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On Coasean Bargaining with Transaction Costs: The Case of Vittel[1]

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Abstract: Based on an authentic case of contracting for environmental property rights, our paper shows several implications of applying the Coase propositions. The case study adds empirical content to basic transaction costs concepts by analyzing the design and implementation of a contractual arrangement between a pollutee –a bottler of mineral water Vittel– and several polluting farmers. We analyse the bargaining between land and water rights owners and the bottler Vittel to determine how they succeeded in contracting for environmental property rights. Valuation disputes, bi-lateral monopoly conditions, and third-party effects are key factors. Several implications for environmental rights negotiations are drawn.

Key-Words: Transaction Costs, Environmental Property Rights, Vittel, Case Study, Contracting, Private arrangement, Environmental-related transactions.

JEL classification: H23; K32; Q15; Q25.

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'By analyzing the details of property rights negotiations, including the positions taken by the various parties, their characteristics, and the information available, one can determine why property rights emerge in the manner that they do.' (Libecap, 2002, p. 155)

1. Introduction

In the early 1970's, intensification of farming practices in the Vittel area, located in the French Vosges mountains, led to concerns about imbalances in the local ecosystem. More precisely, in 1988, the production unit of the bottler of mineral water Vittel[3] noticed a quality deterioration in its mineral water, notably a slow but regular and significant increase in nitrates. The main cause was non-point source pollution from intensive farming practiced in the fields surrounding the Vittel springs, the so-called 'small Parisian basin'[4].

Vittel attempted several unsuccessful strategies to deal with this problem such as the use of regulatory pressures, collaboration with the Chamber of Agriculture[5], purchase of fields and meetings with officials of the Ministry of the Environment concerning significant changes in farming practices. Therefore, Vittel turned its attention to research by contracting with the French National Agronomic Institute (INRA) for a specific research-action program, the so-called AGREV program[6]. Researchers from INRA were familiar with the local agriculture because of previous collaboration with farmers on agricultural development issues (INRA). The question of Vittel was expressed as follows: *"What changes are required concerning farming activity, used on the site, and under what conditions in order to reduce the rate of nitrates found beneath the roots of cultivated plants and grassland, and to ensure that this rate remains below the limit of 10 mg per liter?"*[7] (Deffontaines and Brossier, 2000). This question initiated a negotiated management program that led to a formal contractual arrangement between Vittel and farmers, conceptualized in the Coase's seminal contribution (1960).

At first glance, the problem between Vittel and farmers was potentially very complex and likely to generate high transaction costs that could derail a Coasean solution. Nevertheless, high transaction costs were overcome and Vittel successfully contracted for environmental property rights with farmers. Our primary objective is to show how these two parties with conflictual interests and other stakeholders succeeded in contracting for environmental property rights. The case study adds empirical content to basic transaction costs concepts by analyzing the design and implementation of a contractual arrangement. We make use of detailed records –reports by INRA, academic papers, popular and technical press. These documents describe the bargaining history between Vittel and farmers as they negotiated over land use and property rights. Additionally, we did several interviews with key persons, i.e. some researchers (Marc Barbier, Eduardo Chia and Pierre Morlon) from INRA who were actively involved in the process. These interviews make clear the bargaining positions, strategies and key issues of contention.

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[3] Hereafter, Vittel designates the Vittel Company, regardless of its formal name.
[4] The 'Parisian basin' is a French region famous for its large scale farms and intensive farming.
[5] Established in 1924, the Chamber of Agriculture is a professional public institution representing farmers and rural interests.
[6] AGREV is the French acronym for 'Agriculture Environnement Vittel'.
[7] While European regulation limits the maximum level of nitrates to 15 mg/l for mineral water for infant feeding, some countries impose a tough threshold nitrates level of 10 mg/l (INRA, 1997).

The case of Vittel presented here differs from several to date because it (1) considers the case of a non-point source pollution, i.e. intensive family farming practices in a well delimited area affecting the water quality of an industrial bottler, (2) studies the whole process from the identification of the problem to the selection, design, implementation and running of a specific solution, stressing the difficulties and costs encountered at each step, and (3) analyzes the precise nature of the compensation paid by the pollutee to polluters and subsequent implications. Indeed, the monetary transfers are found to mainly cover the short-term loss changes for which the contract is established.

The case of Vittel provides raw materials for confronting theoretical propositions and arguments with a real world situation. According to Coase (1974, p. 375) 'such studies would enable us to discover which factors are important and which are not in determining the outcome, and they would lead to generalizations which have a solid base. They are also likely to serve another purpose by showing us the richness of the social alternatives among which we can choose'. The contractual arrangement deals with environmental property rights but also attempts to 'lock' polluters into environmentally friendly practices. Moreover, this case can be useful for other situations where there are potential contracting problems, associated with efforts to address pollution, particularly where there are non-point sources and hence, multiple parties to deal with and property rights on which bargain are not accurately defined.

The remainder of the paper is organized as follows. In the next section, we present the Vittel case study to show the nature of the pollution problem and the negotiation issues encountered. We stress some strategic points of the contractual arrangements that deserve attention, notably from a theoretical view point and the replicability perspective. Using a transaction costs framework, section 3 analyzes the key factors of the Vittel bargaining process, i.e. valuation disputes, bi-lateral monopoly and third party effects. Section 4 provides an assessment of the arrangement. Section 5 considers several theoretical insights and policy implications that can be derived from the case study. Section 6 concludes and highlights several exciting challenges for future research.

2. A case Study on the environmental-related transaction between Vittel (French Mineral Water Bottler) and farmers

2.1. A description of the negative externality addressed in the case study and the mechanism used

Established in 130 countries, Nestlé Waters[8] is the world leader in bottled water[9]. The bottler includes several famous brands such as Vittel and Perrier using one or a small number of very specific and geographically delineated springs. The negative externality addressed in the Vittel case is the deterioration of the water quality caused by intensive farming practices. These upstream farmers (about 40 farmers for 3 500 ha) are mainly milk and cereals producers. The dairy production is based on corn, which is considered as an important factor of nitrates increase (Deffontaines and Brossier; Perrot-Maître and Davis, 2001). The percolation of nitrogen runoff and intensive pesticides use affect the quality of the bottled water. Early, Vittel bought several fields (about 1500 ha), i.e. acquired property and tenant rights close to its springs at attractive prices (Chia and Raulet, 1994; Brossier and Gafsi, 1997) and became the owner of 45% of the sensitive area shaping the water quality.

