

The Code of Three Regulations for the Environment Protection Agency or a Saga about 12 Bottles

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Personage: Protection Agency, Moderator, Union Members and Sponsor

Introduction. It is now almost a common truth that measures of the government to avoid damage or contamination of the environment have become significant for nature protection efforts and wild life preservation. The possible outcomes of such efforts might sometimes turn into voluntary solutions that certain companies are keyed up to find a break in the legislation not to, or only formally, participate in environmental protection. In such a situation, which takes into account the nature/content of human behavior, we blow the perception of reality out of proportions. The reader may probably find informative the interaction of the interests of companies and the environment protection agency. One may also think that the efficiency of a solution is powerful enough by being right and proper. However, advancing in the other direction of democratic, i.e., self-governing decision-making process, we still have a chance to make a point.

Analysis. We start with an analysis of the situation. Suppose, the environment protection agency is determined to supervise contaminating activities. The agency when restoring wasted natural resources hopes to reduce expenses. To identify the preferences on the subject in which “*types of activities*” the companies are ready to stop or to hold the contamination, the agency decides to proceed with a survey. The survey exposes that companies/rows might participate in programs/columns to shut down polluting or damaging activities on ecosystems in accordance with Table 1:

Table 1

<i>List of coordinating programs</i>	<i>Groundwater Pollution</i>	<i>Deterioration of Lakes</i>	<i>Fuel Damage</i>	<i>Loss of Forest Cover</i>	<i>Ozone depletion</i>	<i>Total</i>
<i>Comp. nr.1</i>		○	○			2
<i>Comp. nr.2</i>	○	○		○	○	4
<i>Comp. nr.3</i>		○	○	○		3
<i>Comp. nr.4</i>	○	○		○	○	4
<i>Comp. nr.5</i>			○	○		2
<i>Comp. nr.6</i>	○	○	○	○	○	5
<i>Comp. nr.7</i>		○	○			2
<i>Total</i>	3	6	5	5	3	22

We acknowledge that the preferences of companies have been revealed by the survey – “yes” or “no” regarding a particular shutting down of an activity. Almost all, perhaps, know the unreliable nature of companies in keeping to their promises. The agency as a rational organization is aware of this drawback. Therefore, the agency decides to award companies that will be ready to shut down the contamination by participating in protection or preservation programs. The agency turns to a sponsor, who *kindly* agrees to cover the expenses of the awards by a maximum of 12 bottles of wine. The sponsor, nonetheless, insists on finding out whether or not a company fulfils its promises on condition that each company’s budget in the follow-up inspections is under constraint = 4. Besides the budget constraint, all must be free to self-govern, as emphasized by the sponsor, or to break their promises without any penalties. We suppose further that an inspection of a particular activity has its firm price = 1.

In thinking about the rules of how the awards ought to be paid out there are a lot of reservations. In the first place, programs with few participants are not attractive. When operating and wasting time and resources, it is desirable, while keeping to within-budget constraints, that programs are popular. For example, it is not a good idea to act upon a program that has only one or two participants. On the other hand, it is desirable to attract as many companies as possible and to organize a number programs. In the second place, it is meaningless to write down the (certainly twisted) rules and regulation of awards. Normally, in such a situation the initiative is transferred to a moderator, who will be responsible for organizing a union for environment protection. However, the agency wishes to control the situation because of the financing for the programs. Therefore, the agency proposes to write down the first regulation in force for awards payoffs: *The agency awards 1 bottle of wine to a company that will not break its promises while participating in at least k programs from the list agreed by all but members of the coming union.* Thus, the choice of our hypothetical agency is in between k -numbers.

The choice of k is full of twists and turns. The task of the agency is not exactly as it would like to appear that it is going into details of preferences on whether or not a company decides to participate in a program. This task is, more or less, under the jurisdiction of the moderator of the union. Of course, the task is, at the same time, in the responsibility of the companies that intend to become the members of the union.

