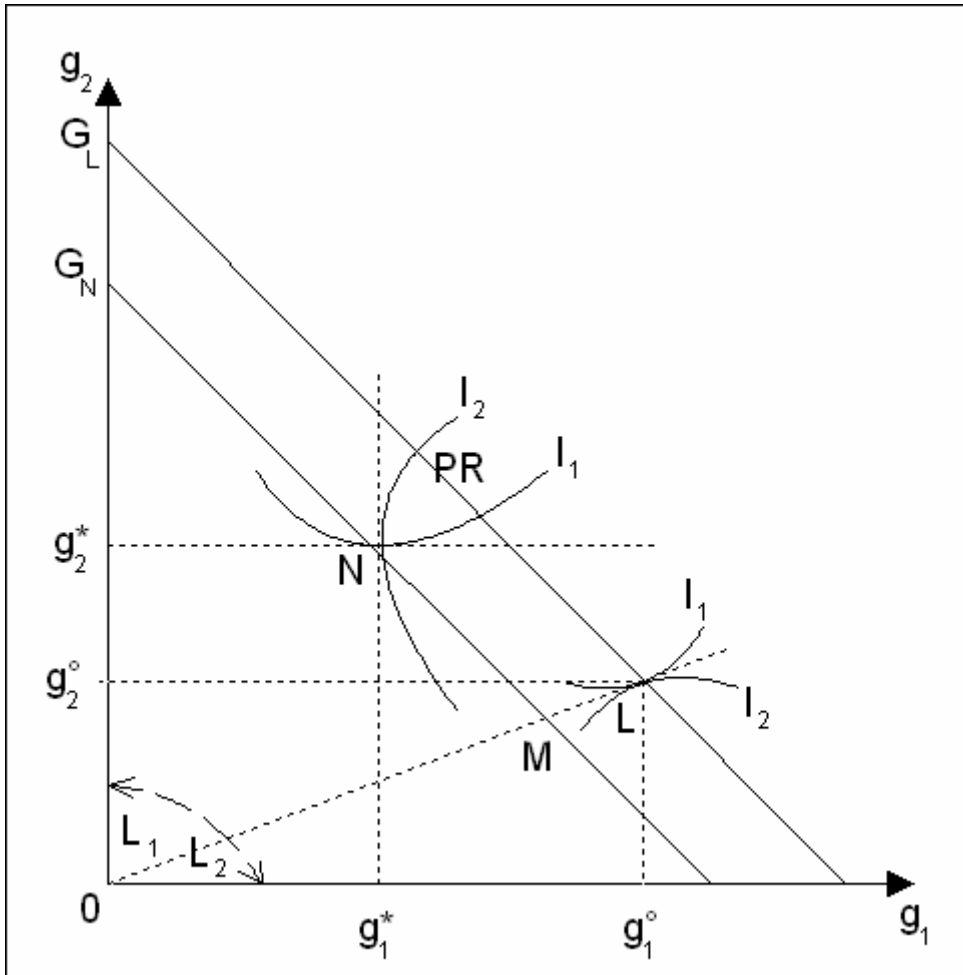
indifference curves but more in line with the traditional Edgeworth-box was taken by Shibata (1971) in his “Bargaining Model” of public goods. His paper entails also a very thorough analysis of his forerunners of a voluntary exchange theory of public goods, especially Lindahl and Musgrave.

In this section we want to deal with an approach introduced by Cornes and Sandler (1985, 1996). Their diagram “allows one to depict both the orthodox Nash equilibrium and the set of Pareto-optimal allocations in an economy with a pure public good.” Furthermore, “this diagram also allows for a simple representation of Lindahl equilibrium in such economy”, Cornes/Sandler (1985, S. 103). In this way their diagram incorporates in one framework the modern approach of voluntary provision of public goods and the traditional Lindahl approach. Furthermore, both approaches can be joined by asking how to move from a state of voluntary provision in the sense of Nash-Cournot that is mostly inefficient to a Pareto-optimal Lindahl state. And finally, we can also join the concepts of a non-cooperative approach (Nash-Cournot) and a cooperative approach (at least when we subsume Lindahl under the last heading as it is mostly done in the literature). Figure 2 (next page) reproduces the graphical representation of the simple but ingenious model used in Cornes and Sandler (1985, figures 2 and 4).