[8] Nestlé Waters was previously known as Perrier-Vittel, which was itself known before as the Société générale des eaux minérales de Vittel.

[9] Vittel is one of the world's top ten best-selling brands and contributes highly to the reputation and financial results of Nestlé Waters. Key data of Nestlé Waters in 2003 includes: Sales: € 5.3 billion; Market share in value (estimated): 17%. (Source: Nestlé Waters: http://www.nestle-waters.com/fr/)

The mechanism used to address this negative externality is a direct negotiation between the pollutee and polluters[10]. The reported alternative of moving to new springs was not accurate because Vittel would lose the reputation gained from the asset tied to a specific and famous location[11]. According to Perrot-Maître and Davis, Vittel 'has come to realize that protection of water sources is more cost effective than building filtration plants or moving continuously to new sources.' This solution was feasible because the involved parties were well-identified, not too numerous and the definition of accurate property rights possible at a reasonable cost. The contracts allow (1) the definition of property rights on production choice and agricultural practices, and, (2) the transfer of property rights from the formal owners or users of the fields, i.e. the farmers to the industrial company, Vittel. Formally, the contractual arrangement is almost a purely private agreement to internalize some negative externalities of intensive agriculture. In other words, farmers agreed to switch to less intensive dairy farming and pasture management. The property rights transfer lasts for a limited period[12] and farmers are rewarded by several ways such as income support, equipment subsidies, and free technical assistance. The payment is not based on the improvement of water quality but rather compensates farmer for the risk and reduced profitability associated with the change to a new agricultural system (Perrot-Maître and Davis). From the Vittel point of view, this arrangement can be considered as more cost-effective and sustainable than a permanent compensation. The expected effect is to 'lock' farmers in the required changes, making a flashback to previous polluting practices, unlikely to occur. Note that the fields previously acquired have been used as powerful incentives to encourage farmers to accept the contractual arrangement by making these fields available for farmers under contracts. A sample of surveyed farms shows they have increased their average usable agricultural surface by 34% (Gafsi). These fields are exploited by farmers under contract, but remain under the control of Vittel (Gafsi). Despite the initial reluctance of some farmers, the number of farmers under contract has grown and reached a rate of 92% of targeted farmers (Barbier, 1997; Gafsi).

Between the initial question raised to the INRA team in June 1987 and the signature of the first individual contracts with farmers at the end of 1992, the period lasts about 4-5 years (INRA). The main quoted reason to explain the non-commitment of some farmers (3/36) is (1) their strong political commitment, notably in farmers unions, to champion their vision of a modern agriculture and (2) the financial situation of some reluctant farmers (very high sunk costs invested in intensive farming) making the obligations of the contract unachievable. Moreover, note that some farmers have left the area since the first negotiations, reducing the total number of target farmers from 40 to 36.

Notice that Vittel could not buy all lands and end farming in the critical region. Indeed, the purchase of lands was very difficult because of the strong opposition of certain farmers and agricultural organizations. Most of the purchased lands (45% of the area) come from farmers leaving the area or retiring. Vittel seems to have benefited from a '*special right'* or arrangement with the SAFER (the French Public Organization in charge of agricultural land transactions) to buy *in priority* all available lands in the defined area. This very particular arrangement, somewhat obscure, cannot be applied to all the lands because of the existing laws that restrain transactions on agricultural lands. Moreover, such an attempt would led them to a 'jacquerie' (Barbier, 2004). One of the goals of these laws is to prevent the purchase of agricultural lands for non-agricultural uses. Moreover, even if it was possible to buy all the lands, Vittel does not have competences to manage the whole area and was not interested in making that. The purchase of some lands and their use in the bargaining process was very powerful to convince some more reluctant farmers. For some farmers, the lands previously purchased by Vittel and supplied after at very attractive conditions have enabled them to considerably increase the size of their

[10] Vittel attempted in 1988 to propose 'ready to use' solutions, elaborated by the French Committee for the Reduction of Water Pollution by Nitrates (CORPEN). This solution was to transform all the fields of the perimeter to grasslands. Vittel could buy all the fields and re-allocate them to farmers. The success of such a strategy was limited because farmers were rejecting this solution as not well adapted to their production system. Because of a high level of refusals, Vittel redefined its strategy with the help of the research team (Gafsi, 1999).

[11] Note that in France mineral natural water must come from the same springs, while natural spring water can come from different springs, regardless of their respective locations.

[12] The duration of contracts is from 18 to 30 years.

farms. Lastly, the main obligations under the individual private contracts are very easy to monitor and enforce, making the enforcement costs of the arrangement relatively low (Chia, 2004).

In addition, there were problems of agreeing on valuation of the impact on the farms. For farm property, the prices proposed by Vittel were very attractive and above the usual expected price for agricultural lands in the small region. The research team played a strong role by studying deeply the farms to simulate several scenarios corresponding to the 'revenue loss' that can be imputed to the required changes (INRA). The impact on Vittel of a nitrate increase was likely to be very high. Indeed, in France and other European countries, one of the most powerful arguments of natural mineral water is their preservation from any pollution. Indeed, there are strong concerns about water quality for drinking and many consumers substitute plain water by bottled water. Note that some rivals (Wattwiller, Vernet) label their bottled waters as 'nitrates free' or 'zero nitrates'[13]. Moreover, recognizing pollution by farmers may make the bottler losing the legal right to market his waters as 'natural mineral' ones[14]. For Vittel, a nitrates contamination constitutes mainly a huge risk of losses, image deterioration and so on. According to Barbier (2004), the only solution was private bargaining. Doing nothing was perceived as a very risky behavior. In 1989, the whole turnover of agricultural activities in the targeted area was less than 2% of the turnover of Vittel, which is also a major employer in the area (1300 salaries) (INRA, 1997, p. 11). In addition, there were bi-lateral monopoly conflicts. Indeed, some farmers reacted opportunistically, trying to make their commitment more valuable (and more costly for Vittel). Some farmers had interest in overbidding. We will explore these questions more deeply to highlight their opportunistic behavior, such as delaying their adhesion or using strategically their individual location in the bargaining process.

