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Working paper

2005/1

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Abstract: Environmental economics has employed the seminal contribution of Ronald H. Coase (1960) intensively but has remained relatively unaffected by the contributions of perhaps his most influential follower, Oliver E. Williamson. As an initial step in addressing this oversight, we apply the analytical framework of discrete structural alternatives to the choice of regulatory instruments. Environmental-related transactions, which differ in their attributes, are aligned with categories of policy instruments, which differ in their cost and competence, so as to effect a discriminating – mainly transaction costs-economizing – result. Insightful strategic and policy implications are stressed.

Key words: Transaction cost economics; Williamson; Environmental economics.

JEL Classification Numbers: D230; Q580.

[1] The authors would like to thank, without implicating, Christophe Déprés, Armelle Mazé, M'Hand Fares, Kenneth Richards and Oliver Williamson for their helpful comments and criticism. Their encouragement is gratefully acknowledged. They also thank Steven Kelly for editorial assistance.

Can Williamson's Analysis of Discrete Structural Alternatives Help Regulators to Choose Between Environmental Policy Instruments?[2]

"The problem is one of choosing the appropriate social arrangement for dealing with harmful effects. All solutions have costs and there is no reason that government regulation is called for simply because the problem is not well handled by the market or the firm. 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"

Ronald Coase (1960)

"Environmental economics is inherently a study of measurement problems. In a world of perfect information, both the problems and the solutions are straight forward: identify the relevant externality and administer the appropriate policy. In this situation the choice of policy is superfluous; taxes, standards, or marketable permits all possess the same efficiency properties."

Kevin Wainwright (1999, p .1)

1. Introduction

Although the contribution of Ronald H. Coase (1960) has been used extensively in environmental economics and is now an integral part of environmental economics textbooks, the contribution of one of his most influential followers, Oliver E. Williamson, has been largely ignored in the same literature. Despite the importance of Williamson's contribution, his systematic treatment of transaction costs in explaining governance structures has never been applied to the field of environmental economics. The aim of this brief paper is to address this oversight, as an initial step towards developing further analysis. In particular, our contribution focuses on the application of the analysis of discrete structural alternatives – market, hybrid forms and hierarchy – to the choice of policy instrument. Once some initial difficulties are overcome, Williamson's transaction cost economics may provide exciting insights, particularly for policymakers. Without investigating the reasons behind Williamson's absence from the environmental economics literature[3], we suggest that his discrete analytical framework (Williamson, 1991) may help policymakers in selecting policy instruments. Williamson himself stressed that "the upshot is that [new institutional economics'] many accomplishments notwithstanding, there is a vast amount of unfinished business –refinements, extensions, new applications, more ideas, more empirical testing, more fully formal theory (Williamson, 2000, p. 611). For Richards (2000, p. 254), a government's choice of policy instrument is "analogous to a private firm's "make-or-buy" decision about whether to produce goods and services directly or to contract with other firms for production. In the environmental instrument choice literature, which concentrates

[2] The authors are indebted to a statement made by Roger G. Noll (1989, p. 1266): "Thus, to Williamson (1975) "markets and hierarchies", we can add regulatory processes as an alternative institutional arrangement among firms for maximizing joint profits." Although the arguments developed in this contribution differ from his proposition, Noll's idea has provided an incitement to undertake the following analysis.

[3] Anecdotally, the traditional textbook of Baumol and Oates (1988) and survey of Cropper and Oates (1992) do not mention Williamson's contributions while the seminal Coase contribution (1960) is used several times.

primarily on minimizing production costs, the decision is generally cast as a choice between incentive-based instruments and command-and-control regulation, with a strong bias toward the former."

The remainder of this paper is organized as follows. The next section applies the transaction cost economics framework to environmental problems. We introduce the concept of environmental transaction between regulated firms and the regulator, aimed at producing a certain level of environmental good (or reducing a certain level of environmental harm). The third section considers policy instruments – market-based instruments, contractual approaches and command-and-control – as *grosso modo* equivalents of alternative governance structures in the theory of organisations, respectively, market, hybrid forms and hierarchy. The fourth section stresses some policy implications of applying Williamson's contribution to the analysis of policy instruments and demonstrates that the insights developed here constitute a challenging and exciting topic for further research. We also acknowledge the limitations of our extension and propose some testable implications that could form the basis of a continued research agenda.

