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Fairness in Decisions on Siting Noxious Facilities: Theory and Empirical Results

§ 1. The Problem

The siting of noxious facilities such as chemical or nuclear waste repositories or landfills is among the more pressing and intricate problems societies face today. While toxic wastes accumulate at transitional storage facilities, neither government agencies, private developers, nor the public at large seem to be able to agree on siting procedures for noxious facilities¹. In addition, the option to export hazardous materials to developing countries is increasingly made more difficult by the activities of environmental groups and by the moral considerations of the electorate.

The use of the price mechanism to regulate the production of potentially hazardous substances will result in an optimal quantity of hazardous wastes produced. Optimality refers to the state where the costs of reducing the output of toxic material by one more unit equal the benefits of this reduction. To prevent market failure it is necessary to assign property rights in a way that guarantees that firms take the full social costs of their activities into account. These include not only the disposal of toxic output but compensation for host communities made worse off by a site as well. Similarly, a regulatory approach will try to set environmental standards at a politically acceptable level. Acceptability is determined by exchanges on the market for regulations. The parties to this market (members of the executive and legislative branches of government, the bureaucracy, industrial and green lobbyists) seek to influence the decision on standards by offering exchanges (votes, money, influence) which are of value to the deciding parties.

The type of siting rule chosen for selecting hazardous waste sites will affect both approaches. Using prices to regulate behaviour, the decision to make compensation for host communities mandatory, for example, will increase marginal costs of production

1. Hamilton, J.T., "Politics and Social Costs: Estimating the Impact of Collective Action on Hazardous Waste Facilities", *Rand Journal of Economics*, 1993, 101-125.

and reduce the amount of toxic wastes produced. Taking a regulatory approach, the decision not to compensate potential host communities increases their cost of being selected and makes lobbying for a complete ban on toxic substances potentially more profitable. Given this impact of siting rules on the incentive structure at the regulatory level, it is of great importance to gain insight into preferences for siting rules.

Theorists as well as practitioners agree that addressing questions of fairness is crucial for the improvement of many ailing siting procedures. Unless the prospective host community feels that it has been chosen on the basis of impartial and fair siting rules, the chances are minimal that it will accept the siting decision². While the importance of fairness is generally accepted, little is known about what constitutes a fair process in the context of siting noxious facilities.

On the basis of a stylized siting procedure, we will analyse the role of fairness issues in the siting dispute. Central to the siting process is the selection of a siting rule. Based on the results of experimental bargaining theory, we shall present a preliminary choice of siting rules which might be considered fair in section 2 of this chapter. Following this theoretical framework, these rules were then empirically tested in two fairness surveys conducted in Germany and Switzerland. Section 3 and 4 will present and discuss the results of these studies. Finally, section 5 offers some concluding remarks with regard to a general theory of fair allocation rules.

§ 2. Bargaining over Siting Rules

For reasons of simplicity, we will use the following stylized siting procedure for our analysis of fairness issues: A private developer seeks to build a repository for nuclear waste. Based on a technical feasibility study, the developer has chosen a number of prospective host communities for the repository. All of these communities (initially) oppose the plans of the developer. The siting procedure then consists of three consecutive steps: 1. Negotiations between the developer and the communities on the selection of an appropriate siting rule. 2. The application of this rule and the selection of a site. 3. The enforcement of the siting decision. In the analysis presented here we will focus on the first step of this stylized procedure. The structure of the bargaining process, determinant variables, and dominant strategies are our main concern.

We believe the first step to be of utmost importance for successful siting. By instituting formal negotiations between the developer and the prospective host communities over the selection of an appropriate siting rule, an *ex ante* consensus with regard to this key element of any siting procedure may be achieved. As we shortly shall see, it is one of the most promising strategies available to opposition groups to question not so much the results of any given siting process but the process as such, i.e. the siting rule. Argu-

2. Vari, A., Reagan-Cirincione, P. and Mumpower, J.L., *LLRW Disposal Facility Siting Processes in the United States, Western Europe, and Canada. Report for the New York State Energy Research and Development Authority*, State University of New York at Albany, 1993.

ments of fairness are almost ideally suited to undermining the legitimacy of siting rules. Without any *ex ante* agreement as to what rule for the selection of a site is to be applied, there is little hope that communities will accept the final siting decision.