2.2. Identification and examination of the institutional setting that prevails

In the following, we highlight the situations where governmental intervention has facilitated the development of the type of provision being described. A close examination of the situation shows that the problem cannot be solved by enforcement of existing laws and regulations, such as the Water Act of 1964 (INRA). Consequently, private agreements between the two parties appear as the most cost-effective solution. Formally, the contracts are traditional contracts between Vittel and farmers defining the use of some rights. No formal or direct governmental intervention was necessary to define, implement or enforce these private agreements. The only indirect and significant governmental intervention was the strong implication of an interdisciplinary research team including scientists from several public research agencies. This research team played a strong role in defining precisely the rights which have to be included in the contracts to achieve the desired performance in terms of water quality. Moreover, the research team played a role of mediation and mutual comprehension between *a priori* divergent and dissymmetric interests of the two parties, i.e. an important industrial company trying to improve its water quality and farmers aware of public concerns but fearing the change of their production systems. Of course, the public authorities played a fundamental role in providing a credible legal system to assure the enforceability of contracts and granting some limited financial aid (Perrot-Maître and Davis). The implication of the State was important for several reasons. First, the research team was interested in having a 'real laboratory' to test and apply an interdisciplinary approach. Second, some public actors were interested in designing a methodology that can be applied to other areas experiencing similar problems (INRA). By participating in the arrangement design, public actors remain key players. Third, the quality of Vittel waters has some public properties (employment in Vittel but also in many related activities such as thermalism and tourism, region reputation and so on). Note also that the research team was more credible because it does not have financial interests in the arrangement. Lastly, there is a strong political willingness to make the project succeed.

[13] LSA, 1998, De grands troubles dans l'eau, n° 1566, 59-69.
[14] In France, Vittel water is 50 % more expensive than the Aquarel water (i.e. the generic spring water of Nestlé that comes from different springs).

The research team has played a strong role in determining the base on which Vittel will negotiate with individual farmers the terms of each contract, especially for the level of compensation based on adjustment costs. Vittel do not have competences in agriculture and do not know what changes are necessary to reach its nitrate rates objective. Note that farmers were also not competent to determine what changes must be achieved. Each party experiences a lack of reciprocal knowledge and trust. The competence of the research team and their mediatory role were essential to reach an agreement on these technical and economic questions. Moreover, the perception of the research team by farmers was better than the perception of Vittel Company, which was perceived as an industrial giant willing to end farming in the sensitive area.

2.3. Organizational arrangement

The organizational arrangement is a private contractual one. The research team helped to define the specifications and clauses of the contracts and the obligations of each party. To contract with targeted farmers, Vittel negotiated with each of them and proposed individual incentives and compensations. The incentives provided by Vittel to encourage farmers' acceptance were variable among farmers according to their individual situations. For example, the geographic proximity with Vittel springs was a strategic variable in the bargaining phase. The main (and average) obligations of the farmers and Vittel are described in Table 1.

Table 1: Main obligations of farmers and Vittel

Farmers	Vittel
Eliminate corn crop	€ 230 per ha and per year during 7 years
Ban pesticides	Equipment investment of about 150 000 euros per farm (haymaking materials, barn drying, buildings, etc.)
Compost all animal waste	
Nitrogen fertilization by composted manure (an additional nitrogen contribution less than 30 units per ha is tolerated)	Free supplying of manure treatments and use (composting, spreading, etc.)
Limit one livestock unit per ha of grazing area and balance livestock feed	Free technical assistance
Ensure farm buildings are up to Agrivair standards, exceeding legal obligations	Free usufruct of the previously bought fields and the quotas associated (about 25% more)

Notes:
1. Farmers have substituted corn by Lucerne and lost the Common Agricultural Policy (CAP) aid attributed to this crop.
2. The services supplied by Agrivair represent 23% of the overall seasonal works for each farm (Gafsi).

Main Sources: Gafsi.

As mentioned above, the payment is not indexed on the improvement of water quality, but based on the switching costs and compensations resulting from the adoption of a less intensive farming system. First, there are significant measurement difficulties. Indeed, 'nitrates and pesticides take several years to reach the groundwater' (French Environment Ministry quoted by LSA). To assess the impact of the changes in practices on the nitrates rate, an important delay is necessary. Moreover, it is frequently difficult to impute the individual responsibility to each farmer and consequently to pay them according to this measure. Many other natural factors (rain, soil and so on) can hedge the degree of pollution (LSA). As mentioned before, reducing or maintaining a low nitrate rate was not really a gain for Vittel, but rather, avoiding a huge loss. Second, farmers who own the rights of using their lands as they want will not engage in any bargaining if they do not have the guarantee that their adjustment costs (their revenue loss) will be clearly taken into account. Adjustment costs seem to constitute a kind of 'best available proxy' to economize on measurement and bargaining costs. To ensure its obligations and prove its sustainable implication in the radical change, Vittel has created an agricultural advisory firm, Agrivair. The mission of this firm is to advise, accompany, monitor and enforce contracts with farmers (Gafsi).

In terms of performances, the records show that the overall nitrates rate in groundwater has decreased. Fifty per cent of monitored springs experienced a decrease of the nitrates rate and the other 50% have a constant nitrates rate (Gafsi).

2.4. Other measures that have facilitated the transaction

As briefly mentioned before, the strong involvement of INRA and other researchers has facilitated the design and implementation of the project. The financial participation of the French Water Agency in the research program was also significant (INRA). Whilst the desired outcome by Vittel was clear, the ways to achieve it needed to be defined. The interdisciplinary research team played an important role in building bridges between the end result expected by Vittel and the farmers' management practices. More than 'ready to use' solutions, the research team, with the assistance of the farmers, progressively elaborated technical and economically feasible solutions compatible with farmers' strategies. This collaborative process contributed to increase farmers' acceptance because the clause of the proposed contracts was co-built and integrated farmers' concerns (INRA; Gafsi). During the process of applied research, an extension specialist was recruited to ensure constant communication between farmers, Vittel and the research team (Gafsi). It should be noted that the person in charge of Agrivair was the same agricultural extension specialist previously recruited by the research team (Deffontaines and Brossier; Chia and Raulet). Agrivair has recently introduced new technologies such as information geographic system to manage sewage spreads, which can increase the quality of its services. Several clauses of the contracts relate to the prevention of fraud, such as free access to accounting documents and visual inspection of farms. According to Chia (2004), 'visual inspection is sufficient and very easy for anyone well experimented in agriculture.' An interesting feature of the enforcement is the use of scientific research procedures that have been adapted for other purposes than their initial use (Chia and Raulet). Finally, several farmers of the Vittel perimeter have switched to organic production, allowing a better valorization of their agricultural products (Reibel, 1999).