2. Environmental-related transactions: definition and attributes

The transaction is the basic unit of analysis that "contains in itself the three principles of conflict, mutuality, and order" (Commons, 1932, p. 4). A transaction refers to an "elementary coordination problem" (Beckmann, 2000) between two parties and involves a transfer of property rights. Despite some differences – e.g. the lack of need for mutual consent or explicit contracts – the harmful effects discussed in Coase's seminal paper share common features with more conventional transactions. Coase (1960) explains that "in order to carry out a 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." Transactions do not necessarily occur "between entirely willing parties of equal power, and herein, it will be assumed only that dealings take place between parties who each exercise some influence over how the transaction is executed and its goal met. Thus, an arrangement made between a regulatory government agency and a polluting firm fits squarely within the definition established here for a 'transaction'" (Richards, 2002, p. 12). *In the scope of this contribution, the environmental-related transaction is somewhat restrictive and implies a regulatory agency and regulated entities for the production of environmental good or the abatment of environmental harm*[4].

Governance is viewed as "the farsighted means by which order is accomplished, thereby to mitigate potential conflict and realize mutual gains." (Williamson, 1998, p. 5). The attributes of the transaction "include the frequency with which transaction recur, the uncertainty to which transactions are subject, and the type and degree of asset specificity[5] involved in supplying the good or service in question." (Williamson, 1991, p. 281; see also Williamson, 1999, p. 309; see also Delmas and Marcus, 2003). We also consider other key attributes which characterize the environmental-related transaction: notably the difficulty of measuring the social output produced by each regulated entity and the number and heterogeneity of regulated entities[6] (Richards, 2000, p. 225-226).

The measurement dimension represents "the capability of government in assessing the social outputs of a private party" (Coglianese and Lazer, 2003). According to the same authors, "assessing social output" (…) [means] that the government is able to measure outputs accurately. For example, in the environmental area this would mean that the government is able to monitor emissions (or well-

[4] Environmental-related transactions can also occur between private actors, without state intervention, but this case lies beyond the scope of our analysis.

[5] Asset specificity may play a major role in certain environment-related transactions. In some cases, for example, the pollution occurs at a specific location and has to be managed at this level.

[6] We remain hesitant to introduce the degree of harmfulness as an attribute of environmental-related transactions because we are sceptical of its worth. It should be noted that a high degree of harmfulness may be interpreted as a very high social marginal cost of pollution. Consequently, a ban is considered as the best solution.

correlated proxies such as inputs) from the various facilities that are covered by an emissions regulation (…)" (Coglianese and Lazer, 2003). The measurement dimension encompasses so-called 'monitoring costs' that are frequently assumed to be zero –i.e. perfect and costless monitoring– or do not vary between policy alternatives (Cole and Grossman, 1999). Although the field of application differs significantly from our topic, the measurement branch of transaction cost economics has nonetheless highlighted the significance of measurement hazards (Williamson, 1996, p. 10; Alchian and Demsetz, 1972; Barzel, 1982). Richman and Boerner (2004) explicitly consider these measurement problems in their analysis of the location of waste facilities. Environmental-related transactions frequently imply a high degree of 'natural' uncertainty inherent to the complexity of environmental processes and the many ways in which humans interact with natural environments. Consequently, some firms may use these complex interactions and private information strategically to confuse the issue and accrue undue advantage. According to Williamson (1975; see Richman and Boerner, 2004 for an environmental-related application) all measurement problems may be traced to a "condition of information impactedness, i.e. when information is asymmetrically distributed between parties and can be equalized only at great cost. Information can be similarly impacted if it is costly to apprise an arbiter of the true information condition if a dispute arises among equally-informed parties".

