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Multiregulation and Development*

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(very preliminary)

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Boris BEREZOVSKY

"On the whole, the horizontal and vertical division of power is a guarantee against arbitrary rule and the usurping of power... In other words, a "bad" elected leader is better than a "good" leader appointed from above because the system of appointing leaders is defective in principle".

"The point of a federal organization of Government lies in the rational balancing of real, objective contradictions between central and local interests".

The Moscow Times - 01/06/2000

Adam SMITH

"Public works of a local nature should be maintained by local revenue"

because

"The abuses which sometimes creep into the local and provincial administration of a local or provincial revenue, how enormous so ever they may appear, are in reality, however almost always very trifling, in comparison with those which commonly take place in the administration and expenditure of a great empire".

The Wealth of Nations 1776

1 Introduction

Which advices should be given to developing countries for the structuring of their regulatory institutions, in particular about the need for multiregulators? This question has many dimensions. One can think of geographical decentralization[1] as one aspect of the problem. Should we have in federal states, a federal regulation or should we decentralize regulation in each state? Should we favor regional regulation beyond the boundaries of national states as in the European Union and as tried in Subsahara-Africa? One can think also of having one regulator per industry rather than a single regulator. For example gas and electricity are often dealt with by a single regulator. One can also think of functional multi-regulation. Should we have a single body to deal with regulation and competition policy as in Australia, or should we have separated regulations for environmental regulation, price regulation and quality regulation as in the regulation of water in Great-Britain?

When discussing multiregulation, one touches therefore on a immense number of issues and one cannot expect simple answers. In this paper, we attempt to review the various trade-offs which affect the choice between a single regulator versus multiregulators. To do so we will proceed in four steps which will enable us to provide a framework for evaluating those various trade-offs. In the first one, we maintain the myth of the benevolent informed Government but we admit that bounded rationality affects its decision making. In a second step we take into account the decentralization of information and the strategic behavior of the agents of the economy with respect to their private information. Still maintaining the benevolence of the Government we assume in step three that contractual incompletenesses affect the mechanisms that can be implemented by the Government. Finally, step four abstracts from the benevolence assumption and takes into account the fact that governments are under the influence of interest groups.

Along the way, we try to see when conclusions are affected by the specific characteristics of less developed countries (LDCs). In a concluding section we attempt to draw some synthetic conclusions despite the speculative character of this endeavor.

2 Bounded Rationality and Centralization

As pointed out by Sah (1991), the role of human fallibility or bounded rationality has not been studied in the debates about diversification versus concentration of political authority.

Even if we stick to a view of Government as a benevolent informed principal, taking into account the Government's bounded rationality leads to some insights into the structuring of power. We will rely here[2] on the theory of bounded rationality put forward

[1]The multiplication of agencies which have authority to contest mergers in the USA (DOJ, FTC, state attorneys general, private parties) might be an example of multiregulation motivated by bounded rationality arguments.

[2]Hart and Moore (1999) provide an alternative model of bounded rationality which also sheds some light on the centralization-decentralization issue. Associated to each project, a decision maker has a prob-

by Sah and Stiglitz in a series of papers (1986), (1988), (1990) and draw heavily on Sah (1991).

The Government can make two types of errors in a decision problem such as the choice of a project, the choice of a manager, the choice of a rule... The type one error is the probability p_1 of taking a bad decision and the type two error is the probability p_2 of rejecting a good decision.

Suppose we have two available decision makers or regulators. Should we organize decision making as a hierarchy, where an acceptance decision has to be made by both or as a polyarchy in which a single decision maker can make the decision and a project which is rejected by one is examined by the other decision maker?

In a hierarchy, the probability of accepting a good project is $(1-p_2)^2$ and the probability of accepting a bad project is p_1^2. In a polyarchy these probabilities are respectively $(1-p_2)(1+p_2)$ and $p_1(2-p_1)$.

Let W and $-V$ the values of a good and bad decision respectively and suppose that ν is the probability that the project is good.

In a hierarchy expected social welfare is

$$\nu(1-p_2)^2W-(1-\nu)p_1^2V,$$

instead of

$$\nu(1-p_2^2)W-(1-\nu)(2-p_1)p_1V$$

in a polyarchy.

A hierarchy is better if

$$(1-\nu)(1-p_1)p_1V>\nu(1-p_2)p_2W. \tag{1}$$

A hierarchical decision process corresponds to centralization while a polyarchical one corresponds to decentralization. Formula (1) gives the following insights[3]. When mistakes are very costly and bad projects quite common centralization is better, while decentralization is favored if good projects are common and have a high value. A weak quality of decision making that we can associate with LDCs favors decentralization.[4]

For questions which can threaten society such as public health or security issues this would favor centralization, while projects which have great potential value and little downside favor decentralization.

Suppose now that the decision makers differ in their abilities to make decisions, and let us now associate decentralization with a larger number of decision makers. Then, if

ability of taking a "good" decision (i.e. a decision yielding some value for him). With the complementary probability he can delegate the decision to a subordinate who can also take a good decision (which has value to the subordinate). Also, the value created by a project decreases with the number of projects undertaken. There are also coordination tasks in addition to those "specialization" tasks.
See also Bolton and Farrell (1990), Radner (1992), Keren and Levahri (1979), Bolton and Dewatripont (1994).

[3]See Appendix 1 for more details and some intuition about the last result.

[4]The robustness of this conclusion should be checked in other bounded rationality models.

decision makers are chosen randomly a less centralized society has the advantage of a greater diversification of its performances. Welfare will have the same mean but a higher volatility under greater centralization. The effect of human fallibility is that more centralized societies will have more volatile performances. However, decision makers are not chosen randomly and to the extent that the single decision maker of a centralized system can be well chosen (in a good merit-based selection of decision makers), centralization is favored. This is particularly true for decision problems which are well identified ex ante and for which appropriate selection mechanisms can be designed. It is not necessarily true in a changing world where the diversity of decision makers of a decentralized system might induce a greater ability to react to unanticipated events.