2.5. Costs and difficulties encountered in getting the mechanism to work

Vittel has incurred different costs in getting the mechanism to work. We distinguish three kinds of costs: (1) the design costs including the contract with the INRA and other costs for defining the accurate area to buy or put under contract, the property rights to contract, the terms of contracts with farmers, (2) implementation costs notably including buying fields and investments in individual farms under contract, the costs associated with creating and running Agrivair, and, (3) enforcement costs such as the economic compensations negotiated with farmers for changes in farming methods and the costs of accompanying and monitoring farmers.

Although Vittel is a major employer in the small region, it had little knowledge of the farmers' realities and reasoning (Barbier). For example, the regulatory context was perceived differently by Vittel and farmers. Indeed, farmers were arguing that potable water requires 50 mg nitrates per liter, which was achieved, but mineral water must satisfy a 15 mg per liter threshold. Moreover, another important difficulty of the project was the negative reaction of the local agricultural bodies, such as the Chamber of Agriculture, which felt threatened by an intrusion of researchers in their field of competences. This tension between traditional extension services and the research team put farmers in an uncomfortable position (Barbier; Chia and Raulet). Some farmers have been reluctant to accept the proposed contracts, e.g. because of union activism.

For farmers, this radical change corresponds to the learning of a double competency, i.e. low input agriculture and water protection. Moreover, the farmers under contract suffered from media pressures and jealousy, notably from other farmers not included in the Vittel perimeter. Conflictual relations

occurred at times between Agrivair[15] and farmers (Reibel). A potential obstacle to the transposition of such a model relates to the technical and financial dependence of farms with regard to the other party involved in the contract (Brossier and Gafsi). The results in terms of nitrates decrease are not immediate. Moreover, the process takes over time and is very progressive to allow the farmers' learning of new practices and contractual relationships with Vittel.

3. Institutional arrangements and Transaction costs: Valuation Disputes, Bi-lateral Monopoly, and Third-Party Effects

According to the line of reasoning of Coase, we first identify the 'richness of the social alternatives' between which Vittel can choose. Several factors stressed by Libecap (1989) – the great size of the anticipated aggregate benefits, the small number of implied farmers, their relative homogeneity and the relative balanced repartition of wealth under the considered property rights allocation – show that an institutional re-arrangement was very likely to occur. At first glance, five alternatives were at least considered by Vittel:

- (1) Vittel relocates its activity by choosing new and non-contaminated springs,
- (2) Vittel buys all the lands around the site,
- (3) Vittel does nothing,
- (4) Vittel constrains farmers to change their practices by taking legal action,
- (5) Vittel achieves a contractual arrangement with farmers.

A closer analysis of the situation shows that the first four alternatives were prohibitively costly, making Vittel 'prisoner' to the last solution. Indeed, relocation would cause Vittel to lose the worthy reputation asset tied with the location at Vittel and the right to label its water as a 'mineral water' (Barbier, 2004). Because of the reluctance of several farmers and regulatory barriers aiming at preserving lands for agricultural activities, Vittel could not buy all the lands around its springs. Such integration would have allowed Vittel to acquire at the same time the environmental property rights bundled with the land use. As developed below, the Vittel attempt to buy surrounded fields succeeded somewhat, but at a small scale. The third alternative was also not suitable because the potential loss from doing nothing could be huge. Indeed, the market of bottled water is very sensitive to water quality. Moreover, the main element, the nitrates rate is frequently discussed in popular press to denounce the quality of drinking water and constitutes in some cases, the most significant motive to switch to bottled water. Any presumption or doubt about the bottled water quality can make consumers switching to a rival product. An increase in the nitrates rate could make Vittel lose the health virtues tied to its reputation. In some European countries, such increase may prevent Vittel from marketing its water because of stricter regulatory thresholds. The fourth alternative was explored, but the liability of farmers seemed somewhat unfunded and even if it was, it could not be imposed and enforced without publicizing the Vittel problem. Such publicity was likely to generate negative spillovers on the image of Vittel with huge consequence on sales (Barbier, 2004; INRA). The fourth alternative could be usefully considered as an application of the theoretical development of Jung et al. (1995). Indeed, the authors show that in certain plausible circumstances, agents may attempt to rent-seek over the initial rights distribution instead of accepting passively a property rights assignment and then bargain. Therefore, only the fifth solution remained, which was considered as the solution with the lowest overall costs.

[15] Agrivair's activities now extend beyond this single farming issue. Agrivair is actively involved in managing forests as well as green parks and golf around the Vittel and Contrex springs.

Let us now consider precisely what transaction costs are implied by this contractual arrangement and their determinants. According to Coase 'in order to carry out a market transaction, it is necessary to discover who it is that one wishes to deal with, to inform people that one wishes to deal and on what terms, to conduct negotiations leading up to a bargain, to draw up the contract, to undertake the inspection needed to make sure that the terms of the contract are being observed, and so on'. Operational definitions of transaction costs usually refer to the phases of an exchange transaction (Dahlman 1979; Barzel, 1985; Williamson 1975; Furubotn and Ritcher, 2000). The notion of transaction costs used here includes the costs of discovering, negotiating, and completing the exchange of an asset, in this case, environmental rights tied to lands. Broadly speaking, exchange requires identifying the relevant parties; communicating information about the asset to be traded and terms of trade (offer and ask prices); inspection, verification, and measurement of the asset; negotiation to reach a sale price over mutually-accepted asset attributes and property rights; and finally, contract drafting and enforcement. The transaction costs literature emphasizes that each of these activities can be complex, affecting the timing, extent, and nature of trade (Libecap, 2004).

The data related to the Vittel case underscores the potential complexity involved in transactions, especially with respect to search, measurement, and negotiation. Two key points are useful for understanding subsequent bargaining disputes. (1) One is related to the precise definition of the asset upon which to contract. The water quality problem encountered by Vittel resulted from agricultural practices in a given area. The right to choose among a set of practices, that can be described as a continuum from harmless practices to very polluting ones (from the Vittel viewpoint) is bundled with the lands. This right is consequently owned by the land user, i.e. the farmer. Once the adequate area (including some farmers and excluding others) and practices are defined, the losses generated by the proposed changes have to be evaluated. (2) In terms of the second problem, the valuation of particular losses was a continuing and significant source of contention because the value agreed for a particular compensation determined the owners' share of the aggregate rents from the transaction for environmental rights of the Vittel area. Farms were somewhat heterogeneous with respect to their location, production process and economic performances. Consequently the valuation of practices changes was a particularly contentious issue for farms with the most strategic location. By 'strategic location', we mean that the farmer has fields located in an area playing a strong role in shaping the quality of the water collected by Vittel.