The second dimension represents the characteristics and degree of heterogeneity of the regulated entities, both across locations and over time. The characteristics of agents, such as point-source polluters versus non point-source or mobile polluters, involved in environmental-related transactions are obviously important and frequently interact with the measurement dimension. "For a regulated sector to be homogeneous it means that (1) at a given point in time that most private actors have similar operations and (2) the technology used by these actors tends to be stable over time." (Coglianese and Lazer, 2003; see also Richards, 2000). A high degree of heterogeneity prevents the regulator from developing an appropriate "one-size-fits all" technology standard (Coglianese and Lazer, 2003). Regulated entities or the regulator may take advantage of such heterogeneity. Certain agents who have private information may promote institutional arrangements that favour them in terms of compliance costs, regardless of the environmental impact. Consequently, the regulator does not receive the expected environmental benefits. Regulated agents seek to minimize costs to achieve the 'right to operate' and eventually harm those competitors who are different (Salop and Scheffman, 1983).

As stressed earlier, the attributes of environmental-related transactions may generate contractual hazards between the regulator and the regulated entities that governance structures try to mitigate (Richards, 2000; 2002; Richman and Boerner, 2004). For Williamson (1996, p.5, 14) "the identification, explication and mitigation of hazards through governance are what transaction cost economics is." If the contractual hazards generated by the regulated entities seem obvious, the regulator is similarly not exempt from opportunistic behavior. For example, the regulator can adopt an opportunistic behavior once private firms have invested in specialized assets. Firms can make expensive investments in plants which are expected to depreciate over a large number of years. The future environmental demands of the regulatory authorities may be somewhat unpredictable, making the security tied to predictability of future regulation very valuable to the industry (Mortensen, 2001, p. 157). Indeed, private firms incorporate legitimate regulatory uncertainty in their investment decisions and this can lower the cost of efficiency-enhancing adaptive changes in the goals of government programs. However, social welfare decreases when investors weaken their investments for fear of expropriation by the regulator (Richards, 2000; 2002; Yao, 1988; Mortensen, 2001; See also Keohane, 2000 for an alternative view of the risk of 'hold-up' by the regulator due to asset specificity in environmental-related transactions).

3. Dimensionalizing environmental governance

Williamson (1991) distinguishes three governance structures[7] i.e. market, hybrid and hierarchy that are substitutable in achieving a transaction. We consider that the traditional typology of policy instruments may correspond, *grosso modo*, to these governance structures, respectively pure market-based instruments, contractual (or voluntary) approaches and command-and-control instruments. In a world of zero-transaction costs, these instruments are perfectly substitutable in achieving an environmental purpose such as pollution abatment. In a world of positive transaction costs, the choice of an institutional alternative depends on minimizing the costs which arise in the presence of measurement and heterogeneity problems (first order economizing).

We consider each category of policy instruments in its purest theoretical form and are conscious that the similarity is not perfect and that several counter-examples can be found in the real world (see Shapiro and Glicksman, 2000 for a discussion). Indeed, real instruments may include properties from different categories, but their dominant features enable us to categorize them. Let us briefly explain the content of each category. (1) ***Market-based instruments*** (or more narrowly price-based instruments), attempt to reproduce the market mechanism by putting a price on environmental goods. They rely on price signal and decentralized decision making by agents pursuing their own self interest to induce pollution abatement (Beder, 1996; Stavins and Whitehead, 1992). At the extreme, close to the vertical axis, there is ***free market environmentalism***, i.e. the use of market institutions particularly property rights, voluntary exchange, and common law liability rules to protect environmental resources. Free market environmentalism seeks to create and expand markets in environmental goods through the extension of market institutions to cover environmental resources that were external to market processes" (Anderson and Leal, 2001; Adler, 2001). Free market environmentalism has been the subject of several criticisms which suggest that the circumstances within which this approach fulfils its promises is quite limited (See for a brief review of these critiques Gunnningham and Grabosky, 1998, pp. 85-88). (2) ***Contractual approaches***, sometimes called co-regulation, correspond to agreements or conventions between governments and polluting firms, under which regulated agents commit voluntarily to undertake pollution control measures (For an extensive discussion and bibliography, see Mortensen, 2001 and Green, 2002). According to the European Commission (quoted by Mortensen, 2001, p. 155), a voluntary environmental agreement is "a contract between individual companies and/or association of companies on the one hand and public authorities on the other hand, concluded with the aim to protect or restore the environment." (3) ***Command-and-control approaches*** correspond to direct regulation by a centralized public authority that, relying on its coercive power prohibits or imposes restrictions on environmentally harmful activities. These regulations frequently impose the same standard on all regulated entities, regardless of their ability to satisfy the standards. They are binding requirements specified in laws and regulations. We consider command-and-control in its narrowest sense, where public authorities impose on each regulated entity *what* to do and *how* to do it. Distinguishing command-and-control instruments according to their ability to differentiate the requirements –'one size fits all' versus differentiated individual requirements or source-specific requirements– may allow a significant refinement of the discussion (For a discussion on the evolution of the concept of "command and control", see ERI, 2001 and Shapiro and Glicksman, 2000). Note that this categorization is by no means stable and remains subject to discussion in the academic literature (Gunnningham and Grabosky, 1998, pp. 37-91; see also Cole and Grossman, 1999). At the extreme, the public authority may fully integrate the whole entity, i.e. produce the environmental goods, such as