So far we have reglected the possibility of gains from coordination and economies of scale which favor centralization. However, centralization requires communication and as communication is also fallible, limiting communication and therefore centralization has also value.

Which lessons can we derive for developing economies? First, the large variability of experiences ranging from highly successful countries (South Korea, Singapore...) to highly unsuccessful ones (in Africa) is consistent with the variability induced by centralization. The greater imperfection of decision making and the higher costs of communication (of the Sah-Stiglitz type) militate in favor of decentralization and also centralization entails more risk since it is likely that the merit-based selection system will be less efficient than in a developed country. Concerning regulation, the extreme lack of human resources clearly militates in favor of centralization to the extent that economies of scale exist. One should even envision regional regulation encompassing several countries, as well as multisector regulators and even an integrated regulation and competition policy. The perspective of improving quickly the expertise of a limited number of regulators with international support appears great. Also, if new information technologies can be developed in these countries, better communication costs also militate in favor of centralization as well, but not relatively to developed countries. Furthermore, those regulatory questions, as important as they are do not threaten the survival of those countries. So the added value of hierarchical systems (which multiply decision makers in a centralized way) seems limited.

We obtain conflicting results summarized below.

	Favors Decentralization Relatively More in LDCs
Cost of communications	+
Cost of regulators	−
Imperfection of decision making	+
Quality of selection of large decision makers	+

Summarizing, we can risk the following advice: Given the lack of human resources, the costs of decision making militate for centralized regulation in a first stage during

which the emphasis should be placed on developing those human resources and simple regulations should be chosen. In a second stage as regulation becomes more sophisticated a partial decentralization of regulation will be desirable.

3 Benevolent Uniformed Government

The next paradigm to discuss our topic is the one of a benevolent Government in a world where the regulated agents have private information.

When all concerned parties are rational agents and when the judicial system is such that complete contracts can be signed, the Revelation Principle gives us a useful benchmark. Any form of regulation by the Government can be replicated by a centralized mechanism in which all agents transmit in an incentive compatible way their private information to the Government who then issues orders for verifiable variables and recommendations for moral hazard variables. Centralization remains optimal despite the superior information of the periphery.[5]

The optimal regulation that the Government can implement entails a trade-off between rent extraction and efficiency. The Government can also have a more proactive behavior with respect to its asymmetric information. It can use intermediaries who will mitigate the extent of the asymmetric information.

Regulatory agencies can be viewed as such intermediaries and we can raise the question of the optimal structuring of these agencies. A few recent papers are relevant for this discussion.

In Dewatripont and Tirole (1999), the separation between two bodies is based on the notion of advocate. The rewards to informational intermediaries can only be based on decisions. Two types of information can be searched for. Favorable type 1 information favors project A, favorable type 2 information favors project B, while no information or two pieces of favorable information lead to no project.

The two costly activities of search for information create negative externalities one on the other. Indeed, after finding type 1 information for which he can be rewarded by a payment conditional on decision A, the regulator has no incentive to search for type 2 information, because this could only lead to no decision and therefore to a lower reward (if some incentives for search are to be set up at all).

By having one regulator in charge of searching for one type of information only, and to the extent that these two regulators do not collude, better incentives can be provided. Indeed, when searching for one type of information, one regulator does not internalize the fact that, if he succeeds, he creates a negative externality on the other regulator. The two moral hazard variables (which given the reward system cannot be contingent on

[5]Many papers (Gilbert and Picard (1996) for example) argue in favor of decentralization because information is decentralized to start with. This argument is not valid under the assumptions of the Revelation Principle. A further imperfection must be postulated, costly communication as in Section 2 or some other form of bounded rationality.

the information discovered itself) are the search for information and transmission of this information when the search is successful.

It is often thought that, when two activities —say gas and electricity— interact it is good to have a single regulator (as in England today, and soon in France). However, having two regulators has the value of making it easier to provide incentives to regulators. Similarly, one may want to separate the Ministery of Finances who is in charge of looking for reasons for not spending on a project from spending Ministeries such as the Ministery of Industries, Transportation or Agriculture.

To which extent this argument compensates for the loss of coordination that separation creates is, of course, an empirical question.

This idea is close but different from the more common notion of yardstick competition where the multiplication of regulators should yield performance measures which enable the Government to cut down the informational rents of the intermediaries. In working for the Government, a regulator does not internalize the fact that he creates a negative externality for the others regulators through the information he transmits. In practice yardstick competition faces the controversial issue of unobservable heterogeneities which weaken considerably the power of these mechanisms. Multiregulation may rely also on the belief that manipulation of accounts makes more difficult if not impossible to identify the performance of each effort level or individual action when the activities are integrated and on the more straightforward ideas, that the disutility of effort functions favor separation (diseconomies of scope) or on the technological characteristics which affect the information rents (Baron and Besanko (2000)).

In all those cases so, it is fundamentally the same idea of providing better incentives to regulators to carry out their tasks, by inducing a more favorable rent-extraction-efficiency trade-off. The tasks in organization theory are in general productive tasks whose outcomes affect directly agents while, in the context of regulation, the tasks are costly for the regulators but impact outcomes which affect them only through the rewards they may have from the Government.

A related idea has been modeled by Laffont and Martimort (1999) as follows. In their supervision function, regulators have in general some degrees of discretion. Rather than transmitting the acquired information to the Government who can then decrease the informational rents of the agents, the regulators can be captured by the agents for not revealing this information and share the information rents with the agents (Laffont and Tirole (1991)). Laffont and Martimort (1999) show that separating the supervision functions between several regulators makes often side-contracting more difficult, and therefore less distortive the regulatory response of the Government to collusion.[6]

Suppose we have two regulators. By not colluding with the regulated agent (i.e. revealing his acquired information), a regulator does not internalize the fact that it makes more difficult or impossible the collusion of the other regulator with the agent. In other words separation of regulators increases the transaction costs of collusion to the benefit of the Government. Note the importance in the reasoning of taking into account the

[6]Gilbert and Kahn (1996) suggest that in the USA the system of state regulatory agencies away from local franchising processes led to more capture by the industry.

regulatory response of the Government who makes use of the lack of coordination of the regulators.[7]

The activities that interact here are the moral hazard variables of not colluding which must be induced. As they create negative externalities one on the other, separation of powers is beneficial as above.