As is in line with the basic model of voluntary public good provision the horizontal and the vertical axis measure the individual quantities g_i of the public good supplied by each of the two groups. In the case of the Nash-Cournot type equilibrium each groups maximises a utility function $u_i = (y_i - g_i, g_i + G_{-i})$ where G_{-i} denotes the sum of the contributions of all groups except i and $y_i - g_i = x_i$ denotes the individual consumption x_i of a private good given an initial endowment y_i and a price of unity for units of the public good. In the two-group case shown in figure 2 a Nash-Cournot equilibrium is a point of intersection of the indifference curves where both are

simultaneously tangent to their budget lines. So given g^*_2 group 1 maximises its utility at g^*_1 as shown by an indifference curve I_1 tangent to the broken vertical line at g^*_1 , and vice versa group 2 maximises its utility at g^*_2 . Each group maximises its utility by taking the contribution of the other group as given, this is the zero or Nash conjecture of the model. Drawing a -45° line through N depicts the public good provision G_N as the sum of the individual quantities demanded at the Nash-Cournot equilibrium on the vertical (or horizontal) axis.

Figure 2: Integration of Nash-Cournot and Lindahl solution



With the help of this diagram some insights in the basic model of voluntary provision of a public good can be easily derived. For example, an income shift from one group to the other does not change the provided quantity of the public good; it just

changes the individual contributions. In figure 2 this change would mean that the equilibrium point would move along the -45° line in the direction of the group which receives the positive income transfer. But this change in contribution would be offset by an opposite change in the private good consumption leaving the utility of each group unchanged. This so-called Warr neutrality, cf. (Warr 1983), holds as long as both groups do contribute at all in the equilibrium.³ Closely connected with this property is the so-called “exploitation of the rich by the poor”, cf. Buchholz/Cornes/Peters (2004, p. 8f). This means that with homogenous preferences a group with a higher income does not receive a “higher utility” (or to be more precise and leave any connotations of interpersonal utility comparisons out of the picture consumes the same bundle of goods). Because of the offsetting effect of income redistributions on the individual supply of the public good there is no gain of being rich in this model (again as long as one is able to buy the public good at all). Figure 2 shows also that allocation N is not Pareto-optimal. There is a Pareto region (marked by PR north east to N) that contains allocations that Pareto-dominate point N.

A special feature of figure 2 is the integration of the Lindahl solution, here shown as point L. While the graphical representations used before, for example the one in Johansen (1963), allowed an analysis of the Lindahl demand curves and possible bilateral bargains they did not contain any reference to a Nash-Cournot equilibrium.⁴

³ This independence of public good provision from income distribution, expressed in a short note by Warr (1983), aroused very much interest. Mainly because it stood in sharp contrast to the by then standard public good approach in the Samuelson tradition where, except for special assumptions on the form of the utility functions, no such independency existed.

⁴ A bit closer to this comes Shibata (1971, p. 9f) who explicitly states that the minimum utility each takes as a reference point in the bargain is not the point without public goods, but the one with the optimal public good provision each can reach on his own.

The Lindahl solution in figure 2 is a point where the indifference curve of each party is tangent to a common ray from the origin that measures the individual Lindahl cost shares given by $L^i = g_i / \sum g_i$. So, as Cornes/Sandler (1985, p. 110) emphasis, point L is a Lindahl equilibrium which is „defined as a vector of cost shares $[L^1 + L^2]$ and a level of output $[G]$ such that for each individual, when his share is $[L^i]$ his most preferred output level is $[G]$. $[L]$ clearly satisfies this definition.” This statement is correct, but in a subtle way this might not be a “true and fair” view of the Lindahl approach. In figure 2 both sides demand “different quantities” g_i of the public good that sum up to G_L . Each party acts on the assumption that the other will match its own demand by a fraction of the sum of both that equals the given cost share of the other party. So the Lindahl approach is here seen as a special matching device that deviates from the orthodox Nash zero-conjectures. In this way then, both approaches can be analyzed in the same framework.

