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Bioprospection practices have proliferated as biotechnological and pharmaceutical companies engage in the collection and genetic screening of biological and genetic resources throughout the world. Under the Convention on Biological Diversity (CBD), agreed upon at the 1992 Earth Summit in Rio de Janeiro, bioprospecting is regulated through "Access and Benefit-Sharing Agreements", which are bilateral contractual arrangements between ecologically-rich states or communities and private corporations and are based on the principles of "prior informed consent" and "equitable sharing of the benefits". Numerous benefit-sharing agreements have already been signed[2] and some of them are currently under review by the CBD Secretariat in Montreal[3]. One of the oldest of these contracts is the Merck-INBio agreement in Costa Rica, signed in 1991. Under the terms of the agreement, Merck, a major US pharmaceutical firm, offered a payment to be invested in nature conservation, equipment and training. In exchange, Merck received access to a "limited number of plant, fungal and environmental samples from Costa Rica's protected areas for scientific evaluation" (Mulligan, 1999, p. 40). Merck also agreed to pay a specified royalty if any commercial products resulted from the company's bioprospection activities.

The purpose of this article is to examine the competing proposals for the institutional framing of bioprospection based on the provisions of access and benefit-sharing embodied in the Convention on Biological Diversity. This debate constitutes the foundation of an emerging regime on access and benefit-sharing that is currently under negotiation at various international fora, including the World Intellectual Property Organisation[4] (WIPO) and the United Nations Environmental Program's Secretariat of the Convention on Biological Diversity (CBD)[5]. This regime is also on the agenda of the

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[2] For an overview of most important benefit-sharing agreements, see Mulligan, 2002; Peña-Neira 2002; Svarstad and Dhillion, 2000.

[3] An overview can be found on the CBD's website at http://www.biodiv.org/programmes/socio-eco/benefit/case-studies.asp.

[4] These questions are debated in the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore of the WIPO, which first met in April 30, 2001; cf. http://www.wipo.org/fre/meetings/2001/igc.

[5] Cf. articles 15-19 of the Convention of Rio on Biological Diversity of 1992 and the Bonn Directives on Access and Benefit Sharing, adopted at the sixth conference of parties in The Hague in April 2002; http://www.biodiv.org/programmes/socio-eco/benefit/bonn.asp#.

implementation plan agreed upon in Johannesburg in September 2002[6]. The aim of this article, however, is not to investigate the formal negotiation process. Rather, through the example of bioprospection, this article analyzes the institutional conditions which guarantee collective learning processes in the governance of biodiversity in a context of globalisation.

The starting point of my reflection is a diagnosis of the insufficiency of the current mechanisms of regulation. Such a foundation necessarily implies the necessity to develop more reflexive modes of governance. Theoretically, this diagnosis relies on two promising research programs in economics: neo-institutionalism and evolutionism. Both approaches highlight the possibility of an alternative approach to regulation, which makes a double shift from the standard tools of economic analysis of bioprospection.[7] First, they propose an enlargement of the neo-classical approach building on critiques raised by theories of organisational learning which take into account the bounded rationality of economic actors (Williamson, 1996). Second, in order to account for the dynamic nature of the social and political environment surrounding the mechanisms of regulation, the approaches develop a dynamic theory of learning and selection. (North, 1990). However, the theoretical models proposed by Williamson and North remain unable to apply their analyses to an expansion of the concept of governance. Neither improvements in the direction of bounded rationality nor improvements in the direction of the dynamics of the context demonstrate how or in what respect they can contribute to a more reflexive approach to governance.

In order to evaluate the contribution of the alternative approach of regulation that emerges from the contributions of neo-institutionalism and evolutionism to a theory of reflexive governance, one must first reconstruct the two stages of the shift from the classical approaches. Only then can one define the way in which the alternative approach takes into account the impact of an action on the reflexivity of actors and institutions in the amelioration of structures of governance. My hypothesis is that, through this reflexive criticism, it is possible to indicate a double gap that remains between the expected results of the proposed mechanisms of regulation on the one hand, and the effective change in the behaviour of the actors on the other. If this hypothesis is confirmed, this investigation would expose the possibility of pursuing an alternative path of analysis that consists of connecting the proposed mechanisms and reflexivity on the social programming[8] in organisations involved in biodiversity conservation.

[6] Cf. Bridges Monthly Review, September 2003, p. 23; http://www.ictsd.org/monthly

[7] For an overview of the standard approaches cf. for example Revéret and Webster, 2002, pp. 241-244.

[8] This includes a connection of the mechanisms to the goals pursued by the central actors in biodiversity policy (the stabilisation of the program) *and* a connection to the content of the objectives of the main organisations involved in those policies (the definition of the problem space). The distinction between "program" and "mechanism" is currently adopted in cognitive sciences in the line of the work of H. Simon or A. Rosenberg. The program defines a transformation of an input in an output in order to realise a certain goal and the mechanism proposes a concrete means of implementing this transformation through a specific causal chain (cf. for a discussion of the origin of this distinction within the cognitive sciences, Kitcher, 1988). An exploration of the broader theoretical framework falls outside the scope of this paper. The epistemological criticism of the mechanisms of governance relies in particular on research on the limitations of modelling of behaviour from the point of view of contemporary debates in philosophy of action. For a more detailed discussion, see Dedeurwaerdere, 2002a.

1. Introduction

In his work on neo-institutionalism, Williamson proposes to supplement market systems with hierarchical organisations to minimise transaction costs which result from incomplete contracts and lack of information (Williamson, 1996). In the context of bioprospection, this broadening of economic analysis shows some of the deficiencies of the market and contractual approach to governance. In practice, the definition of property rights, on which benefit-sharing contracts are based, is controversial and not well defined. For instance, how can one acknowledge the past intellectual contributions of local communities in the selection of species adapted to extreme circumstances of dryness or poor soil such as in Mexico in the contractual language of property rights (Bellon and Taylor, 1993)? Further, how can the contribution to biodiversity preservation (or, contrariwise, the rate of species extinction) be assessed if centuries are needed just to describe the diversity of the most current species (Cracraft and Grifo, 1999)? In light of this incompleteness, the objective of the emergent regime of access and benefit-sharing, according to neo-institutionalism, is to create coordination structures that can limit opportunistic behaviour. This is precisely what is at stake in the current negotiations, which aim to promote better coordination among the various mechanisms of regulation that are currently available.