The complicity of the situation of how to encourage companies not to “spring out” of their promises reveals the difficulty. Therefore, to persuade the coming members of the union to fulfill their collective responsibility not to break promises in the long run, the agency proposes the second regulation in force from which rule must emanate a threat of losing the awards: *If some union member does not keep to its promises, keeping to less than k promises from the list agreed by all but members of the union, all awards will be lost, inclusive of the moderator’s personal award*, which payoff rule is a bit twisted. To act as the agency desired by the third regulation in force, the moderator of the union will be awarded personally depending on the following: *The award basket of the moderator will be equal to the lowest number of promises fulfilled by all but members of the coming union in a program selected from the list of programs agreed in advance.*

Really, even if the union formation is accomplished, it might happen that the moderator can find a break to earn by more organizing some other union deliberately excluding the least popular program from the list of programs agreed by all. While each union member keeps to its promises, an outsider may still shut down or stay away from a particular contaminating activity as the outsider promised in the past. Now it does not matter if the activity is outside the list agreed by all but members of the union or not. These promises fulfilled by outsiders do not count what so ever in the moderator’s award! Thus, it might happen that the list of columns, which contribute to the calculus of the moderator’s award, is going to shrink in size compared with Table-1.

The root of the situation lies in the moderator’s award. If not, then the “grand coalition” is always likely to be formed from all companies as potential participants of the union. Indeed, all should understand that regardless of a reasonably chosen number k , which guaranties the personal award to be paid out, an award might always encourage some companies to participate in unpopular programs. In fact, the moderator’s award may be quite low, because of a chance that only few companies, probably formally, decide to participate in such programs. But, just by this ”unpopular” program our twisted rule accounts for the moderator’s award.

The situation might become even more complicated. The moderator might misrepresent preferences of union members before the agency. Suppose the agency has made a decision $k = 1$ but the moderator happens to know this decision by negligence or some other reason. Knowing that $k = 1$ it is easy to predict the behavior of the moderator. Really, the survey shows which one of programs is most popular and who is participating in this program. The moderator can clearly count on to receive the maximal award by persuading those companies that prefer the most popular program, to become members of the union. In doing so, the moderator may ask those latter not to participate in the rest, i.e., the less popular programs. As rational companies, they will surely agree, because, participate or not, the same, *honestly earned* awards, will be guaranteed.

Now so understood, the agency decides to keep its decision k in secret. This secret, the agency thinks, will encourage rational companies, rather more than less, to keep to their promises. On the other hand, companies have their subjective estimates over k . The situation can be illustrated by a card game. The agency takes a card k and places it face down on the table. The moderator takes his/her own card, and it makes no difference whether it is shown or not to the agency. The game of union formation is over on condition of the moderator. The participants will be awarded if the moderator's card is not less that of the agency. Otherwise, the risk exists for all to come up empty-handed.

It is clear from the card game, as we have already noticed, that highly rational companies would try to expand the list of programs they promised to shut down or contain their activities to reduce the risk of not being awarded with a higher k -decision. Thus, the members of coming union (those with higher environment protection standards) would count on higher k 's and therefore they should persuade those outsiders, those with relatively low "*protection standards*" and having relatively lower k 's, to prevent them from becoming members of the union.

We have not yet told the whole truth. The positive effect f_k , what the agency intends to reach, depends on its decision taken by k -number. For some reason we expect a single \cap -peaked effect of the function f_k towards of the increase of k . Consequently, this assumption separates the region of decisions k into so-called normal and prohibited zones. In the normal zone (the low values of numbers k) the effect does not yet reach its maximum value; the top of the function f_k has not yet been passed, because the normal zone accounts for small values of k . Therefore, in normal zone, from the agency point of view, it is rational to keep the decision k in secret. In contrast, in prohibited zone, the agency and the moderator must cooperate because both of them may decrease or lose their awards in case the value k is too high. Thus, in the normal zone it is in the interest of the agency to keep the decision k secret; secrets in the prohibited zone are counterproductive.