[7] Goldberg (1976) and Williamson (1976) are the first authors who consider regulation as a response to transactions that are difficult to contract. In a more recent paper, Williamson (1999) has extended transaction economics to the public sector by characterizing public transactions (i.e. adding probity to the three other key attributes) and dimensionalizing public governance structures (i.e. incentive intensity, bureaucratization, adaptability, staff security, legalistic dispute settlement). Despite the usefulness of this contribution, we prefer to use the framework of Williamson's (1991) original paper on the discrete analysis of governance structures in the private sector. An integration of the two contributions in a unified framework applied to environmental-related transactions remains a challenging topic for further research. Moreover, our analysis can be considered as positioned at an intermediate level between the levels 2 and 3 of social analysis, distinguished by Williamson (1998, p.25-29). Nevertheless, the analysis developed here must not obscure the role of the institutional environment (in the sense of Douglass C. North, 1990) that constrains the choice of policy instrument.

national parks, itself (Richards, 2000, p. 242, 263). Moreover, sub-categorization is required to deal with real policy instruments, but is beyond the scope of this exploratory analysis. However, the theoretical polar forms seem to correspond sufficiently to justify the comparison.

According to Williamson (1991), governance structures differ in (1) contract law respects, (2) adaptability and, (3) the use of incentive and control instruments. Because of many common features, the dimensionalization of governance structures can be easily extended to the identified structural alternatives of policy. Let us further explore such a dimensionalization by focusing on categories of environmental policy instruments (see Richards, 2000).

(1) *Each type of policy instrument needs to be supported by a different form of contract law*. Market-based instruments seek to imitate the market and can be viewed as supported by something similar to classical contract law (dispute settling by courts) in which the identity of transacting parties is irrelevant and dependence weak. Market-based instruments do not indicate the level of, or the means of achieving pollution abatement. Such decisions are taken by regulated entities in response to market signals. Market-based instruments see the market as "a powerful ally" (Tietenberg, 1990, p. 17) and "rely more on decentralised decision making and market mechanisms than do direct regulations" (James, 1997 quoted by Bari, 2002, see also Beder, 1996). In other words, market-based instruments seek to create markets for environmental goods. For advocates of free market environmentalism, common law liability rules are a key aspect in ensuring the success of this institutional arrangement (Anderson and Leal, 2001; Adler, 2001). Contractual approaches can be viewed as supported by neoclassical contract law or 'private contract law' (dispute settling by arbitration), in which the identity and dependence of transacting parties play a significant role (For a more in depth discussion of this point, see Webb and Morrison, 1999, pp. 229-259 and Dana, 2000). This is clear in the bargaining, implementation and enforcement of voluntary agreements between the regulator and regulated entities (OECD, 1999). The use of binding legal obligations in environmental contracts can vary in importance – located on a continuum from gentlemen's agreements to covenants imposing legally binding obligations related to clearly defined targets – for both parties. While the academic literature considers the obligations of the private party, the obligations of the public authorities are not analyzed. As far as we know, Mortensen (2001, p. 161-162) constitutes an exception and shows that this dimension is important, especially in relation to the risk of opportunistic behaviour by public authorities. Command-and-control instruments can be considered as supported by administrative law and the discretion of public authorities (internal dispute settling). Indeed, "command-and-control policies rely upon the power of a centralized authority, be it federal, state or local authorities" (Karp and Gaulding, 1995, p. 449).