However, Williamson's neo-institutional approach has been criticised by contemporary evolutionary approaches for its basis in a decision theoretic framework at the level of the evaluation of choice regarding the best possible organisation. Indeed, this decision theoretic calculus does not take into account the problem of uncertainty and its impact on the evolution of the broader social and economic context (Metcalfe, 1997). Further, it cannot account for the heterogeneity of actors' preferences, which do not act according to the sole criteria of minimisation of costs, but instead adopt a plurality of logics of action (Nelson and Winter, 1982; Dosi, 1986). Evolutionary approaches therefore suggest a double improvement, which concerns respectively the issue of selection and the issue of learning (Brousseau, 2000b, pp. 1203-1204; North, 1990. pp. 17-26 and 73-82).

Several contemporary analyses of bioprospection contracts also advocate such a double improvement. A first line of analysis proposes to supplement the competitive selection mechanisms at the core of neo-institutional economics with other mechanisms of public action and community solidarity (Brush, 1998; Cardenas, 2000). Such mechanisms in the frame of bioprospection are, for instance, the financing of biogenetic resource conservation by research institutions such as the International Plant Genetic Resources Institute (IPGRI) or community management of risk in agrarian societies based on a system of reciprocity allowing for the preservation of a high level of global biodiversity (Brush, 1998, p. 761-64).

This approach, however, does not address the evolution of the institutional environment within which governance systems are embedded. Consequently, there is no way of insuring that the equilibrium among the criteria of competitive selection, mechanisms of

community solidarity and public action will be oriented towards the interest of the largest possible community. As a result, a second line of research explores the learning process in the institutional environment as a precondition for moving beyond the "capture" of the innovation processes by vested interests. This expanded theoretical approach therefore emphasises learning processes which seek to sustain dynamics of innovation and adaptation within the institutional environment (Mulligan, 1999; Drahos, 1997).

Nevertheless, from an epistemological point of view, these ameliorations of the neo-institutionalist approach remain deficient. Indeed, the relative merit of 'incentive' approaches to regulation and more dynamic approaches (and thus how to choose between them) remains under theorised. While criteria based on some formal properties in particular contexts (such as the degree of heterogeneity of the actors and of action logics, or the uncertainty of the development of new technologies, for example) are possible, the specific context of each situation necessitates a degree of flexibility in each theoretical approach and assessment. Every context has its own autonomy, and competing theoretical approaches must consider their possible connection to the programs of international organisations and social movements involved in biodiversity conservation. In other words, in order to assess the contribution of the double amelioration proposed by the evolutionary approaches, one still must define the conditions that guarantee such a contextual use. This problem will be the subject of the third part of this paper, where I propose a critical outcome in terms of a theory of reflexive governance.

In order to assess the contribution of the neo-institutionalist and evolutionist approaches, the paper proceeds in three steps. First, I will examine the broadening of the standard economic analysis embodied in neo-institutionalist approaches and their application to the issue of the framing of bioprospection contracts. Then I indicate the ways in which this broadening remains insufficient, while simultaneously demonstrating how the double improvement proposed by evolutionist theories attempts to address the shortcomings of neo-institutionalist economics. Finally, in a third part, I propose a critical reconstruction of this double improvement based on a theory of reflexive governance. For each step, I rely on several key authors, without necessarily providing an exhaustive exploration of the literature. Such an approach nevertheless provides the foundation for an assessment of their contributions in an attempt to develop a better understanding of current incentive policies for biodiversity conservation and proposals for their improvement.

2. Bioprospection contracts from the point of view of neo-institutionalist economics

Neo-institutionalist economics offers a powerful critique of most arguments regarding the efficiency of bioprospection contracts, arguing that traditional economic theories consider such contracts in an overly simplified way—as an example of an idealised "spot market" governance structure. Traditionally, bilateral contracts between private parties within a context of a well defined system of property rights have been perceived as the best way to account for the environmental consequences of the economic activities (Coase, 1960). These contractual agreements, reached from negotiations on the allocation of property rights, allow the restoration of a "just price" vis-à-vis market imperfections, secured both through direct monetary incentives (e.g. benefit-sharing) and indirect incentives (e.g. an institutional framing which permits a better flow of information on market-based transactions linked to contracts) (OECD, 1999).

However, this *ex ante* negotiation on the allocation of property rights is necessarily incomplete. As Williamson argues, a "spot market" governance structure is the most appropriate solution *only* when individual incentives are high and arrangements for dispute resolution exist (Williamson, 1996, pp. 95-100). In practice, however, both conditions are flawed. First, financial incentives are insufficient because of the low financial return on most bioprospection contracts which provides for limited royalties (Mulligan, 1999). Second, a well-defined legal regime depends on complete contracts, a condition that is clearly not met in the case of bioprospecting. Rather, the question of how property rights can account for the historical intellectual contributions of local communities—which allowed for the selection of species adapted to extreme circumstances or for the maintenance of a high level of biological diversity—remains unresolved. Should such biological diversity simply be dismissed as "wild species" for which no royalties should be paid? Or, for historical reasons, should the original providers or producers be rewarded *ex post*?

2.1 Incentive policies for conservation from the Coase-Williamson's perspective

Due to the uncertainty of the benefits and the incompleteness of the definition of contracts, the coordination mechanisms of bioprospection activities based solely on bilateral contractual transactions remain deficient. Therefore, in the absence of institutional incentives emanating from the broader environment, actors can always exit the cooperative dynamics initiated in the contracts and revert to a self-interested bargaining (Williamson 2002, p. 7). To overcome this shortcoming, Williamson proposes an enlargement of the classical approaches to economic incentives based on the theoretical lessons derived from the literature on organisational learning. Through this broadening, Williamson seeks to take into account *ex-post* adaptational capacities (Williamson 2002, p. 10) embedded in the relational and organisational network in order to decrease the opportunity costs created by the vulnerability of the contractual relations.