The subsequent quality of the groundwater was bundled with the land. Accordingly, Vittel succeeded in acquiring several fields around its springs, corresponding *grosso modo* to 45 % of the targeted area. Vittel bought available fields in the agricultural land market managed by the SAFER. Vittel benefited from a non-official, but effective 'preemption right' to buy available fields, coming mainly from retiring farmers. At this time, the pressures from other stakeholders remain relatively limited. Nevertheless, these purchases were not enough to improve the water quality. Indeed, the impacts subsequent to the partial integration of some fields are ineffective unless the majority of concerned farmers become participants (Schmidtz, 1991)[16]. Consequently, Vittel had to make farmers change their practices in order to preserve its springs from contamination. In bargaining between farmers and Vittel between 1989 and 1999 there were three general classes of problems that impeded agreement, although they overlapped: valuation disputes, bi-lateral monopoly conflicts, and third-party effects.

[16] The improvement of water quality requires that Vittel have the environmental rights over the most part of the concerned lands. If the quantity of purchased lands plus the quantity of lands under contract are insufficient, the water quality will not be noticeably improved and Vittel may consider that he squandered his resources.

3.1. Valuation Disputes

There were two conflicts in determining compensations for the changes required by Vittel. One was the basis for general valuation of required changes -whether these changes should be valued as the sum of a loss in terms of reduced agricultural output and investments to apply new practices or as an input to the value increase of Vittel water, i.e. the opportunity cost of farmers versus the opportunity cost of Vittel if it does nothing. This was principally a negotiation issue. The second was the determination of the value of any particular changes when farms were somewhat heterogeneous. This was both a measurement and a negotiation issue.

In terms of the first problem, Vittel wanted to use the loss and investments subsequent to the required changes, i.e. adjustment costs in determining the compensations it offered farmers, whereas farmers wanted to use the opportunity cost of Vittel in order to get much more. In terms of the second problem, the valuation of changes in a particular farm was a continuing and important source of contention because the value agreed determined the owners 'share' of the aggregate rents from the transaction. These farmers typically held out for higher compensations.

In negotiations, each farm owner had the most complete information about the agricultural potential of his farm and the impacts of changes, but at the same time, had incentive to exaggerate their values. Accordingly, to reduce disputes with farmers and get an objective basis for individual negotiations, Vittel relied heavily upon the research team which seemed credible and acceptable to both parties. These researchers executed several simulations in order to estimate the loss and investments required to adopt the changes prescribed by the so-called Vittel contract.

During the valuation process, researchers would collect information[17] about each farm —location, technical data, economic and financial results, etc. Nevertheless, some farmers challenged the researchers estimated values. Challenges were based on disputes both regarding the relevant comparison basis, as well as assessment of individual farm characteristics. The disparities between the bid and ask prices due to measurement disputes could sometimes be very large. Agreement on changes valuation was also complicated by a lack of trust on both sides. Vittel viewed some farmers as making exorbitant compensation demands. Farmers, by contrast, viewed Vittel as attempting to undervalue the changes while the benefits for Vittel were huge in comparison. This limited trust meant that neither party held the other's pricing claims as credible or honest. This condition increased the transaction costs of negotiation and lengthened the time necessary for agreement. Because of status, previous relationships and social proximity between farmers and research teams, the research intervention – or 'instrumentalization' by Vittel according to some people – was likely to play a positive counter effect by economizing on transaction costs (Glaeser et al., 2000).

3.2. Bi-lateral Monopoly Disputes

Disputes over valuation of critical changes took place within a bi-lateral monopoly context, and this condition increased the costs of negotiation apart from measurement issues. Vittel was the only 'purchaser' of environmental rights tied to land use in the Vittel area. The reputation asset and the plant located at Vittel were a large fixed, hardly redeployable investment. Their values and future profit flows depended upon the changes in farms. While Vittel could negotiate with each farmer in the targeted area, it could not walk away from the Vittel area as a whole. Each farmer located in the strategic area has also a kind of monopoly power to contract with Vittel, because lands they hold are not substitutable with other similar lands.

Bi-lateral monopolies have indeterminate pricing outcomes because they depend upon the relative bargaining power of the parties. Each party has incentive to misrepresent its position in order to extract a greater share of the gains of trade in such negotiations, and there is little competitive pressure

[17] A major part of this information remains confidential.

to force more accurate information revelation. Accordingly, negotiations often break down and take a long time to complete (Williamson, 1975, 238-47). This was especially the case with farmers owning fields essential for the overall effectiveness of the Vittel arrangement.

3.3. Third-Party Effects

In the case of Vittel, the situation was somewhat surprising and unusual because the pollutee was a big industrial and the polluters, a group of small farms. On the one hand, there were complaints that the Vittel action was disturbing the local agricultural economy and damaging property values within the small region. The magnitudes of the effects were disputed by Vittel and farmers. Tensions and jealousy between farmers located within the critical area and the other ones located outside, and consequently excluded from the negotiations, were sometimes very high. The concerns raised in the farming community –especially on farmers unions and other agricultural organizations – about the impact of changes in farming were also significant, because the dominant, industrial agriculture model was substituted with a new and 'quasi-organic' production process. The limited number of concerned farmers may have mitigated the negative third-party effects, making them quite small. The farmers involved in the Vittel arrangement were also over-publicized, making them very reluctant to further solicitations. On the other hand, because Vittel was a major employer and the water reputation was the determinant of many other activities, e.g. tourism, thermalism, the efforts required by Vittel from farmers were perceived as legitimate and necessary. For example, according to several participants of the research team, because each farmer has a member of his family working to Vittel, they are under pressure to find an arrangement to not threat such jobs. Lastly, there was a strong political support to make the experience successful and at a certain extent, regardless of the overall costs (Barbier, 2004).

4. Assessment of the arrangement

Vittel spent more than € 24,000,000[18] for 3500 ha over seven years and successfully converted the farming practices of most concerned farmers (INRA, 1997, p. 69). While the contracting may seem very costly, the evidence suggests that the arrangement was profitable for both parties and likely to be applied elsewhere. The high transaction costs threatening to derail a Coasean bargain were overcome, notably by indirect public intervention, through research team and other informal arrangement; the main roles devoted to the public authorities in a Coasean solution including notably the definition and enforcement of property rights were evident in the Vittel success (Van Zandt, 1993).

