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NEGOTIATING MUNICIPALITIES-INDUSTRIAL FACTORY WASTEWATER TREATMENT COALITION PROJECT: AN ECONOMIC LABORATORY EXPERIMENT

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Abstract. It is often the case that municipalities and industrial plants treat their wastewater separately bringing the municipalities wastewater to be treated at the industrial wastewater treatment plant and reused by the plant creates potential for social costs saving for both the municipalities and the private firm. In an economic laboratory experiment we demonstrate that such voluntary agreement could be achieved even despite the presence of information asymmetry. This follows our previous research on win-win voluntary agreements and the role of information asymmetry. The biggest challenge remaining to be addressed is the distribution of the extra cake, which in our results is mostly seized by the private firm.

Keywords: cost-effectiveness, negotiated environmental agreement, wastewater management.

AIMS AND BACKGROUND

In our previous research[1], we analysed a case of five small municipalities located near each other and a chemical factory which have a technological chance to co-operate in treating their waste water. The municipalities are forced to solve their wastewater treatment with high environmental efficiency since they are located in a protected landscape area. The factory has to modernise its existing wastewater treatment plant (WWTP) to get new IPPC permit (in its part of wastewater treatment). Although our case concerns chemical industry, other industrial branches also have serious problems with waste waters[2].

Two alternatives (scenarios) have been analysed. In the first scenario, the municipalities would build and operate their individual WWTPs, including the sewage systems; and the factory would modernise its WWTP for the capacity necessary to treat the amount and contents of its waste water. In this case, the total social costs (total costs incurred by all stakeholders, both private and public) would be CZK 593 mil of initial investment costs and CZK 176 mil of annual operating costs. In

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this case the residual pollution from the treatment will remain in the protected area and there still will be a problem for the factory to get enough technology water during the drought periods of the year.

In the second scenario, the municipalities would (only) build sewage systems + extra pipes which would bring their wastewater to the factory. The factory would expand its WWTP within the planned modernisation and it would treat all wastewater from the municipalities. This scenario would increase the factory both investment and operating costs but it would save financial means in terms of a higher profit due to not reducing or even closing the production during the droughts. The total social costs in this case are CZK 592 mil as initial investment costs and CZK 163 mil of annual operating costs. From the environmental point of view, there will be no residual pollution from the municipalities WWTPs discharged to watercourses in the highly protected area. Because the factory will utilise the treated water for its technology purposes, it will not take off water from watercourses; moreover – it could store the extra water in its lagoon and add some amount of water during drought periods.

The budgets of the municipalities are limited but they are willing to contribute to the common project if it is more beneficial for them than building individual WWTPs. The enterprise is also willing to accept the second scenario if it is more beneficial for the factory. However, all parties keep their willingness to contribute to the common project as confidential information. The common proposal for the government could have a form of a negotiated voluntary agreement. For more details about voluntary environmental agreements see Patric ten Brink[3].

The potential of whether such an agreement could be achieved voluntarily was pre-tested in an economic laboratory experiment. Economic laboratory experiments are often used to test hypotheses in various fields[4] and also to pre-test various institutional settings in economic policy[5]. Our study is the second case.

EXPERIMENTAL

Experimental design. The data for the background model were adopted from the above-mentioned study[1] which brings a description of a real case from the Morava River Basin (belonging to the Danube River Basin) in the Czech Republic. The data about Capital Investment Costs and Operating Costs of the projects were converted to the annual basis using the following formula:

$$AAC = IC \times (r(1 + r))^n/((1 + r)^n - 1) + OP, \quad (1)$$

where AAC is the average annual costs of the project; IC – the total investment costs of the project; $r = 0.05$ – the discount rate; $n = 15$ – the service life of the project; OP – the average annual operating costs of the project.

Table 1. Average annual costs of the scenarios

AAC of both scenarios for all stakeholders (municipalities and factory in millions CZK)								
	Mun A	Mun B	Mun C	Mun D	Mun E	All Muns	Factory	Social costs
Individual project costs	4	5.4	8.5	3	3.8	24.7	239.5	264.2
Common project costs						20.0	230.0	250.0

Mun – municipality.

Printed materials were prepared for the subjects in the experiment:

(a) Five subjects (A, B, C, D and E) were playing the roles of municipalities. Each of these subjects obtained: (i) information about the costs of their individual project (municipal WWTP); (ii) information about the costs of the common project (sewage systems and pipelines), and (iii) instructions for the municipality.

(b) One subject was playing the role of the factory *F*. The materials for this subject contained: (i) costs of its WWTP modernisation in scenario 1 (no common project); (ii) net costs of modernisation of its WWTP in scenario 2 (the common project), and (iii) instructions for the factory.

(c) A form to report the results of the negotiations – one for each of the five municipalities + one for the factory representatives.

The instruction list contained:

– A short description of the case and its two potential solutions. This text was the same for the representatives of both the municipalities and the factory. For this info see section 'Aims and Background' above in this paper.

– A description of the experiment procedure and its rules. Particularly it was stressed that both the municipalities and the factory should not show the information about the costs to the other subjects in the experiment, i.e. that they should keep it confidential.

– Information about financial compensation within the experiment. The students were informed that they can earn about the same amount that they receive when working on the basis of a short-term contract in the municipality. It consists of about EUR 3 of attendance fee plus up to EUR 8 depending on the level of success of the given subject in the negotiations.