The major weakness of all the above arguments is that their rely on the implicit assumption that the separated regulators will not collude.[8] Indeed, most of the literature on mechanism design which uses the competition of agents to create incentives has been making this naive assumption. Perfect collusion would bring us back to the single regulator framework. However, to the extent that the Government controls the information technologies made available to agents, it can create asymmetries of information among them. As emphasized in Laffont and Martimort (1997), (2000) asymmetric information between colluding agents creates transaction costs which are beneficial to the principals. So collusion will be imperfect and separation of powers can be designed to be collusion-proof between regulators. Of course, such considerations weaken the value of this institutional design.

Finally, let us note the dangers of reciprocal supervisions which favor reciprocal collusive activities at low transaction costs (Laffont and Meleu (1997)).

Which particular insight can we derive for developing countries? In Laffont and Meleu (2000), we show that most characteristics of LDCs (cost of public funds, transaction costs of collusion, size of asymmetric information) favor even more separation in a framework of the Laffont and Martimort (1999) type. Unfortunately, those same parameters make also more costly to implement a collusion-proof separation of powers (see Appendix 2 for more details).

We obtain:

	Favors Several Regulators Relatively More in LDCs
Cost of public funds	+
Transaction costs of collusion	−
Size of agency problem	+
Cost of regulators	−
Enforcement of separation	−

[7]Not taking into account this institutional response may lead to the misleading idea that centralized regulation is better for corruption because decentralized corruption leads (with a free riding argument) to excessive corruption (Shleifer and Vishny (1993)).

[8]It is very important to take into account collusive behavior in these discussions about structural regulation. In Faure-Grimaud, Laffont and Martimort (2000) we show in a principal-supervision one agent adverse selection problem, that the optimal collusion-proof contract is equivalent to decentralization to the supervisor of the choice of the agent's contract. In other words, if the principal cannot prevent collusion, he is as well off giving up completely the control of the agent.

4 Benevolent Government with Contractual Constraints

We review here the various types of contractual constraints which affect the optimal structuring of regulation.

4.1 Incomplete Contracts

Laffont and Zantman (1999) argue that local politicians are better informed about local conditions than the central Government. The justification given is that local politics creates the incentives for information acquisition by these politicians. However, the Constitution does not allow a complete contract which would enable the center to remunerate those politicians for information transmission. Consequently, despite the fact that they have political biases, it may be better to decentralize to them some collective decisions rather than using a costly supervisor who has no prior information.

Implicitely, the same foundation lies in the trade-off studied by Gilbert and Picard (1996) where local decision makers are better informed, but their objectives are based and unknown from the central Government. The better information of local authorities is balanced with the greater information rents (capture) that those local authorities leave to regulated firms in Caillaud, Jullien and Picard (1996).

As Aghion and Tirole (1997) pointed out, information structures are endogenous. The choice to decentralize decisions creates also more incentives locally to acquire information. However, the value of this is limited by the fact that local preferences differ from the preferences of the center.

The Tiebout (1956) model of decentralization can also be interpreted as a response to incomplete contracts. There, the difficulty is the elicitation of willingnesses to pay for local public goods to achieve the right partition of the population into communities and the right levels of local public goods within those communities. This could be achieved by a grand mechanism which uses non linear and personalized transfers to elicit the relevant information with the best rent-efficiency trade-off. Alternatively, if payments are constrained to be uniform within each community, decentralization of the level of public goods to communities within which agents selfselect themselves by voting with their feet is a second best mechanism of information revelation.[9]

One can expect contracts between the center and the periphery to be even more incomplete in LDCs than in developing countries, and there is no particular reason why local preferences should be more or less biased away from social welfare maximization, or why coordination problems worse. This would create a bias in favor of decentralization when it is really the case that local information is good. This may justify the trend towards local decision making for managing water resources, forests, etc. On the other hand for many issues, like health, or some environmental issues, one may fear that local information is quite poor, and that the central Government with better access to international

[9]Bardhan and Mookherjee (1999) suggest that the role of this type of mobility is less likely to be relevant in developing countries.

information has in fact much better information at least along some dimensions, and this weakens the benefits of decentralization.

4.2 Lack of Commitment

We remained quite vague in the last section about the nature of the contract incompleteness. It might have been that some variables were not verifiable or some contracts not enforceable.[10] The lack of commitment is also a particular form of contract incompleteness.

The delegation of authority for decision making to agents who have particular objective functions may be a way to solve commitment deficiency. For example, if the Government cannot commit to resist a merger, then delegating to a competition agency the right to decide may be optimal.[11] Of course, this requires setting up credibly incentives for the members of the agency which will lead them to favor competition.

For a benevolent Government, this argument requires the merger to be ex post efficient. Delegation then is a way to commit to an ex post inefficient decision (preventing the merger) in order to avoid creating bad ex ante incentives. For example, resisting successfully foreign competition is possible by innovation and other efforts to improve ex ante efficiency. Alternatively, one may not make these efforts and benefit from the increasing returns from merger to be able to resist. However, the second strategy is very costly for consumers because of the market power created.

From contract theory (Baron and Besanko (1992) for example), we know that in repeated relationships with adverse selection (and perfectly correlated types intertemporally) it is optimal to commit to use the repetition of the optimal static contract in the rent-efficiency trade-off. However, after the first period, the type of the firm is common knowledge, this contract is not ex post optimal, and the partners in the contract would like to renegotiate. It is then important for efficiency that the Government should have the credibility to commit not to renegotiate.