As expected, the approach has been applied to other purchased companies, i.e. Contrexeville and Perrier. The application of the same approach to the Contrexeville springs was more directly related because of its geographic proximity. 'The Perrier springs are located in southern France in an area of vineyards and intensive wheat cultivation where phosphates and herbicides are the main sources of water pollution. Perrier successfully introduced organic agriculture to 20 farms that cultivate approximately 350 hectares of cereals and 200 ha of vineyards and regularly monitors over 900 ha of land. The highly favorable market conditions for organic products made significant contributions to the rapid adoption of improved farming practices around the Perrier springs. Other French bottlers — Evian and Volvic — have considered using Vittel's experience as a model' (Perrot-Maître and Davis). The tools and approach developed by the research team have also been applied to other cases of water contamination by farming practices, e.g. in the Migennois and Plateau Lorrain (INRA)[19].

[18] This corresponds to an average of € 980 per ha and per year, including initial investments. Note that in comparison with subsidies from the Common Agricultural Policy (CAP), € 300 per ha and per year, the contractual arrangement was very attractive for farmers.

[19] A similar example can be found in the contractual arrangement between the city of Munich (Germany) and farmers in the Mangfall valley to maintain the city's high drinking water standards. Farmers have been encouraged to adopt organic agriculture and received, as an incentive, about € 275 per hectare and per year, and technical assistance (Heid, 1997).

Several other issues can affect the potential for transferability (Perrot-Maître and Davis):

Scale: The Vittel model may be difficult to use in larger geographic areas or in an area with a greater number of farmers. As noted elsewhere (Libecap; Ostrom, 1990), the greater the number of parties is, the higher the transaction costs associated with designing, implementing and enforcing an agreement are. If the transaction costs overcome a certain level, they can make other alternatives more cost-effective.

Timing: If quality drinking water was needed immediately, the approach adopted by Vittel may be too slow to achieve such a performance, making filtration plants unavoidable with the risk of losing the mineral water label. The timing includes the time needed to design solutions, solve valuation disputes and the lag between adoption and performances change. For example, between February 1993 and February 1996, the proportion of farmers under contract evolved from 3% to 65% and to 92% in 1998 (Barbier; Gafsi). Such a dimension stresses the need to consider pollution problems at early stages rather than when pollution thresholds are exceeded.

Private sector profitability: Given the high level of investment required, imitating the Vittel approach seems limited to highly profitable industries (Gafsi). The purchase of property rights (land acquisition, practices changes) was possible because the value of the water quality was significantly higher for the bottler than the loss incurred by farmers. The opportunity cost of farmers to accept the contract was lower than the opportunity cost of the bottler. The creation of Agrivair was essential because it was perceived by farmers as a signal that Vittel was really investing for agriculture and that farming changes would really benefit from a long term support (Barbier). Despite the significant cost of the Vittel approach, it can be considered as a reasonable alternative by taking into account the unlikelihood of the other alternatives discussed in section 3. In addition, the switch of several farmers to organic production may have contributed to making the new system more sustainable and profitable.

Strong involvement of public research teams: The multidisciplinary research and extension team played an essential role in the success of the operation. 'The research program was finalized in 1996. Seven years of research enabled a preliminary conclusion to be drawn regarding three main aspects. Firstly, the objective regarding sustainable development on the Vittel plateau was achieved. The agrarian system used on the Vittel site has clearly made progress in terms of reducing nitrates levels in the water sources and in terms of farmers' incomes. Secondly, knowledge has been produced over a wider spectrum, such as in technical and socio-economic fields. The apparent high cost of the operation does not make this experience prohibitive. And, when drinking water becomes scarce, financial backing could easily be found. The third aspect concerns the positioning of the research team faced with a complex question: the research team – placed in a highly uncertain context having accepted the challenge of a complex question – formulated, set up and implemented a wide range of technical and social tools which brought the various actors together on several levels. This is a good example of negotiated management' (Brossier and Gafsi, 2000).

In conclusion, this rearrangement of rights, based on individual contracts, constitutes a private solution for externality problems where clear property rights and easy identification of stakeholders played a key role. The applied principle was not 'the polluter pays', but the counterintuitive 'pollutee pays'. This arrangement constitutes an original application of Coase's recommendations in a real world context with high transaction costs. Several lessons can be drawn from this case study that can be useful, especially for other applications by carefully taking into account other institutional environments.

5. Theoretical insights and policy considerations

The Vittel case study points several challenging issues for researchers and policymakers. Without purporting to be exhaustive, let us consider some of them.

First, a clear definition and non-contestable allocation of property rights may economize on transaction costs. In the Vittel case, the intervention of public authorities, notably through research teams, to delineate property rights played a strong role in the success of the private arrangement. The accurate identification of a subset of sufficient property rights tied with land property – i.e. farming practices over a well-defined area – allowed agents to engage in a coasean bargaining process. Research teams also contributed to the identification of key technological variables that play a role in the level of water nitrate rate and proxies used to monitor them (Barzel, 1982)[20]. Let us stress again the strong uncertainties faced by Vittel about the technical path that the farmers ought to follow in order to reduce their harmful effects. Indeed, the causalities between the modification of farming practices and the results in terms of nitrate rate reduction were not well established before the intervention of the research teams. Indeed, the relation between the two variables is complex and non-linear and results are observable at middle or long-term horizons.

Therefore, in the case of externalities, a major role of the state is to provide the basis –i.e. defining and assigning property rights – for a bargaining solution. This investment including learning costs, skills, savoir-faire, can be very costly and can prevent private stakeholders from bargaining. If this investment can be redeployed to other situations, the initial costs appear as less dissuasive and likely to generate economies of scale. In general, public authorities or multinationals because of their operations scale are more likely to benefit from such economies of scale. The more the arrangement is likely to be applied elsewhere, the more the initial high costs are likely to be overcome. Consequently, the intervention costs have to be considered by taking into account the potential redeployability of the outcomes. Closely related to this, in order to ensure the redeployability, intellectual property rights on the arrangement have to be carefully managed.

Second, the status of the intervening party, e.g. public research teams, may play a strong role in generating trust and consequently reducing transaction costs of reaching an agreement (Glaeser et al.). While technical skills may constitute a core 'input' to find 'technical solutions' to the problem, the status of the chosen intermediate party has to be carefully considered, if this is to decrease transaction costs. At first glance, we may consider that minimal technical abilities are necessary, but not sufficient. Technical abilities are likely to generate *technical trust*, trust in the competences, but not *ethical trust*, in the sense that implied parties trust the ethical values of the facilitator.