This works because the individual quantities $g_i = L^i \cdot G$ can be seen at the same time as individual quantities provided or as the individual expenditure on the public good G . One can argue that it should not matter which perspective is taken because the result is the same. So one can interpret the Lindahl equilibrium as a division of cost shares where each demands the same amount of G or as a division of quantities where each provides a specified part of G . But certainly the flavor of the first is a vital part of the Lindahl approach, and the flavor of the last is most suited to cases of voluntary provision where the public good in question is really one that is summed up out of individual provisions, like it is the case for example with charity donations.

A possible draw back of this close integration of both approaches might be seen in the blurring of the difference between an explicit bargain about the cost sharing of a public good (Lindahl) and the implicit bargain by providing individual quantities of the collective good (Nash-Cournot). Formally it is perfectly all right to “translate” a Lindahl

cost share in a quantity of a privately provided public good. But by this a subtle difference of both approaches is lost. This difference might be of relevance for judging the usefulness of the Lindahl solution in the context of different public good settings to which we turn now.

4 The Lindahl Model in the Context of Global Public Good Settings

In this section we take a closer look on the Lindahl model in the setting of global public goods. As Kaul and Conceicao (2006, p. 3) point out, global public goods are not only public in consumption. They are also “public in production: the good emerges from a multiactor production process, summing up individual contributions.” This fits well to the Nash assumption of private provision but is rather far away from the problem Lindahl envisaged.

Nevertheless one can take a Nash-Cournot equilibrium as a reference point for a situation of independent non-cooperative coordination and ask for ways to reach a Lindahl solution. Figure 2 shows that a change from a starting point like N to a point like L would lead to a utility gain for group 2 and a loss for group 1. The change would lead to a Pareto optimal Lindahl equilibrium, but would not Pareto-dominate N because L it is not lying in the Pareto region of N.

Cornes and Sandler (1985, p. 109f) show that with the help of a lump-sum redistribution one could in principle constitute any Pareto optimum as a Lindahl equilibrium and that by this one can also find a Lindahl solution that Pareto-dominates the basic suboptimal Nash-Cournot equilibrium. They conclude therefore, that “lump-sum transfers may be important instruments in the search of acceptable reforms of public goods provision”, Cornes and Sandler (1985, p. 111). This line of argument is taken up by Buchholz, Cornes and Peters (2004). They look for conditions of the

distribution of income that allow for a Lindahl equilibrium that Pareto-dominates the Nash-Cournot reference point. For doing this they decompose the change from N to L in two separate steps. Step 1 leaves the quantity G_L of the public good constant but changes the individual contribution shares. In figure 2 this is shown by a move along the -45° line from N to L. By this, the group who's share rises loses, in our case this is group 1, and the opposite group gains. Step 2 then holds the cost shares constant and allows for the change of the public good. In figure 2 this is shown by a move along the ray (at the optimal Lindahl shares) from M to L. This second step leads to a rise in the quantity of the public good and to a utility gain for all. The question posed then boils down to conditions where the possible negative first step is overcompensated by the univocally positive second step.

Buchholz, Cornes and Peters (2004) show that especially the relatively poor countries might lose from a shift to a Lindahl equilibrium and that therefore some "transfers between countries may help to promote international cooperation (p. 13)." They also point out that as the number of "countries increases the second effect will, in many important cases, dominate the first" (p. 11) and that this can be taken as an "explanation why a high degree of participation in a cooperative arrangement like an international climate convention is required to make cooperation successful" (p. 13).

Especially the last statement can be seen as an argument for the Lindahl approach in the context of global public goods. But to show that maybe no transfers are needed to make a Lindahl solution Pareto-dominant over the non-cooperative Nash solution can at best be only a weak argument in favour of the Lindahl solution. What seems to miss is a stronger argument why *this* solution should be of special interest.