The selection of a particular siting rule largely determines the weight given to different criteria in the site selection process. Compare the following two procedures. If we choose an auction as the siting rule, the wealth of prospective host communities enters as one of the most decisive variables. On the other hand, a random selection of a site through a lottery does not take into account the wealth of the sites at all. Since the selection of a siting rule does not take place behind a veil of uncertainty, that is, the communities know their characteristics and form expectations about what siting rule will favour them, negotiations can be expected to be difficult.

To analyse this first stage of the siting procedure, we will view the struggle over the selection of a siting rule and therewith the importance of different criteria (technical data, social characteristics, political considerations as well as fairness issues) as a *bargaining game*. Given their preferences and risk attitudes, parties participating in a bargaining game pursue the strategy with the highest expected pay-off. In siting disputes, a breakdown of the bargaining process favours in most cases the opposing community which cannot be legally forced to accept the facility³.

Game theory has suggested a number of solutions for bargaining processes, the Nash solution being one of the most prominent. Nash predicts an outcome depending on the risk attitudes of the players involved⁴. Experiments, however, suggest a number of other factors which determine the outcome of bargaining games. The most important are *the plausibility of rational arguments, solutions for bargaining problems perceived to be similar to the one at hand, and norms of equity which shape the bargainers' expectations*⁵. We will take up these three arguments in turn.

Rational arguments: They owe their plausibility in part to shared axioms and the degree to which they are suited to the situation. What the situation is, however, is not a matter of fact but one of definition. After all, reality is a social construct. Both parties to a siting dispute will try to frame the situation and henceforth the bargaining, in relation to their relative advantages in (human) capital. Private developers as well as government agencies rely heavily on technical expertise for the assessment of different sites. They prefer to frame the siting problem as largely technical since this is the area where they enjoy a relative advantage over local opposition groups. The communities, not having

3. O'Hare, M., Bacow, L. and Sanderson, D., *Facility Siting and Public Opposition*, New York, Van Nostrand Reinhold, 1983.

4. Nash, J., "The Bargaining Problem", *Econometrica*, 1950, 155-162.

5. Roth, A. and Schoumaker, F., "Expectations and Reputations in Bargaining: An Experimental Study", *American Economic Review*, 1983, 362-372; Young, P., *Equity in Theory and Practice*, Princeton, Princeton University Press, 1994.

many geologists or risk analysis experts in their own ranks, try instead to focus on questions of procedure and fairness.

One of the commonly accepted principles of fairness is the consistency principle. It states that a distribution can only be called fair for the group as a whole if all members and subgroups regard it as such⁶. The consistency requirement provides the opposition to a siting project with a relative advantage in that it gives them a type of veto power. The developer of a site cannot claim to have struck a fair deal with the community unless the community itself regards the siting as fair.

Given these relative advantages, it is not surprising to see that in many siting disputes governments and developers are convinced that the solution is to explain the technical aspects of their projects to the general public clearly. If the public were to understand the experts' risk assessment, so the argument goes, it would give up its resistance. On the other hand, opposition groups typically spend much of their resources in exploring issues of procedure and fairness⁷. Their emphasis, again in line with their relative advantage, is that siting is not a purely technical matter. As O'Hare, Bacow and Sanderson⁸ noted, the perceptions of the parties involved in the siting dispute are adjusted to these strategies: '... the proponents of a new facility view the opposition as ignorant, irrational, and even anti-social, the opponents of such a facility so often view the developer as insensitive, selfish, and greedy.'