However, a realistic assumption is often that governments have the ability to commit (remember that we are still assuming that they are benevolent) but not the ability to commit not to renegotiate with the regulated agents. This contractual opportunism emphasized by Williamson (1985) was first modeled by Dewatripont (1989), but the characterization of optimal mechanisms when the Government cannot commit not to renegotiate was achieved in Laffont and Tirole (1990). The first step of that analysis is to show that the optimal mechanism is renegotiation-proof, since the principal can anticipate the outcome of renegotiation and mimic it. The optimal renegotiation proof mechanism leads to semi-separating equilibria in which agents only partially reveal their types in the first period in order to maintain an information rent in the second period.

By inducing a first period equilibrium in which the principal remains uninformed he

[10] Note that a lack of information due to a contractual incompleteness may have some value when commitment is weak by creating an arm's length relationship (Crémer (1995)).

[11] See also Dewatripont and Tirole (1994).

commits not to extract completely the information rent of to-morrow, since the optimal ex post renegotiated contract entails an information rent for the agent. He commits to some ex post inefficiency.

An even better outcome can be achieved when the agent is performing two actions, if the Government commits to have two regulators each one in charge of one activity. The non cooperative behavior of the regulators in the second period may lead to a higher rent being awarded to the agent, i.e. yields indirectly a commitment to a greater inefficiency (see Martimort (1999)).

Problems of credibility are likely to be even worse in LDCs than in developing countries and this would tend to favor again decentralization. However, the various ways of delegating decision making to overcome lack of commitment are more difficult to implement in LDCs.

The value of a competition agency to this effect depends greatly on its ability to resist capture and one may argue that the transaction costs of capture are lower in LDCs. Similarly the value of creating a multiprincipal regulatory structure to commit not to expropriate a firm ex post relies on the assumption that those principals will not collude.

4.3 Collusion

From the point of view of the Revelation Principle, the occurrence of collusion may be viewed as resulting from the inability of the center to control communication within its organization. This is an implicit assumption of the revelation principle, and, in a sense, our analysis of separation of powers in order to weaken the costs of collusion belongs to this section as well.

Decentralization can be viewed as an optimal response to collusion as follows. Consider a center who uses a risk averse supervisor to monitor an agent who has private information and suppose that the supervisor and the agent communicate and can collude. Then, Faure-Grimaud, Laffont and Martimort (2000) prove the following. The optimal contract that the center can write with those two agents (which is collusion-proof from the collusion-proof principle) is actually equivalent to delegating to the supervisor the right to contract with the agent, i.e. to the decentralization of the contract of the agent. In other words, in the presence of collusion there is no point in centralizing the design of contracts.

If furthermore we introduce some imperfection in the design of the centralized contract, we may obtain the strict superiority of decentralization (as in Laffont and Martimort (1995)).

Similar insights are obtained in models with moral hazard. Macho-Stadler and Perez-Castrillo (1995) show that when agents can sign side contracts decentralization is equivalent to centralization.[12] This, of course, does not mean that collusion is good for the center. In the absence of collusion the center would achieve often first best efficiency with revelation mechanisms, and when there is collusion, with no constraints on contracts, the optimal allocations can be obtained without collusion (Holmstrom and Milgrom (1990),

[12]See also Baliga and Sjöström (1998).

Itoh (1993)). But, to the extent that collusion is possible communication between agents may be favorable to the center in its construction of a collusion-proof optimal mechanism (Laffont and Rey (2000)).

It is likely that the center will have even greater difficulties to control collusion in LDCs so that the above results favor relatively decentralization in those countries.

5 Non Benevolent Government

The next step to discuss our topic is to give up the hypothesis of benevolence for the Government.

For Seabright (1996), "the difference between centralized and decentralized Government is a matter of which groups of electors are collectively given the power". He argues that local politicians have a greater accountability, because they will be controlled (through election mechanisms) by voters who have a greater probability of influencing their reelection than politicians in the central Government. This gain may counterbalance any loss coming from the lack of coordination that decentralization entails.

Note that it is the contractual incompleteness of the Constitution making complete contracts with politicians impossible which is the source of this trade-off.

Once it is recognized that there is some inefficiency at the central and the local levels of decision making due to the political institutions there is clearly room for the superiority of decentralization or centralization.

Bardhan and Mookherjee (1999) use the Bernheim and Whinston (1986) political economy model of capture to compare centralization and decentralization, and argue that, contrary maybe to a widely shared belief, decentralization is not necessarily worse from the point of view of capture.

Crémer and Palfrey (1996) compare from a positive point of view the choice of centralization or decentralization assuming that collective decisions are made by the majority rule (which yields generically decisions different from those which would maximize a social welfare criterion), with the further constraint that centralization requires uniform rules[13] which favor policy moderation. The comparisons are guided by the risk aversion of the agents. Each voter must arbitrate between his forecasts about the identity of the median voter in his region or in the whole country. They study how voting procedures affect the choice of centralization or decentralization at the Constitutional level. They show that a two stage procedure in which representatives elected by voters decide with a majority vote is more favorable to centralization than direct voting by agents (the aggregation principle).

Similarly, Bolton and Roland (1997) study for given decision mechanisms for public goods when a region prefers separation. Separation is more likely when the median incomes in regions are different from the aggregate median income (political effect), when

[13]See also Besley and Coate (1998).

positive externalities between regions are low (efficiency effect), and when production levels differ between regions (tax effect).

Laffont and Pouyet (1999) show that the competition between national regulators leads to too high powered incentive schemes as each regulator tries to reimburse less of the cost than the other regulator to induce a strategic allocation of costs. Combining this distortion with a political system, they show that centralization which internalizes externalities between regulators but suffers from an excessive fluctuation of policies due to the majority game can be dominated by decentralization which induces too high powered incentive schemes from the regulators but which destroys the discretion of politicians (see Appendix 3).

In this model, a high cost of public funds associated with LDCs favors centralization because of the costly high powered incentive schemes of decentralization. However, if the regulated activities entailed moral hazard variables which were complements instead of substitutes as we have assumed here the reverse would hold.