Applying Coase and Williamson's framework to the question of bioprospection offers two important insights:

(a) *ex ante*: Negotiations between interested parties regarding the definition of property rights relative to collected and/or genetically decoded living resources can take into account the social and environmental externalities of bioprospection; and
(b) *ex post*: Because contracts are embedded in a broader set of agreements with institutions promoting sustainable development, cooperative dynamics can be sustained, notwithstanding the uncertainty and incompleteness of contractual relations.

This broadening of the classical theoretical models of bioprospection contracts sheds a new light on current agreements. In the case of the Merck-INBio agreement, for example, it explains why the parties remained committed to the cooperative dynamic despite major shortcomings in the contract, including the problems of low price incentives and high transaction costs. Indeed, the success of the Merck-INBio contract is due, in part, to the fact that the arrangement is nested within a whole set of agreements with institutions involved in promoting sustainable development. Breaking the bioprospection contract would also impart on the dynamics of confidence and reputation on which the other contracts depend (Steinberg, 2001, pp. 76-84). Particularly, in the case of the Merck-INBio agreement, it is clear that the Costa Rican Office of Biodiversity, created in 1988, played an important in role the coordination of economic actors. That office relied on the already well developed park agency, but it was able to enlarge the institutional dynamics engaged by the park agency to include prominent scientists, public administrators and environmental advocates (*ibid.*, p. 78). Two ideas that emerged within this broadened dynamics had direct institutional consequences. The first idea was to centralise information on biodiversity resources through a comprehensive inventory of the nation's species, most of which to that time remained unnamed and unknown. The second was the recognition of the need for reform of the park management system itself. The first proposal led to the creation of the National Institute for Biodiversity (INBio), while the second facilitated the development of an integrated system of protected areas (*ibid.*). The coordination of actors under the auspices of the Office of Biodiversity thus played a key role in the development of the enlarged institutional environment on which the Merck-INBio contract was predicated.

More generally, many authors demonstrate the important role played by intermediary organisations in framing contracts and managing litigation. In the absence of a central administrative entity for the resolution of conflicts over issues of access and benefit-sharing, intermediary organisations can enhance the circulation of information in order to prevent the *de facto* exclusion of certain actors from the market. By developing a comprehensive database of information, the ability of individual actors to verify transactions is reduced, thereby reducing the risk associated with such agreements (Brousseau, 2000a). In the context of bioprospection, a recent proposal by WIPO's working group on indigenous communities moves in precisely this direction, aiming to include reference to the country of origin in patent applications. This reference would permit a more comprehensive verification of the respective role of partners in the

development of a given patented invention, and would be a first step in the creation of a broadened institutional environment that includes organisations for certification and monitoring of the origin and use of patents[9].

2.2 The limits of incentive politics

Even with the organisational correction of explanations of market mechanisms afforded by Williamson's approach, the real characteristics of economic transactions in biological resources remain insufficiently theorised. While Williamson's perspective demonstrates the necessity of arrangements for the institutional framing of transactions, it remains based on a decision theoretic framework at the level of the evaluation of the choice regarding the best possible organisation. In other words, Williamson assumes that the best possible institutional solution to the problem of contract incompleteness is the one that minimises transaction costs.

Williamson formulates his basic hypothesis as follows: "transactions, which differ in their attributes, are aligned with governance structures, which vary in their cost and competence, so as to effect a (mainly) transaction cost economizing result" (Riordan and Williamson, 1985). But governance structures are coordination devices which, ideally, allowing anticipation of the adaptation patterns of actors within relational networks (Williamson, 2002, note 8; March and Simon, 1958, p. 159). They do not only include "decision mechanisms" for actors, such as price mechanisms for individual consumers, but also mechanisms which provide guarantees and control of the transactions. Different types of governance structures can be distinguished, depending on the relative importance of these mechanisms (cf. figure 1). The choice of an appropriate structure will therefore depend on the attributes of the specific transaction situation. According to Williamson these attributes are the specificity (and so the vulnerability) of transactions as a relational system (the so-called "asset specificity"), as well as the uncertainty and the frequency of the transactions (Williamson, 2002, p. 8).

However, the application of this alignment hypothesis supposes complete information regarding transaction attributes to which the governance structures should be aligned— a condition that is rarely satisfied in practice. Particularly as they are conceived in Coase and Williamson's perspectives, the incapacity to integrate the evolutionist dimension of the context imposes a double limit on incentive policies. First, a given incentive will have an influence on the evolution of this context and may modify transaction attributes. As a result, its effects cannot always be known in advance. Second, the modified transactions will, in turn, affect governance structures and therefore may necessitate an evolution of the institutional environment to reinforce property rights.

[9] In the broader context of the problem of biodiversity governance, one can also think of the role of intermediary organizations such as the Forest Stewardship Council, which gathers different certification organizations for sustainable forest management, and whose objective is to "evaluate, accredit, and control organisms of certification of forest products" (Schmidt, 1999, p. 24). It is only through the existence of such intermediary organizations that certification schemes can go beyond the stage of "codes of good conduct" which lack any substantive content and capacity for verification. The weakness of such codes was highlighted by a WWF study which demonstrated that, out of a sample of 80 declarations on environmental protection on paper or wood products, 3 only could be justified, and even then only partially (*ibid*, p. 23).