Similarity: A second variable identified by experimental bargaining studies is the players' tendency to choose solutions they are familiar with. Roth and Schoumaker⁹ found in their experimental study that bargainers' behaviour was largely determined by the results of earlier bargaining rounds. Any prediction of what type of siting rules the parties to the bargaining game might consider has, therefore, to rely on mechanisms already used in similar contexts. We will consider the following four allocation mechanisms:

- the market: The allocation of 'goods' and 'bads' through the use of prices is one of the common decision-making systems. It is especially noteworthy that market allocations quite often find acceptance in spite of the fact that they result in unequal distribution. This does not say much about individuals' preferences with regard to distribution, but is rather to be seen as a result of the difficult trade-off between distribution and incentives which improve efficiency. Market mechanisms

6. For the history and applications of the consistency principle, see Young, P., *o.c.*, 1994.

7. Kemp, R., *The Politics of Radioactive Waste Disposal*, Manchester, Manchester University Press, 1992.

8. O'Hare, M., Bacow, L. and Sanderson, D., *l.c.*, 1983.

9. Roth, A. and Schoumaker, F., *l.c.*, 1983

such as auctions have been suggested to solve the siting problem in an efficient way¹⁰.

- bureaucracy: Many allocation decisions are made by administrative bodies. While the literature on administrative decision making does not provide many insights why this allocation mechanism should be preferred¹¹, it none the less seems to enjoy the trust of many citizens¹². Many existing siting procedures are a mixture of bureaucratic and political decision-making systems.
- random mechanisms: Random mechanisms such as lotteries are advocated for reasons of fairness. They were used for politically sensitive decisions such as the draft for Vietnam in the United States. Lotteries have also been suggested as a crucial component for siting procedures¹³.
- traditional rules: For a large number of situations, traditional rules for the allocation of goods and bads exist. The queue is a traditional method for the allocation of scarce goods. In the sphere of politics, referenda are often used to decide difficult trade-offs. Switzerland's constituency makes decisions on a wide range of issues by referendum. Recent examples include the decision on whether to abolish the national army (production of a public good), the building of new railway lines (production of private goods), as well as decision packages with important distributional consequences (membership of the European Economic Area). The decisions are legally binding.

Norms: A third element predicted to be of importance by bargaining theory are social norms. In our context, it is most interesting to see whether concepts of fairness constitute such a norm. The Facility Siting Credo, a set of rules for successful siting compiled by people involved in siting procedures, suggests that notions of fairness are indeed seen as a social norm that applies to the situation¹⁴. Our own empirical research confirms this observation. A survey among 900 households in various parts of Switzerland with different probabilities of being selected as a site for a nuclear waste repository, found that 79% of all respondents rated fairness as "very important" (6 points given on a scale from 1 to 6) when choosing an acceptable siting rule. Concepts of fairness are well established as social norms in the context of siting disputes.

10. Kunreuther, H. and Portney, P., "Wheel of Fortune: A Lottery / Auction Mechanism for Siting of Noxious Facilities", *Journal of Energy Engineering*, 1991, 125-132.
11. Breton, A. and Wintrobe, R., "The Bureaucracy of Murder Revisited", *Journal of Political Economy*, 1986, 905-926; Tullock, G., *The Politics of Bureaucracy*, Washington D.C., Public Affairs Press, 1965.
12. Frey, B.S. and Pommerehne, W.W., "On the Fairness of Pricing - An Empirical Survey Among the General Population", *Journal of Economic Behavior and Organization*, 1993, 295-307.
13. Kunreuther, H. and Portney, P., *l.c.*, 1991.
14. Kunreuther, H., Aarts, Th.D. and Fitzgerald, K., "Siting Noxious Facilities: A Test of the Facility Siting Credo", *Wharton Risk and Decision Processes Centre Report*, 1 March 1992.

§ 3. What Rules are Considered Fair?

Given the importance of fairness both as a social norm and a plausible rational argument in a difficult bargaining process, we can expect that the siting rules which are perceived to be relatively fair will do better *ceteris paribus*. The central question is, what is a fair rule?