(2) *The adaptive capacity* of market-based instruments is located in the so-created market. According to Williamson (1991, p. 277, quoting Hayek, 1945), "the economic problem of society is mainly one of rapid adaptation in the particular circumstances of time and place." By putting a price on environmental goods, the resultant price system created by market-based instruments encourages independent agents to undertake appropriate action (autonomous adaptability labelled as adaptability of type A). It is worthwhile to note that market-based instruments are "regulations that encourage behaviour through market signals rather than through explicit directives regarding pollution levels or methods" (Stavins, 2001, quoted by Bari, 2002; see also the virtues of free market environmentalism with respect to this aspect in Anderson and Leal, 2001). Conversely, the adaptive capacity of command-and-control locates this approach in the organization and cooperation generated by public authorities (Karp and Gaulding, 1995). A major advantage of command-and-control or hierarchical instruments is that they allow rapid adaptation to change. Formally, 'rapid adaptation' means that public authorities do not rely on markets or bargaining with private parties to achieve environmental progress. For instance, public authorities require only a small delay to ban a presumably harmful product, e.g. the ban of the Bayer insecticide *Gaucho* in France legitimated by the precautionary principle. Therefore, command-and-control may appear the most appropriate choice where the optimal level of pollution is zero and no pollution can be tolerated. In this particular sense, the adjustment process is obviously quicker than what can be obtained by market-based instruments or contractual approaches. In the case of direct public provision, or full integration of the considered activity, the

regulator has the residual rights to intervene, which constitutes an important option in the case of high uncertainty (Richards, 2002). Nevertheless, the political and administrative processes are frequently considered to be too long. This dimension devotes further attention to distinguishing the conditions under which the previous proposition about adaptation delay holds. This kind of cooperation is conscious, deliberate and purposeful (Williamson, 1991). This cooperative adaptability is labelled as type C. Contractual approaches display semi-strong adaptations of both kinds. For example, contractual approaches may include a clause limiting the public authorities' right to pass additional or stricter regulation for a fixed period. Indeed, the environmental demands of public authorities are supposed to be maintained for the duration of the contract. This security for the private party can have negative effects, if new scientific investigations, new technologies or new international obligations call for updated targets. Such negative consequences may be avoided, or at least reduced, by selecting a limited duration for the clause or including renegotiation clauses (Mortensen, 2001).

(3) Lastly, governance structures can be distinguished by their *incentives intensity* and level of *administrative control*. The academic literature argues that well-designed and well-implemented market-based instruments generate high-powered incentives to abate pollution and require limited administrative controls that together lead to autonomous adaptability. Production decisions are left entirely to private parties (Richards, 2000, 2002). For defenders of free market environmentalism (Anderson and Leal, 2001; Adler, 2001), institutional arrangements combining a system of well-specified property rights and common law liability rules generate positive and powerful incentives to preserve the value of that which is owned, e.g. the environmental resources. A mechanism where individuals act in self-interest offers the greatest potential to protect the environment: "Because the owner's wealth depends on good stewardship, even a short-sighted owner has the incentive to act as if he or she cares about the future usefulness of the resource" (Stroup, undated). Command-and-control instruments are frequently criticized because of their high administrative costs and low-powered incentives that lead to a more cooperative adaptability (Richards, 2000, p. 263; Hahn, 1989). Command-and-control instruments, in their purest form offer little or no discretion to the polluting party and maximize regulator control (Richards, 2002). Moreover, market-based instruments often reflect the key role of incentives in defining their character through the use of such expressions as 'incentive-based instruments', 'economic incentives' and 'incentives-based systems' (Cropper and Oates, 1992). According to a literature survey by Cropper and Oates (1992; p. 699), "command-and-control systems typically result in substantial "overcontrol" relative to incentive based systems." According to Stavins and Whitehead (1992, p.7), market-based instruments are approaches "that require less bureaucracy and governmental intrusion into business and household decisions." Contractual approaches are characterised by semi-strong incentives and an intermediate degree of administrative apparatus (Webb and Morrison, 1999; Mortensen, 2001; Green, 2002). Indeed, many contractual approaches include discretion sharing mechanisms, e.g. large building projects, development of new technologies, that place them between pure market-based and pure hierarchy approaches. The discussion above is summarized in table 1.