	Governance attributes		
Governance structures ↓	Incentive Intensity (Direct incentives)	Administrative Control (Indirect incentives)	Contract Law regime (Indirect incentives[10])
Spot Market	++	0	++
Hybrid	+	+	+
Hierarchy	0	++	0

Figure 1: Attributes that define three viable modes of governance (adapted from: Williamson, 2002)

The first limit can be illustrated through the problem of the "crowding out effect," and highlights the major limit of this analysis of bioprospection agreements in the first section. Crowding out effects arise in situations where the behaviour of the actors is initially based on cooperative attitudes, but where this behaviour is undermined as a result of the influence of monetary incentives addressed to these actors. Incentives are also informational devices addressed to a context. Consequently, under conditions of incomplete information regarding the attitudes of the different actors, a price incentive operates as a signal that undermines the credibility of altruistic behaviour (Frey, 1994). The crowding out effect is clearly present in the case of bioprospection contracts. Indeed, substantial empirical evidence shows that the knowledge and sustainable use of genetic diversity in a local community is linked to the reciprocal cooperative practices that prevent the depletion of such resources (Ostrom *et al.*, 1999; Posey, 1985; Hammer *et al.*, 1993; Cardenas, 2000). By emphasizing financial reward for conservation in a given community, however, bioprospection contracts may undermine the credibility of the altruistic motivation of the actors involved in this conservation. From an evolutionary perspective, the monetary incentive enhances the fitness of the egoistic behaviour compared to the altruistic behaviour. In such a situation, the bioprospection contract will undermine the practice of sustainable use of the resource. In the worst case, this could

[10] Here I employ the broad definition of incentives used in the OECD handbook on incentive measures, covering both direct and indirect incentives: "The incentive measures presented can be roughly categorised in the following eight groups: fees, charges and environmental taxes; market creation and assignment of well-defined property rights; reform or removal of adverse subsidies; regulations and access restrictions; environmental funds and public financing; information provision and capacity building; economic valuation of environmental benefits and costs; and stakeholder involvement and institution building. Only the first five groups actually comprise "incentive measures" as traditionally understood, i.e. the implementation or abolition of an administrative act by an authority, usually the central government, with a legal grounding and the explicit objective to induce a certain behaviour" (OECD, 1999, p. 73). In this discussion, I have included information provision, stakeholder involvement, economic valuation, and capacity and institution building under the evolutionary approaches to incentive politics, while other approaches might have chosen to group them under framework building (OECD, 1999, p. 97) or reflexive implementation processes (*Ibid*, p. 14; p. 73).

lead to a silent agreement on the depletion of the resource, in the private interest of both parties, under the umbrella of an incentive measure whose objective is to enhance conservation (cf. for example, Hufty and Mutsinger, 2002, p. 305).

The second limit is located on the level of capacities for innovation in the relational network in which the incentive structure is nested. According to Williamson's decision theoretic account, incentives structures are adapted through an optimisation process based on the criterion of transaction cost minimisation. However, in practice, such optimum is never realised. Indeed, the innovation process will depend both on the effective capacities for innovation of the relational network and on the perceived benefits by the interested parties (North, 1995, p. 24). However, certain groups will have greater influence than others in the adaptation of governance structures. As a result, the innovative capacities of the relational networks will always remain limited by the risk of capture by powerful interest groups.

This phenomenon of capture sheds a new light on the incentive role of the Office of Biodiversity in the Merck-INBio agreement. On the formal level, as we have seen above, the Office of Biodiversity was able to enlarge the participation in the reform of the conservation system in Costa Rica to include prominent scientists, public administrators and environmental advocates. In practice, however, the apparent expansion of participation primarily served the goals of two particular interest groups: the science community and the private corporations. Indeed, the science community was able to secure the financial support of the private foundations and companies towards the goal of a comprehensive survey of the nation's species (Mulligan, 1999, p. 42). So the innovative capacities of the enlarged community remained limited to the new perspectives promoted by the science community.

According to this analysis, a double limit of incentive politics—as conceived in Coase and Williamson's perspective—becomes apparent. First, a gap between the expected outcome of an incentive and its real effects on the behaviour of actors becomes apparent. Second, a gap between the formal requirements, on which the choice of coordination structures is based, and the effective innovation capacities of the relational network, depending on the means to go beyond the capture of the participatory process by certain interest groups, emerges.

3. The double improvement proposed by evolutionary approaches in economics

Due to the double limitation of incentive policies conceived from a neo-institutional perspective, the hypothesis of bounded rationality[11] remains insufficient for moving beyond the limits of classic approaches to the economic valorisation of biodiversity as a market commodity. Particularly, it is unable to account for either changes in preferences, which play a role in this valorisation, or the role of established interests in the evolution of the rules that govern the innovation process. For this reason, evolutionary approaches propose a different analysis of the role of institutions, which allows an exploration of the effects of a given action on the dynamics of the context.

In order to examine the analysis of institutions proposed by the evolutionary approaches, let us consider the work of Brousseau (1999, 2000), who offers a critique of the basic scheme of neo-institutional economics as proposed by Williamson. Williamson's reasoning allows one to reconcile the hypothesis of bounded rationality with the idea that agents behave according to the economic rationality of the market[12]. As we have already seen, Williamson proposes to supplement market organisations by hierarchical organisations which allow for the minimisation of transaction costs associated with the negotiations resulting from contracts incompleteness (resource allocation) and the exchanges based on incomplete information (market organisation). According to transaction properties (assets specificity, frequency, uncertainty), this permits the selection of the most appropriate governance structures (market, hierarchical, hybrid). However, as Brousseau demonstrates, this hypothesis of alignment between transaction properties and governance structures relies on two research heuristics that prevent a more dynamic analysis. First, Williamson maintains a hypothesis of optimisation at the level of choice regarding the best possible hierarchical organisation. He therefore supposes that economic agents select the most efficient forms in a more or less predictable manner (Brousseau, 1999, pp. 200-201). Second, the hypothesis of alignment takes both transaction properties and the institutional environment as given. However, the choice of governance arrangements may affect the properties of the transaction situation and the institutional frame (Brousseau, 1997, pp. 10-12).