The lack of confidence in governments leads to a limitation of their mandates. Consequently, Governments can only commit for a short period. In an adverse selection principal agent context this leads to the ratchet effect. The agent hides himself with a mixed strategy to maintain a rent in the future, since he knows that future regulators will leave him no rent if they are fully informed about his type (Laffont and Tirole (1988)).

Olsen and Torsvick (1995) show then that, committing to have several regulators (who will leave in the future more rents to the agent through their non-cooperative behavior if the regulated activities are complements) helps mitigate the ratchet effect. Less pooling in the first period is needed to indirectly commit to the same informational rent in the second period.

Even though on can presume that non benevolence at all levels is an even greater problem in LDCs which lack appropriate institutions and counterpowers, it is not clear in which direction this tilts the choice between centralization and decentralization "Simple generalizations about relative capture are therefore hazardous on the basis of theory alone" Bardhan and Mookherjee (1999).

6 Conclusion

It is quite acrobatic to try to synthesize all these arguments into any form of recommendation. Nevertheless, a general rule seems to emerge. Viewed from the Revelation Principle, multiregulation is a way to mitigate problems created by the cost of communication, the imperfection of decision making, the need for incentives, collusion, incomplete contracts, limited commitment etc. To the extent that these problems are even more serious in LDCs, the institutional designs of multiregulation appear even more useful in LDCs.

However, the lack of human and real resources make these innovations more difficult to implement in LDCs where furthermore collusion is more difficult to fight.

Of course, multiregulation entails a loss of coordination that we have not stressed in

this paper because we do not see arguments suggesting that this problem could be worse in LDCs.

These considerations suggest the need to start in LDCs with rather centralized regulation of public services which require high technical knowledge (telecommunications, electricity, gas, competition policy...), leaving policies which require a lot of local information and little technicity (water management, social regulation) to local authorities.

A major effort, and the possible focus of aid, should then consist in building up human resources in regulatory expertise to move, in a second step, towards more decentralized regulation when local information is very useful.

For functional multiregulation the lack of resources favors again centralization, but the capture arguments which could motivate decentralization are ambiguous in the general case.

Finally, let us emphasize that we have taken here a normative approach. When looking at the historical evidence, one is struck by the role of political constraints. In a federal state, regulation is likely to be decentralized. To each Ministry will be associated a particular type of functional regulation. A less powerful political body, like a city, may obtain some regulatory power, in water for example, if there is no natural regulator associated with a more powerful political structure. From a given allocation of regulatory powers determined by political structures, cooperation between those structures which recognize externalities between their regulatory activities as well as the issues we have stressed above may lead or not to a socially better allocation of such powers.

Consequently any advice should take very seriously into account[14] the current political structures.

[14]In England nationalization of the electricity industry in 1948 appeared to be the only way to coordinate the fragmented and municipally regulated local distribution.

APPENDIX 1
Bounded Rationality and Decentralization

There are two kinds of projects. Good projects with a value W in proportion ν and bad projects with value $-V$ in proportion $1-\nu$.

Decision making is imperfect. Let p_1 be the probability of accepting a bad project, while p_2 is the probability of rejecting a good project.

If $p_1 = p_2 = 0$, decision making is perfect. If not, it makes sense to assume that the probability of accepting a good project is not less than the probability of accepting a bad project, i.e., $p_1 \leq 1 - p_2$.

If projects are always accepted, the expected social value is $X = \nu W - (1-\nu)V$.

We will say that projects correspond to critical decision problems when $\nu W < (1-\nu)V$, i.e. accepting bad projects is very costly with respect to the gain of accepting good projects and non critical if the reverse holds.

Let $(1-\nu)V = \alpha\nu W \equiv$ Projects are critical if $\alpha > 1$.

The expected value of a hierarchy is then

$$V_H = \nu W[(1-p_2)^2 - \alpha p_1^2],$$

and for a polyarchy it is

$$V_P = \nu W[1 - p_2^2 - \alpha p_1(2-p_1)].$$

First, we consider the case where $p_1 = p_2 = p$ and from $1 - p_2 \geq p_1$, p in $[0, \frac{1}{2}]$. We have immediately:

Proposition 1 *If $p_1 = p_2 = p$, a hierarchy (polyarchy) is better for critical (non critical) decision problems.*

Proof:

$$\begin{aligned} V_H - V_P &= \nu W[1 - 2p + p^2(1-\alpha) - (1-p^2) + \alpha p(2-p)] \\ &= \nu W(\alpha - 1)2p(1-p) > 0 \quad \Leftrightarrow \quad \alpha > 1. \end{aligned}$$

The main intuition is therefore that hierarchies are better for situations where mistakes are very costly, and we find such situations both in developed and non developed countries.

Let us now consider a more general class of decision problems where $p_2 = kp_1$ with $k \leq 1$ to respect the condition $1 - p_2 \geq p_1$.

Then we find:

Proposition 2 *If $p_2 = kp_1$, a hierarchy is better than a polyarchy if*

$$\alpha > \frac{k(1-pk)}{1-p}.$$

Figure 1 illustrates this result.

Proof: Let $p_1 = p$; $p_2 = kp$.