While there are a number of yardsticks for the measurement of fairness derived from theories of social justice¹⁵, these theories lead to contradictory results. Based on axioms as they are, we have no way of accepting some results and rejecting others. Throughout our work we rely on an individual and empirical concept of fairness (as opposed to the more social and normative notions of justice or equity). While individual assessments of fairness may be influenced by normative propositions, we expect the former to be relevant for individual behaviour, namely the decision to accept a site or to lobby for favourable regulation. In addition, we were also cautioned about the application of a single rule by empirical results of an earlier fairness survey¹⁶.

To learn about the perceived fairness of different allocation mechanisms two situations of excess demand had been presented to 1,750 households in Zurich and Berlin. Respondents had to decide how to distribute (a) 100 bottles of water among 200 thirsty hikers, and (b) a limited number of snow shovels the morning after a snow storm. We asked the respondents to rate the relative fairness of four different allocation rules: the price mechanism (market clearance is achieved by higher prices), a traditional rule (in this case "first come, first served"), a random mechanism, and the distribution of the scarce goods by local authorities acting "according to their respective judgement" (administrative rule). The results of the survey are given in tables 1 and 2.

Table 1: Subjective Evaluations of Alternative Allocation Procedures (in percentage of all respondents)

	allocation procedure for water bottles			
evaluation	price	tradition	random	administration
fair	27 %	76 %	14 %	43 %
unfair	73 %	24 %	86 %	57 %

15. Classical utilitarianism, Rawls' theory of justice (Rawls, J., *A Theory of Justice*, Cambridge, Harvard University Press, 1971)

16. Frey, B.S. and Pommerehne, W.W., *l.c.*, 1993.

Table 2: Subjective Evaluations of Alternative Allocation Procedures (in percentage of all respondents)

evaluation	allocation procedure for snow shovels			
	price	tradition	random	administration
fair	23 %	93 %	27 %	48 %
unfair	77 %	7 %	73 %	52 %

The answers are surprising in two respects. First of all, the allocation mechanisms which are favoured from theoretical points of view, price and random rule, are not considered to be particularly fair: 73% of all respondents regard it as unfair to clear the market for water bottles by price increases, 77% do not advocate this method for the distribution of snow shovels. Subjective fairness clearly ranks the traditional procedure of "first come, first served" as fairest. This is despite the fact that this rule does not take into account the individual's preferences nor their potential utility gain.

The second unexpected result are the relatively wide discrepancies between fairness judgements in two very similar situations: 27% regard it as fair to allocate snow shovels randomly, only 14% find the same procedure fair when allocating water bottles. The differences even upset the ranking of the procedures. The random procedure is judged to be the least fair for the allocation of water bottles. In the case of snow shovels it is the price mechanism.

To gain further insight into perceived fairness aspects of the siting of noxious facilities we conducted a survey among 900 households in four regions of Switzerland. In a personal interview respondents were asked to judge various allocation mechanisms for a nuclear waste repository using a 6 point scale (1 = completely unfair, 6 = completely fair). We varied the level of risks associated with the facility by asking one group to site a repository for low and mid-level radioactive waste, another group a facility for highly radioactive waste. To limit difficulties associated with opinions about hypothetical situations, we chose the current search for a nuclear waste repository in Switzerland as our scenario. Based upon its feasibility studies, a private developer had suggested a number of areas thought to be suitable for the construction of repositories. We asked the respondents to choose a rule upon which to select a host community in these areas. We emphasized that - whatever the rule - only communities in "safe" areas would be considered. The allocation procedures we suggested included the following:

- current approach: Under the current approach, the private developer, a consortium which mainly consists of big utilities owning nuclear power plants, proposes a

community. Federal experts evaluate this choice and the national parliament has to grant the construction permit¹⁷.

- compensation demanded: Communities are asked to state a compensation demanded if the facility were to be built on their grounds. The community with the lowest demand hosts the facility.
- willingness to pay: Communities are asked to state their willingness to pay for not having to accept the facility. The community with the lowest offer hosts the repository.
- random mechanism: A lottery including the names of all the communities in "safe" areas decided where the repository is built.
- referendum: The host community will be picked in a national referendum. This procedure can be seen as one of the traditional rules.