Evolutionary approaches have developed a dynamic frame of analysis, where the role of institutions is no longer the static arrangement of resource allocation. Instead, institutions promote the development of an environment of selection which allows for the maintenance of innovative and adaptative capacities in the evolution of the coordination structures. These approaches therefore offer a double improvement over the approach of Williamson (Brousseau, 2000b, pp. 1203-1204):

[11] I use Simon's concept of bounded rationality to refer to the fact that human beings are limited in knowledge, foresight, skill and time (Simon 1957, p. 199). As we have seen, the main lesson drawn by neo-institutionalist economics from bounded rationality is the incompleteness of all complex contracts. In this respect, neo-institutionalist approaches do not incorporate another, more psychological line of research, initiated also by Simon, regarding the role of satisficing through aspiration level mechanics (Williamson, 1996, p. 37).

[12] Williamson thus completes the hypothesis of bounded rationality with a self-interest-seeking assumption, variously described as opportunism, moral hazard and agency (Williamson, 1996, p. 56).

- With regards to the issue of selection: By the developing research that takes into account the effective plurality of preferences that play a role in the selection processes; and
- With regards to the issue of learning: By developing analyses of the co-determination of the evolution of the institutional environment, the economic coordination structures and the properties of transactions.

In order to appreciate the implications of this change in perspective for the framing of bioprospection activities, we must understand how the evolutionary approach provides a response to the limits of classic incentive policies. To this end, two bodies of research are particularly important: research on the crowding out effect in the line of Frey and North's work on institutional dynamics.

3.1 The issue of selection

Frey's work on the crowding out effect provides an example of the interaction among a plurality of selection criteria used by economic agents. As we have seen in the case of biodiversity protection, self-interested behaviour and cooperative behaviour both coexist in the users' community of biodiversity resources. A monetary incentive for conservation will *increase* the frequency of actors adopting a self-interested behaviour, which will *decrease* the survival probabilities of the cooperative behaviour. Therefore, in order to account for this interaction among the plurality of selection criteria, the structure of incentives must be modified. More precisely, as Frey demonstrates, what is at stake in the crowding out effect is a phenomenon of population extension. Indeed, cooperative behaviour may survive in the particular case of populations of small scale, where an agent may suppose that his behaviour has a direct influence on the behaviour of other actors. But, in larger populations, as for instance the one including a biodiversity users' community, local administrations and companies involved in bioprospection, actors can no longer assume that they will have an influence on this extended population. Therefore, in the extended population, it is more rational for actors to adopt a self-interested behaviour. In the long-run, they therefore adopt a behaviour that will conflict with the objective of biodiversity conservation. According to Frey, this conflict can only be resolved through a political mechanism, which allows for the strengthening of incentive systems that compel the whole population to act in an environmentally-friendly manner. As Frey writes, "actors may nonetheless be ready to act in a respectful manner for the environment, as long as other people act in the same way. As this is only the case within limited groups having an imitation behaviour (as demonstrated in the developed model), individuals may rationally request that all the members of the society be compelled to act in a respectful manner for the environment" (Frey, 1992, p. 48). According to Frey, recourse to a "political action" must be made. Such action may consist of imposing charges for non-respectful behaviour, such as through eco-tax systems, or through rewards for respectful behaviour.

More generally, a modification of the incentive structure, acting on the plurality of selection criteria, must be envisaged if one wants to support cooperative behaviour.

Rather than acting on bioprospecting practices through a contractual mechanism, based solely on market logic, one should act on incentives within the broader environment in order to support environmentally-sound behaviour. Such a model, of so-called bio-cooperation, is developed by Brush in his case study on the preservation of agricultural genetic resources in Mexico (Brush, 1998). In this study, Brush highlights the two steps of Frey's reasoning regarding the extension of the population. First, with regards to bioprospection contracts, Brush points out the inappropriate character of the resort to classic intellectual property mechanisms, addressed to individual actors or isolated communities, in the context of a resource such as maize, where the ownership of the innovation is properly collective (*ibid*, pp. 760-762)[13]. However, expanding a bioprospection contract to a larger group, in order to take into account the collective character of agricultural innovation, would dilute the benefits and therefore cancel the economic effect of the incentives. Moreover, on the political level, such an extension is not a solution in itself because it fails to deal with the problem of conflicts that may arise between particular communities on the issue of benefit sharing. Brush therefore proposes to move beyond the simple extension of the benefit sharing mechanism to a global modification of the incentives structure in order to favour behaviours that are oriented towards the preservation of biodiversity as a public good (*ibid*., p. 764). Thus, Brush notes that "the conservation of genetic resources requires a long term investment in institutions and in human capital that is beyond the range of contracts" (*ibid*.). One example of the long-term investments proposed by Brush are the programs for enhancing human capital within agricultural research institutions involved in research programs on the utilisation of local resources. In the same way, mechanisms to expand the frequency of cooperative behaviours of reciprocity, such as mechanisms for voluntary participation to benefit sharing funds, also conform to Brush's model. One such fund is the Genetic Recognition Fund, established at the University of California and based on an agreement through which researchers commit to pay a fixed royalty to the fund if they discover and patent genes of germlines obtained from developing countries.

3.2 The issue of learning

While such an approach permits the adoption of a more dynamic conceptualisation of incentive mechanisms, it remains unable to adequately theorise the determinants of the evolution of the institutional environment in which incentives structures are embedded. More precisely, Brush and Frey's analysis demonstrates the necessity to consider a more global modification of the incentives structures in a setting of polycentric governance[14].

[13] Indeed, the permanent exchange of seeds between farmers is an evolutionary trait that allows for the maintenance of a greater global diversity than any individual isolated farmer could guarantee. This diversity plays an important role in risk management within agrarian societies (Brush, 1998, p. 761).

[14] The notion of polycentric governance is used here in the sense of the research program initiated at the *Workshop in Political Theory and Policy Analysis* of the University of Indiana at Bloomington (USA) (cf. for an overview Mc. Ginnis, 1999a, 1999b, 2000). Polycentric governance connotes a system of many centres of decision making, including those related to different types of social logics, such as market, government or communitarian logics. It has been introduced by Vincent Ostrom in the context of his study of metropolitan governance and is defined as a system of "many centres of decision making which are formally independent of each other", but which nevertheless function as a whole "to the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative

However, it does not consider which actors will modify the rules, or actors are mobilised to participate in the innovation process? Therefore, the innovation dynamic in the research for a greater efficiency at the level of the effect of incentives may be hindered as a result of capture by vested interests. That is why a second line of research focuses on learning processes in the political environment—processes that aim to maintain adaptation and innovation dynamics in order to go beyond simple inertia in the interest of the more powerful actors (North, 1990).