Indeed

$$V_H - V_P = 2p\nu W[\alpha - k + p(k^2 - \alpha)].$$

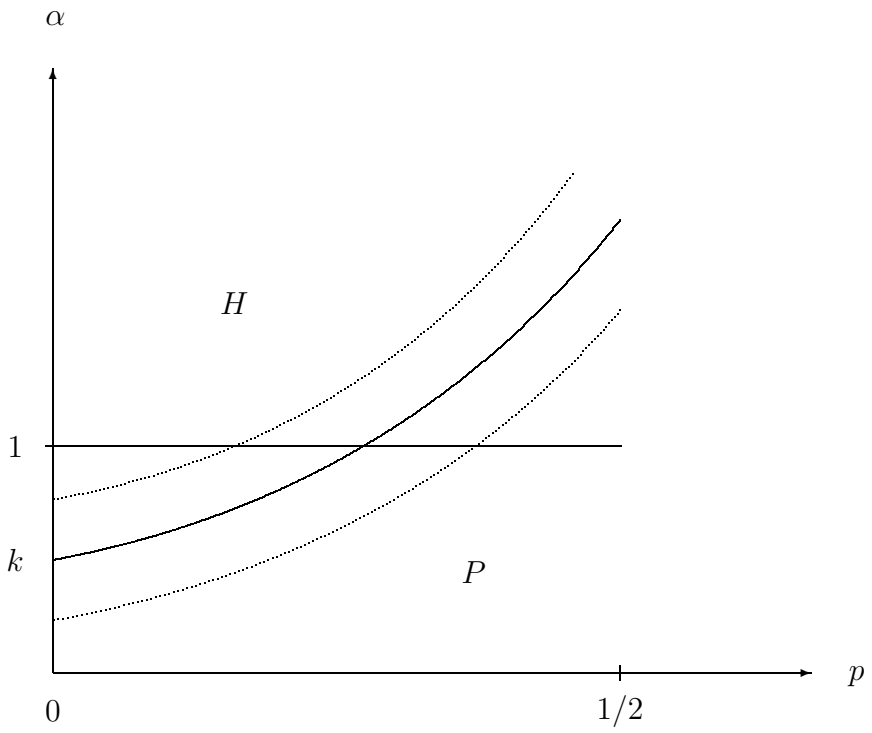

Figure 1

$$\phi_k(p) = \frac{k(1-p^k)}{1-p}$$

is an increasing convex function of p.

We can conjecture that the decision process is less efficient in LDCs in the sense that p is higher. This induces a bias in favor of polyarchies. Also if k increases (the decision process is less discriminating), the polyarchy is also favored ($\frac{d\phi_k}{dk} > 0$).

Intuitively, as the quality of decision making deteriorates, the quality of hiearchies worsens faster. For good projects we have:

$$\begin{aligned} G_H &= \nu W(1-p_2)(1-p_2) \text{ for a hierarchy} \\ G_p &= \nu W(1-p_2)(1+p_2) \text{ for a polyarchy.} \end{aligned}$$

As p_2 increases, then G_H decreases faster than G_p. For bad projects we have:

$$\begin{aligned} B_H &= -(1-\nu)Vp_1 \cdot p_1 \\ B_p &= -(1-\nu)Vp_1(2-p_1). \end{aligned}$$

Also as p_1 increases the cost of bad decisions increases faster for B_p than B_H, but this second effect is less than the first effect because $p_1 \leq 1 - p_2$, bad projects are accepted less often than good projects.

APPENDIX 2
Separation of Powers and Development
with Mathieu Meleu

1 Introduction

It is well recognized now that the design of proper institutions is key to development. Among the characteristics of governmental institutions, separation of powers stands as a shining cornerstone of democracy. Article 16 of the French Declaration of the Rights of Man of 1789 goes as far as saying "A society in which the guarantee of rights is not assured, nor the separation of powers provided for, has no constitution". Indeed, since Montesquieu (1748), separation of powers is explicitely recognized as vital:

> "Tout serait perdu si le même homme, ou le même corps des principaux et des nobles, ou du peuple, exerçaient les trois pouvoirs : celui de faire des lois, celui d'exécuter des résolutions publiques, et celui de juger les crimes ou les différents des particuliers", p.589 .

Hamilton and Madison in the Federalist Papers (Madison et al. (1788)) referred to Montesquieu as "the oracle who is always consulted and cited on this subject". They put these principles into practice for the American Constitution within a broader view of checks and balances.

It is only recently that economists have started modeling the value of separation of powers.[15]

A first reason for duplicating regulation agencies is yardstick competition. Using the correlation of the signals obtained by these agencies enables the principal to extract in a costless way their information rent. This idea was modeled by Shleifer (1985) in the case of perfect correlation and Crémer and McLean (1988) in the case of an arbitrary degree of non zero correlation.[16]

A second reason for separation of powers is to act as a device against regulatory capture. This general idea has been known for a while by political scientists (Moe (1986), Wilson (1980), Mueller (1997)). The Public Choice school has emphasized the fact that institutional rules may be designed to discourage rent seeking behavior. Rose-Ackerman (1978) and Congleton (1984) have argued that increasing the number of individuals who must be bribed before getting a permit may be optimal. Laffont and Martimort (1999) have provided a modeling of this idea which must be distinguished from yardstick competition which is a pure informational competition. Recent studies of relative capture of

[15] We refer mainly to the modeling literature in terms of adverse selection because we will use this framework. There exists a parallel literature for models with moral hazard especially for the first motivation given below.

[16] Auriol and Laffont (1992) consider a stochastic structure with a common part and idiosyncratic shocks. Then, yardstick competition decreases but does not eliminate rents. Dana and Spier (1994) obtains a similar outcome with limited liability of regulators.

local and central governments include Seabright (1996), Bardhan and Mookherjee (1999), Laffont and Pouyet (2000).

A third reason reported in Moe (1986) is that separation of powers may be beneficial when intertemporal commitment is limited. It may act as an indirect way to commit. Agency models have been developed recently to capture this idea (Olsen and Torsvick (1993), Tirole (1994), Martimort (1999)).

A fourth reason modeled by Sah and Stiglitz (see (1986), (1991) for example) is that it may be an efficient way of dealing with the risk of errors.

A fifth reason (based on a model of multitasks with some incomplete contracting (see Dewatripont, Jewitt and Tirole (1999)) is that separation of missions makes it easier to provide powerful reputational incentives.