Experiment procedure. The experiment was conducted with students of economic disciplines at the University of Economics in Prague, who played the roles of the subjects, in April 2018. The participants were divided into groups of six at the beginning of the experiment. The roles of the subjects in the experiment were assigned and the materials were distributed to the subjects. After that, the case and rules of behaviour in the experiment were explained by the supervisor. Both the subjects playing the role of the municipalities and the subjects playing the role of

the factory were asked to keep their individual (economic) information confidential. They were also informed about the financial compensation they will receive based on the result of the experiment. Then they had 40 min for negotiating and filling in the form (table) related to the solution.

In the first stage of negotiations, the municipalities were asked to negotiate their individual contributions to their common project to cover its total costs. Then the experiment continued with the second stage – a common negotiation between the group of municipalities and the factory. Having delivered the sheets with the solutions at the end of the experiment, the students filled in a short questionnaire. The students were also paid the compensation after the experiment.

RESULTS AND DISCUSSION

Eight groups of six subjects took part in the experiment (Table 2).

Table 2. Results of the Experiment

Group number	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	Average
Scenario negotiated	second	second	second	second	second	second	second	second	
Factory contribution	0.3	1.5	–3.5	–2	0	2	2	1.5	0.2
Extra cake share of factory (%)	68.3	59.9	95.1	84.5	70.4	56.3	56.3	59.9	68.8
Average mun contribution (% of max)	77.0	81.5	105.2	88.7	91.9	78.0	69.9	78.9	83.9
S-dev of mun contributions (percentage points)	7.3	20.9	36.2	9.1	29.3	14.2	10.9	16.7	18.1

As it is obvious from the tables, all eight groups concluded an agreement that the common project with the factory (second scenario) will be implemented. It is clear at first sight that the players representing the factory were able to make use of their asymmetric position skilfully. In all cases, they were able to win more than a half of the extra cake created by the common solution. The table shows their average contributions relative to their budget constraints (some even felt pressured to contribute more than this maximum; in group 3 one municipality promised to contribute 175% of its maximum pushing the average over 100%). The standard deviation of the municipalities relative contributions shows that they were able to achieve quite balanced agreements with each other. All three cases where the standard deviation exceeds 20% points of the maximum (groups 2, 3, and 5) can be attributed to a single outlier being either a free rider or the most significant contributor.

This goes to show that the first round of negotiations helped to push down the requirements of all municipality representatives and create a relatively open

and fair environment for their bids. They were able to overcome the information asymmetry thanks to the symmetry of their positions vis-à-vis each other. On the contrary, the second round proved very ineffective in distributing fairly the extra benefits created by the cheaper solution, as the factory representatives were able to make use of their unique position adeptly. The means through which this could be achieved remain to be identified in further research but it could disclose more information about the factory, including more rounds of negotiations in smaller groups with the factory representatives, or changing the sequence of rounds.

DISCUSSION AND CONCLUSION

Although the model is simplified for the purposes of the economic laboratory experiments, it still yields some promising results with respect to its practical implications. There are few cases where common treatment of municipal and industrial waste waters occurs in reality and it is usually based on the specific situation of the areas. It is typical that household and industrial wastewater is treated in one WWTP. Technologies for such collaboration do exist and future will definitely bring new ones[6].

Solution investigated in this paper is a further development of cases, where several small municipalities build a common WWTP (Ref. 7), which is supported as one of the solutions for small municipalities by the Czech ministry of Environment[8].

The public private partnership studied in the paper is actually a way to implement the principles of circular economy at the local level. But it is obvious that this voluntary agreement would need to have some binding form.

As for the company – it could be pressured by the need of obtaining the IPPC and its mechanisms would control the company. The voluntary agreement presented is consistent with the stepping up security measures of the policy concerning the protection of waters against chemical pollution from industry[9].

As for the municipalities – treatment of wastewater generated in small settlements is expensive. But the agreement can be boosted by financial support from public sources (regional budgets, the State Environmental Fund, the state budget, EU sources, etc.). The audit mechanisms of such support would also supervise implementation of the agreement.

As far as future research is concerned, our case could be analysed and experimented in more details if more options for common projects are considered. For instance it could be optimal if only several municipalities built a common wastewater treatment plant; for the factory it would not be efficient to join any common project with the municipalities, the factory would have a common project with only several municipalities, etc. For such combinatorial projects[10]. Although the data for the background model in the experiment were adopted from practice,

it still makes sense to test how sensitive the results of cost distribution are, namely between the municipalities and the factory.

Solving the water quality requirements would be a part of more complex measures with more parallel effects, such as a contribution to increased water retention in landscape, as a part of anti-flood measures, etc. These complex measures have a potential to bring higher efficiency into public expenditures in environmental protection. The complex measures are also a part of the adaptive policy strategy related to recognition that trends in precipitations are not predictable[11]. Effects of such complex measures can be stressed by the tools of multicriteria analyses[12], or/and expressed in financial terms using so-called non-market valuation of nature goods and services. In the Czech Republic, such methods were first applied for the economic valuation of the effects of anti-flood measures in 1990s (Ref. 13). Common projects negotiation processes could have a close relation to environmental social impact assessment (ESIA) (Ref. 14).

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