Table 3 and 4 list the results of individually perceived fairness. Those who attributed to a procedure at least 4 out of 6 points are listed to have judged it as fair.

Table 3: Subjective Evaluations of Alternative Siting Rules for a nuclear repository for low and mid-radioactive waste (in percentage of all respondents)

siting rule for low and mid-radioactive waste repository					
evaluation	current approach	compensation demanded	willingness to pay	random rule	referendum
fair	50.6 %	20.4 %	6.0 %	31.2 %	36.8 %
unfair	49.4 %	79.6 %	94.0 %	68.8 %	63.2 %

Table 4: Subjective Evaluations of Alternative Siting Rules for a nuclear repository for highly radioactive waste (in percentage of all respondents)

siting rule for a highly radioactive waste repository					
evaluation	current approach	compensation demanded	willingness to pay	random rule	referendum
fair	68.0 %	22.1 %	9.6 %	31.6 %	35.8 %
unfair	32.0 %	77.9 %	90.4 %	68.4 %	64.2 %

17. Seiler, H., *Das Recht der nuklearen Entsorgung in der Schweiz*, Bern, Stämpfli, 1986.

A clear ranking emerges from the individual assessments. The current approach based on expert opinions and administrative rules is judged to be the fairest. It is in fact the only rule which a majority of the respondents views as fair. As in the situations discussed previously, applications of the market mechanisms trail far behind other procedures.

§ 4. Fairness is Difficult to Achieve

In spite of the differences in the exemplified situations, the empirical data presented so far allow us to draw some tentative conclusions about fairness judgements in general. First of all, the much acclaimed *market mechanisms* consistently fare poorly in individual fairness judgements. This is in spite of the fact that they allow individual valuations to be accounted for. Consistent with an understanding of Coase¹⁸, the underlying entitlement structure, i.e. the distribution of property rights, has a systematic effect on fairness rankings. It is seen as much fairer if we assume that communities have a right to deny the construction of a waste facility and must be compensated if they allow it. The alternative entitlement structure, namely that there exists a right to build nuclear waste repositories and that communities have to pay if they do not want any on their grounds is judged to be the least fair of all. The fact that individuals perceive the situation as completely different under the two entitlement structures may partly account for the differences between compensation-demanded and willingness-to-pay values found in many studies¹⁹.

But even the more favourably judged *compensation mechanism* is not considered particularly fair. One of the reasons given by the respondents is that a community's endowment enters as a variable in the compensation procedure. 72.9% stated that it is "important" that the siting rule completely ignores the financial standings of the candidates (at least 4 points given on a scale from 1 to 6, where 1=not important at all, and 6=very important). A majority of the respondents thought of this as "very important" (6 points given).

Similarly, a *random mechanism* such as a *lottery* is not seen as a fair mechanism. This may be due to people's belief that there exist valid arguments in favour of, or against, a particular location of a noxious facility. The favourable ranking of expert driven processes, such as the current Swiss approach, tends to support the hypothesis that people believe that scientific knowledge is to play a major role in siting decisions. If this holds true, selecting a site at random must seem unethical.

In line with the predictions of bargaining theory, the *better known procedures* such as the current approach and referendums have found wider acceptance. On fairness

18. Coase, R.H., "The Problem of Social Cost", *Journal of Law and Economics*, 1960, 3, 1-45.

19. For nuclear waste, see Kunreuther, H. and Easterling, D., "Gaining Acceptance for Noxious Facilities With Economic Incentives", in Bromley, D.W. and Segerson, K., *The Social Response to Environmental Risk: Policy Formulation in an Age of Uncertainty*, Boston, Kluwer, 1992, 151-186.

grounds, the use of *referendums* as a decision-making process, however, was still opposed by more than 60% of all the respondents. The judgement seems to be based on the view that referendums do not attach enough weight to the opinion of those most concerned. 71.4% thought it to be "important" that a site was not chosen against the will of a majority in the host community (at least 4 points given on a scale from 1 to 6, where 1 = not important at all, and 6 = very important). 40.9% judged this to be "very important" (6 points given).