Even though, decentralization and separation of powers are often discussed in development economics, we are not aware of any research which inquires if the characteristics of LDCs affect the trade-offs involved in these institutional choices. This paper is a first attempt at this task in a model where separation of powers in a regulatory framework is a tool of yardstick competition against regulatory capture. Section 2 lays out the model. The power of a regulator is his ability to enter collusive agreements with the regulated firm. Section 3 describes optimal benevolent regulation with one or two signals. Sections 4 and 5 characterize the optimal collusion-proof regulation with one regulator and two regulators respectively. We identify some parameters of the model which take higher values in developing countries. The comparative statics on these parameters provides in Section 6 the answer to our question of how the value of separation of powers varies with the level of development. It shows that most indicators suggest that this value is even higher in developing countries than in more developed ones. On the contrary Section 7 reveals that the cost of implementing the separation of powers increases with underdevelopment. Section 8 sketches a political economy model to discuss the endogeneity of the particular institution which is the separation of powers. Section 9 concludes.

2 The Model

Consider the problem of public good provision by a regulated monopolist which has private information about its cost function. Producing q units of public good has a cost θq. The marginal cost θ can take one of two values $\{\underline{\theta}, \bar{\theta}\}$ with respective probabilities ν and $1-\nu$. Let $\Delta\theta = \bar{\theta} - \underline{\theta} > 0$. Denoting t the transfer from the Government to the firm, to obtain participation of the firm, an individual rationality constraint must be satisfied for all values of the information parameter θ, namely

$$U = t - \theta q \geq 0.$$

Consumers derive an utility $S(q)$, with $S' > 0, S'' < 0$, from public good consumption. Funding of public good production requires indirect taxation with a cost of public funds $1 + \lambda > 1$, hence consumers' welfare is

$$S = S(q) - (1 + \lambda)t.$$

Social welfare is defined as

$$W \equiv S + U = S(q) - (1+\lambda)\theta q - \lambda U.$$

Under asymmetric information about θ, the benevolent social maximizer is obliged to give up a costly information rent to the firm.[17] To mitigate this cost, the social maximizer delegates to regulators the task of supervising the firm. A regulator observes a signal correlated with θ which enables the social maximizer to decrease the information rent of the firm. More specifically, consider the case of two supervision technologies.[18]

Technology i provides a signal $\sigma_i \in \{\phi, \underline{\theta}\}$, $i = 1, 2$. The signal σ_i, either is non informative ($\sigma_i = \phi$), or identifies in a verifiable way the value of θ when $\theta = \underline{\theta}$.

The stochastic structure of the signals is given by:

$$\begin{aligned} p_{11} &= \Pr(\sigma_1 = \underline{\theta} \text{ and } \sigma_2 = \underline{\theta}/\theta = \underline{\theta}) \\ p_{12} &= \Pr(\sigma_1 = \underline{\theta} \text{ and } \sigma_2 = \phi/\theta = \underline{\theta}) \ ; \ p_{21} = \Pr(\sigma_1 = \phi \text{ and } \sigma_2 = \underline{\theta}/\theta = \underline{\theta}) \\ p_{22} &= \Pr(\sigma_1 = \phi \text{ and } \sigma_2 = \phi/\theta = \underline{\theta}). \end{aligned}$$

The regulator i receives from the social maximizer an income s_i. He has no private wealth and his utility function is

$$V(s_i) = s_i \geq 0.$$

The regulator i is risk neutral but faces a limited liability constraint.

We will distinguish two cases. First, the case of a single regulator who has access to both information technologies. Second, the case where a different regulator is associated with each information technology.

3 Duplication of Informative Signals and Benevolent Regulation

Suppose first that the regulator is benevolent and only observes the signal σ_1.

With probability $p_{11} + p_{12}$ he is informed that $\theta = \underline{\theta}$ when it is indeed the case. He reports truthfully his signal. Then, the Government is fully informed and implements the optimal complete information regulation, i.e.,

$$S'(\underline{q}^*) = (1+\lambda)\underline{\theta} \quad ; \quad \underline{t}^* = \underline{\theta}\underline{q}^* \tag{1}$$

which equates the marginal utility of production to the marginal social cost and leaves no rent to the firm.

[17] See Baron and Myerson (1982), Laffont and Tirole (1986).

[18] See Tirole (1986) for more on these supervision technologies with hard information.

When the signal is "uninformative", the Government updates its belief that $\theta = \underline{\theta}$ as

$$\hat{\nu} = \Pr(\theta = \underline{\theta}/\sigma_1 = \phi) = \frac{\nu(p_{22} + p_{21})}{\nu(p_{22} + p_{21}) + (1 - \nu)} < \nu \tag{2}$$

and chooses the regulation which maximizes expected social welfare under incentive and participation constraints,[19] i.e., solves:

$$\max \hat{\nu}[S(\underline{q}) - (1 + \lambda)\underline{\theta}\underline{q} - \lambda\underline{U}] + (1 - \hat{\nu})[S(\bar{q}) - (1 + \lambda)\bar{\theta}\bar{q} - \lambda\bar{U}] \tag{3}$$

s.t.

$$\begin{array}{rcl} \underline{U} & \geq & \bar{U} + \Delta\theta\bar{q} \\ \bar{U} & \geq & \bar{U} - \Delta\theta\underline{q} \\ \underline{U} & \geq & 0 \\ \bar{U} & \geq & 0. \end{array}$$

From classical reasoning,[20] we know that $\bar{U} = 0$ and $\underline{U} = \Delta\theta\bar{q}$, hence the optimal regulation:

$$S'(\underline{q}^{\phi}) = (1 + \lambda)\underline{\theta} \; ; \; \underline{t}^{\phi} = \underline{\theta}\underline{q}^{\phi} + \Delta\theta\bar{q}^{\phi} \tag{4}$$

$$S'(\bar{q}^{\phi}) = (1 + \lambda)\bar{\theta} + \lambda\frac{\nu(p_{22} + p_{21})}{1 - \nu}\Delta\theta \tag{5}$$

and $\bar{t}^{\phi} = \bar{\theta}\bar{q}^{\phi}$.

No rent is given up to the inefficient type $\bar{\theta}$ and a downward distortion of production for the inefficient type is made to decrease the information rent, $\Delta\theta\bar{q}^{\phi}$, of the efficient type.