In order to understand the consequences of this second improvement of the neo-institutional approach for the issue of bioprospection, let us briefly compare neo-institutional and evolutionary theories on governance structures. From the new-institutionalist perspective, the role of the institutional environment consists of reinforcing politically the economic system of property rights and rules. It directly raises the question of which economic actors will adapt and innovate (Brousseau, 1999, p. 199; Williamson, 1993). However, there is a dialectic between the evolution of structures of economic coordination, on the one hand, and the institutional environment, on the other. Indeed, as North's works on economic history demonstrate, innovations and adaptations frequently destabilise the broader institutional frame of their creation, thereby compelling further development and evolution. In order to fully understand this dialectical process, one must thus also envisage learning processes, organised at the level of the political environment, which guarantee consideration of the interests of new actors in the choice, implementation and reinforcement of political rules of economic coordination. North thus raises a new question, which was not addressed in Williamson's static framework, namely how to organise an institutional framing of coordination structures that does not solely benefit current interests but which, through its elaboration, also considers its own evolution and incorporates the interests of the largest possible community (North, 1995, pp. 21-22).

Intermediary organisations can play an important role in this process, moving beyond their restrictive function of adjustment and conflict resolution considered above. Indeed, in practice, intermediary organisations do not only play the neutral role of facilitating communication, but they also limit opportunistic behaviours associated with certain interest groups. As V. Ostrom, Tiebout and Warren demonstrate with respect to local public economies, intermediary organisations may ensure that externalities associated with the extension of a group, such as the provision of public goods and services, are supported by the whole population (Ostrom, V. *et al*, 1961). In the field of bioprospection, a proposal by the Working Group of Like-Minded Megadiverse Countries to deal with the problem of political opportunism provides an excellent example of such an intermediary organisation[15]. The group aims to formulate common proposals for upcoming negotiations on the issue of access and benefit-sharing. The

undertakings or have recourse to central mechanisms to resolve conflicts" (V. Ostrom, Tiebout & Warren, 1961, p. 831).

[15] The Working Group of Like-Minded Megadiverse Countries includes Bolivia, Brazil, China, Columbia, Costa Rica, Ecuador, The Philippines, India, Indonesia, Kenya, Mexico, Peru, South Africa and Venezuela (cf. TradeBioRes, Vol. 2, n° 19, http://www.ictsd.org/biores/index.htm).

group has specifically defended the necessity of attesting to the prior informed consent of a country provider of biological resource in patent applications, a step they argue is necessary to allow for better control over opportunistic practices such as "biopiracy". More generally, the role of intermediary organisations and informal networks allows for a "modified form of competition" (North, 1994, p. 23; E. Ostrom, 2000, p. 35) at an inter-organisational level, which provides incentives for actors to modify their perceptions and motivations in order to take into account the interests of new populations.

Thus, if one wants to apply this dynamic analysis of the innovation process to the issue of access and benefit sharing, Frey and Bush's analyses must be supplemented by a consideration of the learning process in the institutional environment that allows for a reorientation of polycentric interaction towards the interest of the largest possible population. Indeed, developing a joint action on the different types of incentives within a polycentric framework, as envisaged by Frey and Brush, allows market incentives for the sustainable use of biodiversity to be supplemented with incentives for the cooperative management of remaining externalities. However, even if market incentives are supplemented with cooperative management, there is no guarantee that the cost of these externalities will be supported by the whole population. Frey and Brush overlook this danger, believing that public interest may be simply imposed through a government-type command-and-control structure (Frey, 1992, p. 48) or an international organisation such as FAO (Brush, 1998, p. 764). In particular, it is not clear, given the context of trade and economic liberalisation, whether the agricultural sector would be capable of supporting the additional costs imposed by public regulations in order to manage externalities[16]. Therefore, in the absence of intermediary organisations acting upon the political environment, the threat of the capture of the mechanism for interest generalisation within a polycentric framework by certain groups, such as expert communities or the pharmaceutical and the seed industries remains real. These organisations could relay the interests of the largest population, which includes new actors such as indigenous people, or propose rules for the participation of the different parties in meeting the costs of economic externalities.

4. Towards a theory of reflexive governance

As we have seen through our analyse of the neo-institutional approach in economics, the integration in the economic explanations of a hypothesis of bounded rationality that better accounts for the real characteristics of economic transactions associated with biological resources, allows for broadening neo-classic approaches at the core of the theories of economic valorisation of biodiversity as a market commodity. The neo-institutional approach indicates the necessity of regulatory institutional arrangements which, according to the properties of the transaction situation at stake, range from a legal regulation of market exchanges, through a system of intellectual property rights, to hybrid solutions involving intermediary organisations or administrative bodies.

[16] Cf. the meeting of December 2-4, 2002 of the expert group on "Capacity Building for Equitable Access and Benefit Sharing" of the CBD Secretariat in Montreal, oral communication of one of the delegates.

From an epistemological point of view, the formal typology of regulatory institutional arrangements, however, remains insufficient. Indeed, the question of to assess the relative merit of different systems of regulation that alternatively rely on market, hierarchical or hybrid organisations, remains unaddressed. As we have seen, the choice largely depends on the properties of the environment, such as asset specificity, frequency of transactions and uncertainty. This means that the selection principle leading to the adoption of a new system of regulation relies on the reaction to an objective environment working as an external control variable. However, the political and social environment has its own autonomy, and the chosen approach still must consider its own contextual interpretation according to the work program of an international organisation, a social movement or an administration involved in biodiversity conservation. In other words one still has to take into account, the particular use that will be made of the institutional arrangements proposed by each approach within the concrete context of social programming.