It is noteworthy that even the siting rule judged to be relatively the fairest, the *current approach*, is supported by merely 50.6% in the case of low and mid-radioactive waste and by 68.0% in the case of highly active waste. This is due to the difficult nature of the trade-offs present in siting disputes. It is very difficult to design a procedure that satisfies fairness criteria. As for the allocation of scarce goods, administrative decision-making processes fare much better in the judgement of the public than in theoretical concepts. Moreover, with higher levels of risk the fairness attributed to expert decisions seems to be on the rise as well.

Generally, fairness judgements seem not to be very sensitive to various levels of risk. This result, however, holds at *prima facie* only and further empirical research will have to confirm it. The exception is the rating of the current approach. As pointed out above, it might well be that expert decisions are viewed as fairer with higher levels of risk. A competing hypothesis, however, is that fairness is not so much a process related concept but mainly outcome determined. The selection of a siting rule that is perceived to be fair *ex ante* would therefore be no guarantee that the decision resulting from this rule is seen as fair as well. Our data seem to confirm this hypothesis. The search for a nuclear repository for highly radioactive waste has just begun in Switzerland. The siting decision will not be made until well into the next century. In this case, 68% of all respondents judge the current approach to be fair. Since little is known about which community will site this repository, the respondents' perspective is *ex ante*. On the other hand, the search for a low and mid-active waste repository is almost completed. The developer has chosen a community as a potential site. This choice is currently under federal scrutiny. The situation is almost *ex post*, and only 50.6% judge the siting rule to be fair. This may be due to the fact that not so much the procedure but the outcome itself is judged to be unfair.

§ 5. Concluding Remarks

One of the major conclusions from our research is that much speaks in favour of looking at fairness in terms of rules, i.e. *processes*, instead of in terms of outcome. But the task does not end in finding a 'fair rule'. Rather, the empirical research provides us with useful notions about the relative fairness of methods of allocation. The price mechanism is considered much less fair than economists seem to believe on the basis of their

efficiency view²⁰. The same holds for random mechanisms which many scholars take to be the embodiment of equal treatment but which individuals seem to reject exactly because they feel that different values and circumstances are not adequately taken into account. This means that they are not satisfied with the construction underlying the application of random procedures, where first of all the substantive aspects are considered, and then a choice is made among the remaining alternatives.

Many individuals seem to have more trust in the fairness of procedures where substantive aspects are continually taken into account, as is the case when expert opinions and administrative rules are combined. Our empirical results cast some doubt on those siting procedures relying simply on some form of monetary payments. While the methods of compensation demanded and willingness to pay lead to efficient (Pareto optimal) results they are often not acceptable in terms of fairness and therefore tend to be politically resisted. Random procedures also play a major role in some siting procedures but should be re-evaluated on the basis of our empirical findings.

Knowledge about the relative fairness of decision rules is only one part of the story. The process governing the relationship between a decision rule's '*ex ante* fairness' (when the decision has not yet been taken) and '*ex post* fairness' (after a decision has been reached via the rule) has to be taken into account. Looking back at our stylized siting procedure outlined in the beginning, the application of a fair rule (step 1) does not solve all the fairness problems involved in siting. If *ex ante* and *ex post* considerations of fairness differ systematically, an assumption supported by our data, the enforcement of a siting decision (step 3) presents yet another difficult step.

A natural hypothesis is, of course, that a rule is the more likely to be acceptable *ex post*, the higher was its acceptability *ex ante*. However, our research suggests that it does not suffice to simply postulate this relationship to be positive, and leave it at that. An important task of the research on siting will be to identify more precisely, by *how much ex ante* acceptability supports *ex post* acceptability, and therewith facilitates enforcement, and by what specific factors this relationship is influenced.

20. Frey, B.S., "Economists Favour the Price System - Who Else Does?" *Kyklos*, 1986, 537-563.

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