Before coming to this point back again, let's first look at the general applicability of the Lindahl model in the context of a global public good, for example, to cut (or

limit) greenhouse-gas emissions by an international environmental agreement. The aggregate reduction in these emissions functions as a global public good. Applying directly the standard Lindahl approach would mean that there has to be first a kind of cost sharing. Given the rule of cost sharing, each party would then argue for the wanted reduction in aggregate quantity of emissions. According to divergences in the wanted aggregate quantity of reduction, the shares would be reallocated till hopefully an agreement is reached. This seems not a very realistic story for the problem at hand. While for Lindahl the given tax structure was something like the given cost shares this would not hold similar true for an agreement on greenhouse-gas emissions.

A second story, where we do not start from the prices but start from an aggregate reduction in emissions, and then ask for the willingness to take a share in the burden, seems more realistic. In principle, one could by this reach an agreement that is compatible with the Lindahl solution. But surely all kinds of strategic interactions are here not taken under consideration.

A special character of a global public good like “reduction in emissions” is the summation technology. For the Lindahl approach this means that the individual costs of the public good can be directly measured in individual provision of the good. A cost share is then simply the ratio of own provision to the aggregate provision. This is not what Lindahl had in mind, but it seems more to ease than to complicate the argument. Assuming that there is no problem in measuring the individual provisions one would gain a simple way to compare cost shares. Furthermore the aspect of matching would be made more discernible. As was pointed out above the cost share can be seen as a special matching device. Each party is willing to match the provisions of others positively in line with the cost share. Or, looked from the perspective of a given aggregate quantity, each party is willing to state their matching rate in relation to total supply. This kind of

matching behaviour – or reciprocity – is by many seen as a fundamental driver of real bargaining situations. It is also argued for in voluntary public goods situation as an alternative to non-cooperative Nash behaviour, cf. for example Sudgen (1984) or Guttman (1987). Buchholz and Peters (2005) develop in a very general framework a “minimum fairness requirement” and apply it to international cooperation. Their fairness requirement demands reciprocity in financing public goods: “A country is only willing to enter a cooperation and to provide an additional effort if all other countries, at least in the aggregate, are ready to do the same”, Buchholz and Peters (2005, p. 30).

This leads us back to our question in what sense the Lindahl solution might be seen as attractive. There are many different concepts of matching conceivable. And bargaining about an international environmental agreement to reduce greenhouse-gas emissions is also a debate on what is an acceptable standard for reciprocity. For example, should only the well developed industrialized nations participate? Or would that be unacceptable because it would create adverse incentives for the less developed nations? From point of view of a pragmatic application of the Lindahl concept of benefit taxation, one would argue that on the first hand there should be more a political debate on the different cost shares each has to bear and not so much about the differential benefits each one gets. In this sense then there will be an assumption that the benefits are equally spread. This leaves the question how to estimate the costs each country has to bear for a given reduction in emissions. Following Lindahl one would agree that the (marginal) sacrifice for each should be the same. A differential cost share is needed to create a widespread participation. And in the beginning this could mean that real reductions for one group are joined with limits on growth of emissions for another group. Considering the example of a garden given by Lindahl, one should remember that in the real word it was mostly at first rich and well to do private actors who erected

gardens and opened it to the public. So the same might hold true for the rich and well to do nations considering the “global garden”.

5. Conclusion

This paper analyzed the Lindahl model in detail and tried to look for its applicability in the context of global public good. We first dealt with the classical Lindahl presentation, we gave due consideration to positive and normative aspects of this approach. In this we argued that the approach should be seen as clearly positive, but with a lack of operational significance given to the demand curves. We could not resolve the problems of the positive bargaining solution, but we differentiated two versions of a path to equilibrium, and showed that one of them, although looking at first side unusual, has at least the advantage of keeping each side both on their demand curve. In comparing the Lindahl and the Nash-Cournot approach we argued that looking on Lindahl from the standard approach of voluntary provision of public goods blurs the differences between a real summation technology and a given Public good where only the expenditures are summed, but not individual provisions of the public good. But the matching character of the Lindahl model becomes by this more visible. This reciprocity played also a role in the last section where we tried to consider the Lindahl approach in a somewhat direct manner for the case of a global public good. Different interpretations were given showing that the Lindahl solution bears really some meaningful reference point for international bargaining. These bargains are somehow even facilitated when they can be made in more real terms as is the case for a summation technology with a matching of an individual provision by the rest of the participants.

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