Example. Let us look more closely at the incentives of moderator and members of the union regarding the awards in accordance with Table 1, and let the awards be granted at $k = 1$ or 2 . The agency expects actions closing down all \circ -activities in Table 1 marked below as contained \otimes -activities; all 22 promises are fulfilled. Every company will become a member of the union: the most efficient solution – the “grand coalition” by other means, e.g., voluntary. Indeed, each company is to be awarded with a bottle of wine. Nevertheless, the agency is prohibited by reason of budget rules to proceed with all programs in the follow-up inspection: the expenses = 5 exceed by 1 the budget of company nr.6. The moderator’s basket size equals 3. On the other hand, the moderator may persuade the coming members of the union not to keep to their promises at “*Groundwater Pollution*” and “*Ozone Depletion*” activities. All union members will still preserve their *well-earned* awards sounds the argument of the moderator. This solution, as everyone can see, is in the interests of both: the moderator’s award increases from 3 to 5, and the expenses upon the inspection of company nr.6 drop from 5 to 3; only 3 activities have to be inspected instead of 5, now in compliance with the budget constraint = 4 (see the Table 2 below).

Table 2

List of coordinating programs	Deterioration of Lakes	Fuel Damage	Loss of Forest Cover	Total
Comp. nr.1	⊗	⊗		2
Comp. nr.2	⊗		⊗	2
Comp. nr.3	⊗	⊗	⊗	3
Comp. nr.4	⊗		⊗	2
Comp. nr.5		⊗	⊗	2
Comp. nr.6	⊗	⊗	⊗	3
Comp. nr.7	⊗	⊗		2
Total	6	5	5	16

Table 3

Deterioration of Lakes	Total
⊗	1
⊗	1
⊗	1
⊗	1
	0
⊗	1
⊗	1
6	6

One can also notice that the total of award expenses may again rise up to the maximum 12. However, someone from the environment board may insist that the proposal to vote for $k=1$ is undesirable because of additional intersection since the moderator can misrepresent the members' preferences. Indeed, by this motion the moderator may offer one bottle to an environment board member for *signaling* about the decision $k=1$. Knowing that $k=1$, as a result, the moderator may persuade the union members to keep only to one program – to contain the activity “*Deterioration of Lakes*”. In this regard, the moderator may compensate company nr.5 losses by one bottle¹. If not, company nr.5 is at right to receive an award since it may keep to promises to stay away from activities other than “*Deterioration of Lakes*,” and therefore the company nr.5 may threaten to send a *signal* to the board regarding the moderator's fraud. The moderator's award in this case, following the regulations in force (see Table 3), will be 6 minus 1 for the signal, and minus 1 for the compensation. That makes 4 which is greater than 3, as the Table 1 suggests. Obviously, a similar situation may happen when $k=2$, and the like.

This understood, the board may probably follow the line of reasoning not to propose $k=1,2$ because of the misrepresentation argument and to insist on the decision $k \geq 3$ to eliminate or obscure the moderator's fraud. One may argue that $k \geq 3$ might yield an undesirable effect of environment contamination since the polluting activities of companies' nr.1, nr.5 and nr.7 are now not the issue (see Table 1). Indeed, these companies will be excluded from the union and will be free to self-govern, i.e. to break (or not, which is irrelevant) their promises without any penalties, as we have

¹ Quite unpleasant suggestion.

already noticed, and, eventually, to carry on these contaminating activities once again. Someone may, however, counter-argue that, despite the eventual resumption of contamination by companies' nr. 1, nr. 5 and nr. 7, as everyone can see from the Table 4 below, the remaining companies nr. 2, nr. 4 and nr. 6 will still be awarded and will still downgrade the total of environment contamination or damage.

Table 4

<i>List of coordinating programs</i>	<i>Groundwater Pollution</i>	<i>Deterioration of Lakes</i>	<i>Fuel Damage</i>	<i>Loss of Forest Cover</i>	<i>Ozone Depletion</i>	<i>Total</i>
<i>Comp. nr.2</i>	⊗	⊗		⊗	⊗	4
<i>Comp. nr.3</i>		⊗	⊗	⊗		3
<i>Comp. nr.4</i>	⊗	⊗		⊗	⊗	4
<i>Comp. nr.6</i>	⊗	⊗	⊗	⊗	⊗	5
<i>Total</i>	3	4	2	4	3	16

Now the award basket of moderator equals 2, since only companies nr. 3 and nr. 6 keep to the promises to shut down the “*Fuel Damage*” activity. The awards expenses will decrease from 10 to 6. However, the agency may compromise to increase the moderator award to 3, excluding “*Fuel Damage*” from the inspection list in Table 4. Actually, the compromise is better off for both: the moderator award increases, $2 < 3$ and the elimination of “*Fuel Damage*” from the list does not any more exceed by 1 the budget for inspections of company nr. 6. But now, in accordance with the second regulation in force, as a result of collective responsibility, company nr. 3 will be excluded from the union because of only two promises fulfilled by nr. 3 ! At the same time, the expenses for the sponsor do not change: $2 + 4 = 3 + 3 = 6$, as shown in Table 5.