Third, the co-construction of the contractual arrangement is likely to reduce barriers and to induce a greater formal acceptability. In the Vittel case, several points of the contractual arrangement were designed in close collaboration with farmers (Deffontaines and Brossier). Unlike 'external or imposed institutions' where rules are defined independently of agents and where they have only a 'binary choice' to follow them or not, the co-construction increases the overall effectiveness by mitigating several potential barriers. Agents are not 'rules takers' but 'rules makers' and their early and voluntary participation would increase formal acceptance. Such a co-construction shares several similar features with 'internal or induced institutions' and their articulation with legal rules or regulator power (Dulbecco, 2003).

Fourth, there can be a degree of substituability between the different categories of transaction costs that arise at different times of the transaction. Indeed, Williamson (1985) emphasizes the distinction between *ex ante* and *ex post* transaction costs whereas Dahlman distinguishes different types of transaction costs according to the stage of the transaction. This substituability is analogous to the substituability between inputs in production functions. Measuring the degree of substitutability

[20] Note that efficient measurement would be undertaken by the party who has easy access to information and lower costs of measurement, provided that incentives to cheat are curbed and trust is established. 'The survival hypothesis also suggests that, other things being equal, quality must be measured at points in the process of production, exchange and consumption where it can be done with the least expenditure of resources' (Eggertsson, 1999, p. 201).

between any pair of categories of transaction costs can be done similarly to the estimation of the elasticity of substitution. More formally, the elasticity of substitution measures the percentage change in transaction costs proportions due to a change in marginal rate of 'technical' substitution. Substitution effects can allow minimizing overall transaction costs in order to achieve a specific transaction. Because of asymmetric information and unequal allocation of power, some parties may have a vested interest in making other parties support their transaction costs, exploiting the substituability described above, in order to minimize their own transaction costs, regardless of whether or not this results in overall minimization of overall transaction costs. Such 'substitution effects' between categories of transactions have to be taken into account in order to minimize the overall transaction costs.

Fifth, the higher the expected rent from a rearrangement of property rights, the more likely the rearrangement. In the Vittel case, the opportunity cost of Vittel doing nothing was huge, especially compared with the opportunity cost of farmers changing practices. Such a situation makes the rearrangement very likely. The switching costs to move to more environmentally friendly farming practices were not well estimated. Consequently, Vittel had to give up a part of the informational rent, growing the gains of the farmers. Farmers may tend to adopt an opportunistic behavior, increasing the monitoring costs of Vittel. The strategy adopted by Vittel seems able to generate a kind of self 'lock-in' of farmers to the environmentally friendly changes. Rather than permanent funding for the quasi-integration of the relevant subset of rights, Vittel causes the changes and finances them, but once these changes are achieved, they are supposed to be self-enforcing through being self-financing. Indeed, farmers are supposed to acquire specific knowledge and abilities about environmentally friendly farming and price premiums for environmentally differentiated products, such as organic products. Once this is done, it is expected that the opportunity costs –including notably switching costs – will be sufficiently high, making the return to the traditional polluting process not profitable. So, coasean solutions are more likely to occur if the expected gains from the rearrangement of property rights are high, even in the presence of high transaction costs.

Sixth, the in-depth study of the Vittel case suggests that the Williamson's analysis of governance structures could be usefully applied to environmental-related transactions. Although such an issue is out of the scope of this paper, we may consider several promising points. Formally, a subset of the property rights shaping the nitrates rate in groundwater belongs to the French public authorities. These property rights are defined and delineated by the regulatory threshold ('command and control' performance standards) on nitrate rate. The governance structure has a quasi-hierarchical form (Richards, 2000) but the enforcement appears very difficult and costly mainly because of measurement problems. In order to secure the nitrate rate at a level stricter than the regulatory threshold, an additional governance structure is necessary. As suggested by neo-institutionalists (Coase; Demsetz, 1969; Williamson, 1996) agents implied in the environmental-related transaction have explored and attempted several alternatives before selecting the contractual arrangement that appeared as the most efficient at the decision time. Because the property rights shaping the water quality were tied to the land, Vittel established long term contracts with farmers to 'quasi-integrate' such rights, to exercise a kind of hierarchical discretion on the use of these rights. Indeed, Vittel was the one who valued these rights the most, compared to the farmers who held the second highest values, making the bargaining solution potentially profitable for the both transacting parties. The Vittel situation, presents a high degree of asset specificity and bilateral dependency notably because of reputation and the label 'natural mineral water', both being tied to the location. Such bilateral dependency makes each party very vulnerable to opportunistic behavior by the other transacting party.

The identification of the relevant subset of property rights on which to contract shows that precise definition of rights can avoid too much integration in favor of a more efficient solution where only some property rights (as indicated in the contracts between Vittel and farmers) are transacted. Moreover, other barriers were preventing a full integration of all lands around the Vittel springs. Note that Vittel attempted a full integration but faced strong opposition of several targeted farmers who were very tied to their lands and jobs. Nevertheless, a significant fraction of sensitive lands were purchased by Vittel and re-used to get a higher level of adhesion from resistant farmers. So, the

definition of rights on which to contract was a socially more acceptable solution rather than a whole land acquisition (INRA). Thus, high specific assets do not automatically lead to full integration of the other transacting party, but may be mediated through long term contracts that allow the quasi-integration of the relevant subset of rights.

The Vittel strategy to minimize organization costs –costs of setting up and running the hybrid organization – needs to be explained. A large part of the cost was indirectly incurred by the public authorities through the research teams and the so-called 'Agence de l'Eau Rhin Meuse'. Vittel has benefited from the pre-existing non-adversarial and non-lucrative relationship of researchers with farmers and has consequently economized on a kind of 'learning costs'. Moreover, as mentioned before, an extension specialist was employed by the research team to manage the relations between farmers and the research teams. This specialist has acquired very specific competencies, such as precise knowledge of local farms and proxies used by the research teams and so on. These core competencies were redeployed at relatively low cost to the Agrivair structure. Interestingly, this person became the director of Agrivair at the end of his collaboration with the research teams. Agrivair may be considered as a micro-institution that improves the enforceability and enforcement of arrangements (Ménard 2003, Ménard and Shirley, 2002). Such micro-institutions may explain why similar arrangements in similar institutional contexts perform differently.

Seventh, the financial compensation paid by Vittel and the other expenditures implied in this contractual arrangement may be used to estimate the value of an environmental (and health-related) good, e.g. the decrease of the quantity of nitrates per liter. The case study may provide raw data to apply the averting behavior methods. The rationale of such a method is that the cost a pollutee, incurred in order to avert the negative effects of polluted water, can be considered as an indicator of the pollutee's willingness to pay for the improvement of water quality. Such method is likely to provide an underestimated value of the asset and to allow for comparison with second most valuable possible asset use.