Table 1: Distinguishing attributes of market-based instruments, contractual approaches and command-and-control (Inspired from Williamson, 1991, p. 281)

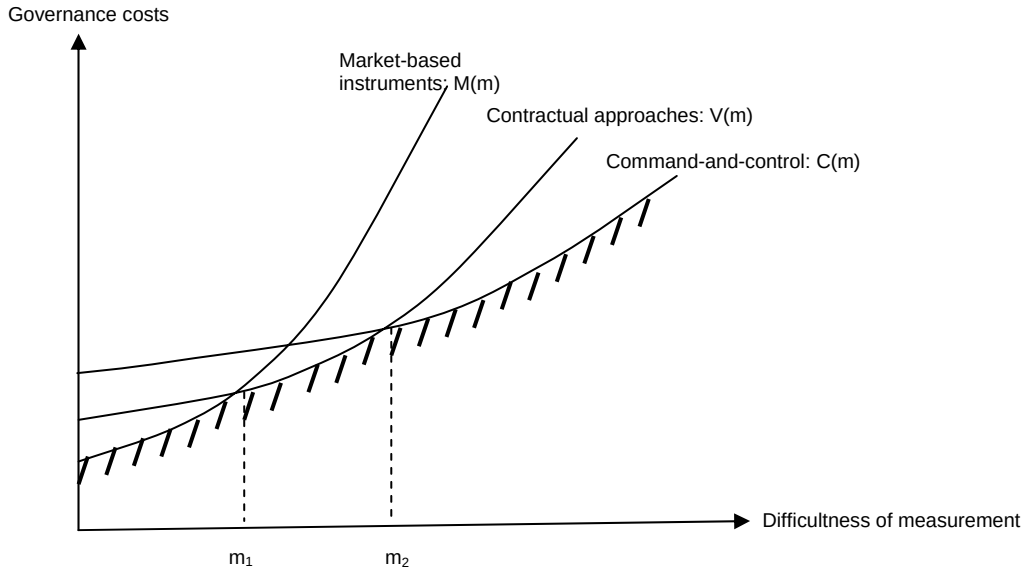
	Governance structure		
Attributes	Market-based instruments	Contractual Approaches	Command-and-control instruments
Instruments			
- Incentive intensity	++	+	0
- Administrative controls	0	+	++
Performance attributes			
- Adaptation (A)	++	+	0
- Adaptation (C)	0	+	++
Contract law	++	+	0

++ = strong; + = semi-strong; 0 = weak

4. Discriminating alignment: The reduced form analysis of alternative policy instruments in the field of environmental regulation

Like Williamson (1991, p. 282-283), we only achieve a truncated analysis. The governance costs are expressed as a function of the difficulty of measurement and a set of exogenous variables. Let M= M (m; θ), V = V (m; θ) and C = C (m; θ) be reduced form expressions that denote the governance costs of market-based instruments, contractual or voluntary approaches and command-and-control instruments as a function of the difficulty of measurement (m) and a vector of shift parameters (θ). Assuming that each mode chooses the same level of difficulty of measurement, the following comparative-cost relations obtain: M(0) < V(0) < C(0) and M' > V' > C' > 0. For a minimal level of measurement difficulty, that is to say zero, governance costs are positive. To achieve such an environmental-related transaction, the governance costs of market-based approaches are lowest and increase respectively with contractual and command-and control approaches. More formally, the first of these three inequalities reflects the fact that the bureaucratic costs (or weaker incentive intensity) of internal organisation exceed those of the market because the latter is superior in adaptation (A) respects, which is the only kind that matters when measurement is easy. The intercept for market-based governance is thus lower than is the intercept for hierarchy. The second inequality reflects the marginal disability of markets as compared with hierarchies in adaptation (C) respects as difficulty of measurement, hence bilateral dependency, becomes more consequential[8]. The third inequality reflects the intermediate position of contractual approaches. Following Williamson's (1991) reasoning, we obtain the relations shown in figure 1. Efficient supply implies operating on the envelope, whence, if m* is the optimal value of m, the rule for efficient supply is as follows: I, use market-based instruments for $m^* < m_1$; II, use contractual approaches for $m_1 < m^* < m_2$; and III, use hierarchy for $m^* > m_2$.