Table 5

<i>List of coordinating programs</i>	<i>Groundwater Pollution</i>	<i>Deterioration of Lakes</i>	<i>Loss of Forest Cover</i>	<i>Ozone depletion</i>	<i>Total</i>
<i>Comp. nr.2</i>	⊗	⊗	⊗	⊗	4
<i>Comp. nr.4</i>	⊗	⊗	⊗	⊗	4
<i>Comp. nr.6</i>	⊗	⊗	⊗	⊗	4
<i>Total</i>	3	3	3	3	12

Is this decision rational? Suppose not, and let $k = 5$ be the board proposal. Now, only company nr. 6 is a potential participant of the project, see Table 6.

Table 6

<i>Industry Effects</i>	<i>Groundwater Pollution</i>	<i>Deterioration of Lakes</i>	<i>Fuel Damage</i>	<i>Loss of Forest Cover</i>	<i>Ozone Depletion</i>	<i>Total</i>
<i>Comp. nr.6</i>	⊗	⊗	⊗	⊗	⊗	5
<i>Total</i>	1	1	1	1	1	5

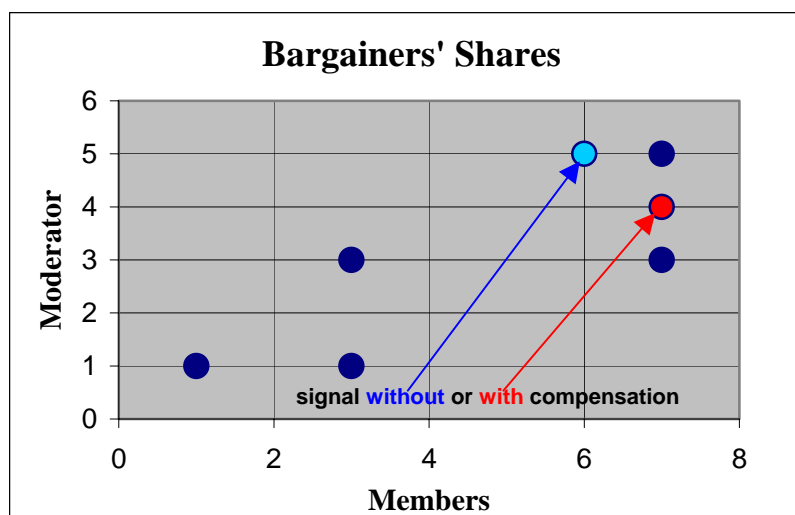
The moderator may disagree to organize an “Environment Protection” union because his/her award is only one bottle. From the other side, neither is it exactly the purpose of the project to waste time and resources, which exceed the budget amount on inspections to inspect all five activities with only one potential company. The agency decides to vote against the proposal $k = 5$. The union game ends here without telling the whole truth of what the decision k at the company’s board was.

To reach a conclusion, the basic nature of the agency’s difficulty in making a decision k lies on what principle to pick up a row in the following table:

Table 7

	<i>Members</i>	<i>Moderator</i>	<i>Compensation</i>	<i>Signal</i>	<i>Bottles of wine used</i>	<i>Bottles of wine left</i>	<i>Expenses on inspection</i>
<i>Table 1</i>	7	3	0	0	10	2	5
<i>Table 2</i>	7	5	0	0	12	0	3
<i>Table 3</i>	6	4	1	1	12	0	1
<i>Table 4</i>	3	1	0	0	4	8	5
<i>Table 5</i>	3	3	0	0	6	6	4
<i>Table 6</i>	1	1	0	0	2	10	5

Below we visualize the agency’s difficulty in a bargaining game to share 12 bottles of wine between the bargainers: (i) – the members of the “Environment Protection” union and (ii) – the moderator of the union.