6. Conclusion

The in depth case study of the environment-related transaction between Vittel and farmers provides raw materials for confronting theoretical propositions and arguments with a real world situation. Several policy implications and theoretical insights have been drawn from the Vittel case, showing that the 'problem is one of choosing the appropriate social arrangement for dealing with harmful effects (…). Satisfactory views on policies can only come from a patient study of how, in practice, the market, firms and governments handle the problem of harmful effects' (Coase). The confrontation has put into relief several exciting and challenging issues. Indeed, the Vittel case shows that even in the presence of high transaction costs, a Coasean bargaining solution may be designed and implemented successfully.

The degree of subdivision of rights can improve the efficiency of transactions, because agents can contract on the necessary rights only. Consequently, they make the Coasean bargaining process more efficient. However, such precise delineation and definition is not costless and must be considered in context with the expected benefits, over a comprehensive horizon, including the possibility of other similar applications. The role played by public authorities was also decisive and obviously reduced the overall transaction costs, as well as reducing the transaction costs incurred by each party. The success and the transposition of the approach in other places must not hide the risk that public authorities may be 'instrumentalized' by private parties.

One of the most promising issues resides in the possible extension of the Williamson's framework to environmental economics; in the dimensionalization of environmental-related transactions and governance structures and in their alignment, especially in the policy instruments chosen for supporting environmental-related transactions. The contractual arrangement with an *ad hoc* structure – between a pollutee and several polluters generating non-point source pollution – provides an original experience that can be transposed and applied in similar situations.

References

Barbier, M., 1997. Quand le pollué et les pollueurs se découvrent conventionnalistes. Revue Française de Gestion 112, 100-107.

Barbier, M., 2004. Personal communications.

Barzel, Y., 1982. Measurement costs and the organization of markets. Journal of Law and Economics 25 (1), 27-48.

Barzel, Y., 1985. Transaction Costs: Are They Just Costs? Journal of Institutional and Theoretical Economics, 141 (1), 4-16.

Brossier, J., Gafsi, M., 1997. Farm management and protection of natural resources: analysis of adaptation process and dependence relationships. Agricultural Systems 55 (1), 71-97.

Brossier, J., Gafsi, M., 2000. Une gestion négociée d'un problème de pollution : pratiques agricoles et qualité de l'eau, l'exemple de Vittel. Comptes rendus de l'Académie d'Agriculture de France 86 (2), 57-72.

Chia, E., 2004. Personal communications.

Chia E., Raulet, N., 1994. Agriculture et qualité de l'eau : négociation et rôle de la recherche - Le cas du programme AGRE. Etudes et recherches Systèmes Agraires et Développement 28, 177-193

Coase, R. H., 1960. The problem of social cost. Journal of Law and Economics 3, 1-43.

Coase, R. H., 1974. The lighthouse in economics. Journal of Law and Economics 17 (2), 357-376.

Dahlman, C. J., 1979. The problem of externality. Journal of Law and Economics 22, 141-62.

Deffontaines, J. P., Brossier, J., 2000. Système agraire et qualité de l'eau. Efficacité d'un concept et construction négociée d'une recherché. Nature Science Société 8 (1), 14-25.

Demsetz, H., 1969. Information and efficiency: another viewpoint. Journal of Law and Economics 12, 1-22.

Dulbecco, P., 2003. The dynamics of institutional change and the market economy: Understanding contemporaneous market development process. Review of Austrian Economics 16(2-3), 231-251.

Eggertsson, Thráinn, 1999, Economic behavior and institutions, Cambridge Surveys of Economic Literature, Cambridge, UK.

Furubotn, Eirik G., Richter, Rudolph, 2000, Institutions and economic theory: the contribution of the new institutional economics, Ann Arbor, University of Michigan Press.

Gafsi, M., 1999. Aider les agriculteurs à modifier leurs pratiques – Eléments pour une ingénierie du changement, INRA SAD, Façsade 3, 1-4.

Glaeser, E. L., Laibson, D. I., Scheinkman, J. A., Soutter, C. L., 2000. Measuring trust. Quarterly Journal of Economics 115 (3), 811-46.

Heid, P., 1997. Organic agriculture protects drinking water around Munich, Germany. Ecology and Farming (14), 24.

INRA (National Institute for Agronomic Research), 1997. Vittel. Les Dossiers de l'environnement de l'Inra 14.

Jung, C., Krutilla, K., Viscusi, W. K. Boyd, R., 1995. The Coase theorem in a rent seeking society. International Review of Law and Economics 15, 259-268.

Libecap, Gary, 1989, Contracting for property rights, New York, Cambridge University Press.

Libecap, G., 2002. A transaction costs approach to the analysis of property rights, In: E. Brousseau and J.M. Glachant (Ed.), Economics of Contracts, Theory and Applications, Cambridge: Cambridge University Press, 140-157.

Libecap, G. D., 2004. Chinatown: transaction costs in water rights exchanges—The Owens valley transfer to Los Angeles. Working Paper, Eller College of Management.

Ménard, C., 2003. L'approche néo-institutionnelle: des concepts, une méthode, des résultats. Cahiers d'économie politique 44, L'Harmattan, 103-118.

Ménard, C., Shirley M., 2002. Reforming public utilities: lessons from urban water system in six developing countries. Mimeo. Washington, DC, World Bank.

Ostrom, Elinor, 1990, Governing the commons: The evolution of institutions for collective action, Cambridge University Press.

Perrot-Maître D., Davis P., 2001, Case studies of markets and innovative financial mechanisms for water services from forests, Forest Trends, Washington.

Richards, K. R, 2000. Framing environmental policy instrument choice. Duke Environmental Law and Policy Forum 10 (2), 221-285.

Reibel, C., 1999. Dans le périmètre de captage d'eau, 24 agriculteurs sous contrat avec Vittel. Réussir Lait Elevage 117, 80-81.

Schmidtz, David, 1991, The limits of government, Boulder, Colorado, Westview Press.

Van Zandt, D. E., 1993. The Lessons of the lighthouse: Government or private provision of goods. Journal of Legal Studies 22 (1), 47-72

Williamson, Oliver E., 1975, Markets and hierarchies: analysis and antitrust implications, New York, Free Press.

Williamson, Oliver E., 1985, The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting, The Free Press, New York.

Williamson, Oliver E., 1996, The mechanisms of governance, Oxford University Press, New York.

WORKING PAPER

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