The double improvement of Williamson's static frame considered by evolutionary approaches already develops some hypotheses on the possible connection to the content of social programming in the environment[17]. However, each improvement emphasises on only one part of this programming, whether it is the stabilisation of the program through the goals pursued by the main actors, or the representation of the content of this programming within political institutions. Missing from both is any reflection on the articulation between the two levels. On the one hand, the polycentric approach to regulation in the work of Frey and Brush develops an action on the stabilisation of the plurality of **selection** criteria that govern the behaviour of the actors. Their emphasis is on the purposes of the social actors to be taken into account in the institutional design. However, as mentioned before, this approach presupposes a mechanism of self-adjustment of the competing actor logics without considering the role of political institutions in the choice and the reinforcement of these different mechanisms.

On the other hand, North proposes an action on the level of the mechanisms of **learning** that allow an evolution of the cultural preferences in the broader institutional environment, which plays a role in the definition of the general interest, in order to account for the interest of the largest possible population. However, North's analysis of

[17] The notion of social programming refers to a set of works that can only briefly be described here. The concept is used in the sense developed by Feenberg (1999). He introduces the notion of social programming in relation to the issue of the democratization of the development of new technologies (ibid., pp. 116-119). Feenburg distinguishes three levels of the democratization process: The first is the level of the strategies of technological innovation; the second refers to the democratic beliefs mobilized by these strategies; while the third level is the level of the effective possibilities that allow a connection between strategies and beliefs too often dissociated in practice (taking into account both the selected possibilities and the non-selected possibilities by the social context) (ibid, pp.142-147). It is this third level that is designated by the notion of social programming. In our epistemological critique of regulation mechanisms, the first level refers to the strategic choices of regulation mechanisms; the second to the beliefs mobilized by the neo-institutionalist and the evolutionist approaches in the selection of the governance mechanisms; and the third, finally, corresponds to the implementation of the mechanisms at the level of its connection to the goals pursued by the main actors and the content of the main organisations involved in biological diversity conservation. (For an application of these notions in other social fields, cf. for instance Maesschalck and Dedeurwaerdere, 2002 and Maesschalck and Loute, 2003).

learning is based on an *ex post* historical reconstruction of the innovation processes that allowed the western economies to reach their current state of development. His analysis proceeds in a retrospective manner, subordinating the end state of the learning process to a particular state of development encountered in advanced capitalist societies.

The contextual translation of both approaches therefore remains incomplete. More specifically, each approach mobilises resources, whether of learning or adjustment, without constructing the articulation between these resources in an explicit way. Either it is assumed that the relationship is automatic and the learning processes are considered to be a natural consequence of the interaction between the multiple action logics[18], or it is assumed, in a retrospective manner, that the characteristics of the learning process are already given, by supposing that in the end the learning process is oriented towards the state of a certain type of society. However, in both cases, the resources allowing for this articulation are taken as given. In the first case, one assumes that functional resources of self-adjustment of the actors' orientations are given. In the second case, cooperative resources allowing for orienting learning processes towards a certain direction are similarly presupposed.

In order to construct a more complete approach, our proposition is to consider a different, more reflexive articulation between the learning processes and the action logics. In this reflexive perspective, the stake is not so much to rely on existing capacities, whether they are capacities of self-adjustment or cooperative learning, but to act on the conditions of emergence of these capacities through appropriate institutional means. If we take into account this new order of conditionality, we must combine the double amelioration proposed by the evolutionary approaches in a different way. On the one hand, the goal of the learning processes considered by North would not be to generalise the conditions of innovation that have allowed a certain type of society to be successful in the past, but to organise a reflexive learning process enabling the emergence of new representations of the conditions of performance. Such an approach would necessarily consider a plurality of action logics beyond those related to only one type of society. On the other hand, the adjustment process considered by the polycentric approach should also act on the political institutions that enforce a particular equilibrium among the selection criteria. Instead of considering an independent action on both learning within the political environment and the selection principles governing the equilibrium among the different social logics, a reflexive understanding of this process develops a joint action on the processes of learning and selection in order to create the conditions for their common transformation.

In order to assess the consequences of this epistemological critique, let us consider again the example of the group of biologically rich countries. As we have seen, the emergence of groups of countries that try to elaborate common proposals is an example of a learning dynamics aiming to transform the political environment. However, this learning process is most often interpreted in a restrictive sense, as a means to control the existing regime of market exchange, rather than to consider other logics. But such groups frequently seek to articulate different logics of action, seeking to control the opportunistic practices of

[18] This is certainly the case of the polycentric approach discussed above.

biopiracy (Dutfield, 2000) or increase the negotiating power of Southern countries, thereby allowing them to obtain more favourable conditions within the emerging regime of access and benefit sharing (Mulligan, 1999, pp. 58-59).

Yet this analysis of the learning process remains incomplete, as it does not take into account the actors' reflexivity on a plurality of selection criteria. While it envisages a position with respect to the emerging market regime, it does not consider the enabling of learning processes that may reinforce alternative regimes that are based on other social logics. In particular, no analysis is made of the link between the collective learning with regard to the international regime of biodiversity on the one hand, and the social programming of donors that are mobilised in the implementation of this regime such as USAID or GEF on the other. As Hufty shows in his analysis of forest management in Madagascar, promoting incentive mechanisms based on the potential benefits of the marketing of indigenous knowledge or resources is also a way of having local people bear the cost of biodiversity protection (Hufty, 2002, p. 304). Moreover, in the case of Madagascar, the targeted actors of forest conservation programs, which are mainly the forestry developers and the forest administration, refuse to engage in a genuine collective learning process with respect to the international biodiversity regime, as this would imply a change in their management practices. Indeed, the programs for sustainable use allow them to gain access to complementary financial resources in the name of conservation without having to abandon the non-sustainable forest exploitation practices in which they are involved (Hufty, 2002, pp. 305-306).