Summary. A final topic is necessary to conclude our pleasant story. This time we have to *jump into cold water* of rigorous issues. Let three actors be engaged in the interaction: companies N , the moderator in charge of union formation, and the agency accountable for environment protection. Certain companies x from $N = \{1, \dots, i, \dots, n\}$ – the coming members of the union, $x \subseteq N$, $x \in 2^N$, have expressed their willingness to live up to their promises to shut down or to contain contaminating activities y from programs $M = \{1, \dots, j, \dots, m\}$, $y \subseteq M$, $y \in 2^M$; the inspection list of programs y has been coordinated in advance by union members x . The preferences of companies' N as pre-orderings² P_i , $i \in N$, are given upon numbers $A = \{1, \dots, k, \dots, k_{max}\}$. For example, an ordering $P_{jm} = \langle 4, 5; \text{next some numbers } k > 5, \text{ indifferent in which order, but the list ends always as } 3, 2, 1 \rangle$ is acceptable.

Let a table $W = \|a_{ij}\|_n^m$ reflect the result of a survey regarding the willingness of companies' to participate in protection programs; $a_{ij} = 1$ if company i promises to shut down the contamination or damaging activity j , $a_{ij} = 0$ if not. So, we know the lists $y \subseteq M$ of allegedly coordinated programs, by which the members of the coming union $x \subseteq N$ promise to shut down contaminating activities; the number of distinct lists y equals 2^m , the number of potential unions under formation equals 2^n . We also suppose that characteristic functions $v^k(x)$, $k \in A$ are known, supermodular on N for the coalition game: for every pair $x' \subset x''$, $x', x'' \in 2^N$, it holds that $v(x' \cup x'') + v(x' \cap x'') \geq v(x') + v(x'')$, and consequently $v^k(x') \leq v^k(x'')$, i.e., the monotonic property as well in the direction of increasing $x' \subset x''$ ³. So understood, we determine the moderator payoff $F_k(x, y)$ using a subtable (x, y) on crossing entries of the rows x and columns y in the original table W . The moderator payoff $F_k(x, y)$ is determined by the list y of columns by further selection of a column with the smallest number of 1-entries. It is possible to find the best choice $(x^*, y^*) = \operatorname{argmax}_{(x, y)} F_k(x, y)$ of the moderator for each particular k -number (see Mullat 1995). The agency gain for the contribution into protection of the environment is an advantage function $f_k = f(x^*, y^*)$, single-peaked upon k . Agency expenses are equal to $[v^k(x^*) + F_k(x^*, y^*)]$.

² Reflexive and transitive binary relations are known also as quasi-orderings.

³ Cherenin was the first who introduced supermodular functions.

Conclusion. We propose some ideas for the reasonable solution of our game. The situation is similar to the Nash Bargaining Problem from 1950, where two rational partners (players' Nr.1 and 2, e.g., the union members x and the moderator/agency) try to find a fair agreement. However, the problem of the best choice of k -numbers itself is somewhat different. We have pointed out earlier that the choice $k = 4,5$ may be useful from some per se reasoning. Maximum payoff $F_k(x^*, y^*)$ is guaranteed for players nr.2 when $k = 1$. Counting on that decision is irrational, because here only one contaminating activity will be shut down with the maximum number of participants but without significant effect on environment protection, c.f. the advantage function f_k of the environment protection. On the other hand, the choice of higher $k \gg 1$ numbers is counterproductive due to the constraint of follow-up inspections – a lot of protection activities, eventually, will be organized, but with few participants, when only saving of payoffs assets is desirable. For example for $k = k_{max}$, a company with the longest list of preferred promises to shut down k_{max} contamination activities might become the only member of the union. It seems to us that the situation is like a median voter scheme (see Barbera et. al., 1993). Nonetheless, a consultation in this “white field” of social choice theory is necessary, since difficulty is well known following the classic result of Gibbard (1973) and Satterthwaite (1975) theorem to meet both the individual and collective rationality objectives within “unrestricted domain.”

Literature

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