Figure 1: Goverance costs as a function of the difficultness of measurement
(Inspired from Williamson 1991, p. 284)



[8] According to the OECD (2001, p. 190), "there are many instances where command-and-control measures are necessary, nevertheless. This is the case, for example, where *technical or measurement problems* make it difficult to continuously monitor the environmental damage attributable to individual agents, or where – as for some hazardous substances – it is desired to reduce emissions to zero." While advocating for market-based instruments, Stavins and Whitehead (1992, p. 8) also explain that "in situations where monitoring problems are particularly severe, however, technologies are specified." See also ERI (2001, p.6) and Richards (2000, p. 265).

"In a very heuristic way, moreover, one can think of moving along one of these generic curves as moving toward more intrusive controls" (Williamson, 1991, p. 284). This point is particularly true for policy instruments where market-based instruments in their purest form or free market environmentalism, leave the higher degree of freedom for regulated agents, contractual approaches occupy an intermediate position where the public authorities take a hierarchical approach by retaining control over the target, the instruments selected and the tied rights (Richards, 2000).

5. Some policy implications and concluding remarks

Transaction cost economics constitutes an 'empirical success story' and has proved helpful in choosing between governance structures, especially in the private sector. This contribution is an attempt to extend Williamson's analysis to the choice of policy instruments for regulating environmental-related transactions. We assert that transaction cost economics remains largely unexplored in environmental economics and politics despite constituting a powerful analytical tool. For instance, transaction cost economics may provide guidance for policy makers choosing between categories of policy instruments. A major contribution of our exploratory analysis is to question the relevance of many economists prescription in favour of incentive-based instruments. Indeed, in some plausible circumstances, e.g. when output measurement is prohibitively costly, a command-and-control instrument may be more efficient by economizing on transaction costs. In other words, under a *ceteris paribus* clause, the measurement costs exceed the cost savings resulting from the greater flexibility allowed by other instruments. Moreover, the repartition of transaction costs between private parties and the regulator constitutes an important issue. Indeed, the desire to minimize overall costs may be mitigated by the regulator's (or regulated entity's) desire to attenuate his costs, regardless of the impact on the costs incurred by other parties. In certain circumstances, public authorities are likely to prefer command-and-control instruments, not because of their overall superiority in terms of economic efficiency, but because they can economize on transaction costs incurred by public authorities. A testable implication of this would investigate if developing countries use command-and-control instruments to economize on their own scarce public resources, regardless of this approach's overall efficiency.

As opposed to an in-depth analysis, our contribution constitutes a first step, an appeal for further research on the application of Williamson's analysis to environmental economics. As Williamson (1991, p. 294) asserts, "further developments of conceptual, theoretical and empirical kinds are needed". The definition of environmental-related transactions, the identification of their key attributes and the implied agents should be identified and analyzed more thoroughly. The correspondence between governance structures and categories of policy instruments, their dimensionalization and dynamics require further examination. Equally, the categorization of policy instruments employed in the paper is underdeveloped and deserves more attention. The transaction costs tied to each category of policy instrument may be refined by considering each category as including three constitutive stages, i.e. *design, implementation and enforcement* that are very similar to contract analysis (Williamson, 1985). Such analysis may help policy makers to predict the responses of regulated entities under different scenarios and legitimate their instrument choice. The simultaneous use of several categories of policy instruments, considered as the combination of substitutable modes of private and public ordering to regulate environmental-related transactions needs to be explored. The precise alignment of transactions to alternative modes of ordering principally market-based instruments, contractual approaches and command-and-control is still non-existent (see Delmas and Marcus, 2003 for a first attempt). The empirical testing of the theoretical propositions deriving from this extension – including the expected effects of transactions attributes on governance costs under different governance structures– constitutes a challenging issue and merits future research.

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