Hufty's case study demonstrates the gap between the learning process that resulted in a change of norms at the international level (from conservation to benefit-sharing and sustainable use) and the instrumental use of these new norms, which reproduces the social logics of the dominant actors. However, this reading by Hufty of the process of implementation of international norms in the line of the programs of the dominant organisation is also reductionist. Indeed, it emphasises the logics effectively selected for in the implementation of norms, without envisaging the possibility of another role of the learning process that is more reflexive, which consists in the capacitation of a plurality of logics that play a role in the implementation of norms.

In the field of biodiversity, several efforts to develop such reflexive approaches in the implementation of conservation policies are already underway. For example, the work of G. Dutfield on legal tools of governance attempts to articulate the construction of an alternative conceptual background for intellectual property rights and the proposition of new mechanisms of regulation (Dutfield, 2002). Classical systems of intellectual property rights are unable to take into account the public character of the collective processes of innovation in traditional communities (Brush, 1998). Indeed, merely asserting property rights over traditional knowledge or techniques is hardly going to be effective when so much of it is already in the public domain. In order to take into account this public character, Dutfield argues in favour of conceiving the system for protecting intellectual property rights as a liability regime rather than as a classic property regime (Dutfield, 2002, p. 31). Unlike a property regime, which provides owners with exclusive rights under which the rights of determining the conditions of access to the property at issue are

the most fundamental, a liability regime, is based on the principle of free use of the resource, but with an obligation of an *ex post* payment. In other words, use is authorised without any permit from the rights holders without conferring free usage—*ex post* compensation is still required. Such a system provides certain advantages in countries where the major part of traditional knowledge and techniques is already freely circulating, thereby negating the possibility of claims by the original owners. The regime of *ex post* compensation is therefore a pragmatic solution that allows for the free use of traditional knowledge and techniques, but which also requires that the original providers or producers of these knowledge and techniques be rewarded.

Some of the most promising proposals for *sui generis* rights have been elaborated in the context of liability regimes. For example the proposition for the creation of a global biocollecting society (Drahos, 2000), of an international repository for traditional knowledge (Swanson, 1997, pp. 168-170), or a private collective management institution to monitor the use of traditional knowledge, issue licenses to users and distribute fees to right holders (Dutfield, 2002, pp. 31-32) are all types of an *ex post* rewards system in a liability regime. Other proposals aim to establish an adequate legal framework to allow these *ex post* rewards relating to the "use" of knowledge and techniques. Examples are systems of users' fees for the traditional knowledge databases – different from a system of copyrights, which limits the reproduction rights to the authors of the database (Carvalho, 1999) – or compensatory liability regimes allowing for the protection of know-how (Reichman, 2002). The purpose of these propositions is to link an alternative conception of intellectual property rights to concrete proposals that may be inserted into the working program of organisations already involved in biodiversity conservation.[19]

In the field of economic regulation, some authors have also begun to develop more reflexive approaches. Timothy Swanson, for example, calls for a rearticulation of the economic system to allow for enabling a plurality of different paths of development. This "plural" conception of development offers an alternative to the objective of direct integration of the use of biogenetical resources within the global economy. Indeed, as Timothy Swanson writes,

> At present, a developing country that wishes to capture the informational value of its diverse resources must become fully integrated vertically (from conservator through to developer) because the exclusive rights do not attach before the final consumer product is developed. The idea of establishing a new level for the registration of property rights in genetic resources is to allow developing countries to specialise in the conservation of genetic resources without the necessity of proceeding to the development of the final consumer product (Swanson, 1997, p. 170).

The principal objective of *sui generis* rights is thus to allow the capacitation of a differentiated development. Other proposals that are envisaged by Swanson in this perspective are a global plan of incentives for conservation efforts of different types of

[19] Consequently, they may provide an alternative to the propositions of geographic indications, which are still situated in a non reflexive learning process based on the adaptation to the regime of strong property rights.

resources (*ibid*, pp. 164-166), and a certification mechanism for investments in biological diversity (*ibid*, p. 166).

5. Conclusion

The aim of this article was to evaluate the contribution of the different neo-institutionalist and evolutionist propositions in economics to the problems of framing of bioprospection contracts. This evaluation allowed us to verify the hypothesis of the necessity of a double amelioration proposed by the evolutionary approaches. This hypothesis firstly indicates the necessity to take into account a plurality of preferences determining the choice of the actors, and second, to consider the interaction between the political environment and the economic coordination structures. More profoundly, as we have seen, this double amelioration indicates the necessity of completing the mechanism of choice of the governance structures proposed by neo-institutionalist economics with an action on the connection of these mechanisms to the content of the social programming in the organisational environment. In this respect, this analysis confirms the insufficiency of the actual forms of regulation and the necessity to evolve towards more reflexive forms of governance.

The result of this analysis is to define more precisely the conditions of such a reflexive approach to governance in the context of the problem of the emergent regime on access and benefit sharing. In particular, the analysis has shown the necessity to develop a *joint* action on the processes of selection and learning that plays a role in the implementation of the proposed institutional mechanisms. Such a joint action should allow the effective linking of these mechanisms to the social programming in organisations advocating biodiversity conservation. The implications of this reflexive criticism were highlighted through two examples of reflexive learning, the first focusing on the emergence of new conceptions of intellectual property rights, and the second considering a plural conception of economic development.

Beyond the condition of joint action, however, a question remains. Indeed, it is still unclear if the practical realisation of this condition assumes the existence of capacities for reflexive learning of the actors and organisations, which needs to be reinforced through appropriate institutional means. This supplementary question will be the subject of further work on organisational learning in the political science literature[20].

[20] The example of IUCN reveals this insufficiency. Indeed, the social policy program, launched by the permanent secretariat with the perspective of organizational learning in 1992, was suspended by the same secretariat in 1998 despite a resolution on co-management adopted by the General Assembly in 1996 and the success of the program. In fact, the broadening of the organisation's objectives, allowing it to consider social policy issues, was not able to anticipate a change in the global orientation of environmental conservation programs at the international level. This change created an increasing dependency of the IUCN on major donors and the correlative adoption of a project-funding logic that was not compatible with the broadening of the organisation's objectives promoted by the members organisations (cf. Ken Mac Donald, 2003, pp.15-20).

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