We can model informational competition with an additional benevolent regulator who observes the signal σ_2. Now, the Government is informed that $\theta = \underline{\theta}$ with probability $p_{11} + p_{12} + p_{21}$ when $\theta = \underline{\theta}$ and, then, it implements the optimal complete information regulation. When $\sigma_1 = \sigma_2 = \phi$, the posterior probability that $\theta = \underline{\theta}$ is

$$\frac{\nu p_{22}}{\nu p_{22} + 1 - \nu},$$

leading to an optimal regulation characterized by

$$S'(\bar{q}^{\phi\phi}) = (1 + \lambda)\bar{\theta} + \lambda\frac{\nu p_{22}}{1 - \nu}\Delta\theta. \tag{6}$$

The duplication of regulators has a pure informational value when their signals are not perfectly correlated and it enables the Government to enhance efficiency. Indeed, in

[19] From the revelation principle, there is no loss of generality in restricting the analysis to pairs of contracts $(\underline{t}, \underline{q}); (\bar{t}, \bar{q})$ which specify a transfer and a production level for each type. Then, we denote $\underline{U} = \underline{t} - \underline{\theta}\underline{q} \; ; \; \bar{U} = \bar{t} - \bar{\theta}\bar{q}$.

[20] See Laffont and Tirole (1993).

the optimal trade-off between rent extraction and efficiency, the expected cost of the rent is now lower since the probability of facing an efficient firm is now lower. However, with benevolent regulators, the separation of regulators has no incentive value and the same result would obtain if a single regulator was observing both signals.

Remark: For simplicity we have considered a version of the Baron-Myerson (1982) regulation model with adverse selection. There, higher incentives mean higher production levels. We could have use the Laffont-Tirole (1993) procurement model with both adverse selection and moral hazard with cost observability. There, higher incentives mean higher effort levels. All our results hold with such an interpretation.

In the next section we consider the possibility of collusion between regulators and the regulated firm.

4 Optimal Regulation with a Single Regulator

When the regulator is not benevolent, he can collude with the firm and hide his informative signals in exchange of a bribe. However, optimal regulation entails no collusion.[21] The collusion-proof constraint writes:

$$s \geq k\Delta\theta\bar{q}^{\phi}. \tag{7}$$

Indeed, the firm is willing to offer to the regulator as much as its rent $\Delta\theta\bar{q}^{\phi}$ when the signals are hidden, since it has no rent when they are revealed. The parameter k represents the inverse of the transaction costs of collusion.[22] If $k = 0$, the regulator behaves as if he was benevolent. If $k = 1$, collusion entails no transaction costs. A high value of k in $(0, 1)$ may reflect several institutional features. It may correspond to a higher "morality" of regulators, a better control of corruption or greater difficulties of quid pro quos in side-contracting, for example difficulties in using money. To avoid collusion a payment s satisfying (7) must be made to the regulator when he reports the verifiable signal $\sigma = \underline{\theta}$.

When the regulator is not benevolent, the following additional expected social cost is incurred to ensure collusion-proofness:

$$\lambda\nu(p_{11} + p_{12} + p_{21})k\Delta\theta\bar{q},$$

since it must be paid to the regulator each time the firm is efficient (with probability ν) and identified as such by the regulator (with probability $(p_{11} + p_{12} + p_{21})$).[23]

[21] For this collusion-proof principle, see Laffont and Tirole (1993) which shows that if the regulator entails no cost it is always better to use it when internal side contracts have transaction costs at least as large as λ.

[22] $k = \frac{1}{1+\mu}$ where μ is the transaction cost of collusion. See Laffont and Tirole (1993) for a discussion of these exogenous transaction costs. We also assume without loss of generality that all the bargaining power belongs to the regulator and that the firm is informed of the regulator's message. This eliminates possibilities of extortion by threatening to report $\underline{\theta}$ when ϕ has occured.

[23] It is weighted by λ because we include the regulator's welfare in the utilitarian social welfare function. Otherwise if would be $(1 + \lambda)$.

Reoptimizing expected social welfare with this additional cost yields immediately (1) when the firm is efficient and the signals are informative, and the following new distortions, when the signals are uninformative:

$$S'(\underline{q}_I^{\phi}) = (1+\lambda)\underline{\theta} \quad ; \quad \underline{t}^{\phi} = \underline{\theta}\underline{q}_I^{\phi} + \Delta\theta\bar{q}_I^{\phi} \tag{8}$$

$$S'(\bar{q}_I^{\phi}) = (1+\lambda)\bar{\theta} + \frac{\lambda\nu}{1-\nu}\Delta\theta(p_{22} + k(p_{11}+p_{12}+p_{21})). \tag{9}$$

Summarizing we have:

Proposition 1 *The optimal regulatory response against capture leads to lower incentives for production of the inefficient type, i.e.,*

$$\bar{q}_I^{\phi} < \bar{q}^{\phi\phi},$$

and to a lower information rent for the efficient type, i.e.,

$$\Delta\theta\bar{q}_I^{\phi} < \Delta\theta\bar{q}^{\phi\phi}.$$

Asymmetric information is now more costly since it requires incentive payments (for regulators) proportional to the information rents, even when the signals are informative. The information rents are more costly and, to mitigate them, a greater production inefficiency for the inefficient type is accepted. Note that both consumers **and** the firm lose from the need to fight potential capture. Only the regulator gains. In addition to the technical cost of the regulator's information technology, there is an additional incentive cost of delegation.

In this simple model, four parameters are candidates to characterize less developed countries. First, it is well known that developing countries have a high cost of public funds[24] (λ high). One can expect in these countries that governments suffer from more asymmetric information and less efficient technologies ($\Delta\theta$ higher with $\bar{\theta}$ higher), that collusion is less easily detected (k higher), and that the supervision technology is less efficient (for example p_{22} higher).

Note from (9), that all these features militate in favor of lower $\bar{q}_I^{\phi}$. Hence

Proposition 2 *Optimal incentive mechanisms should be less high-powered in less developed countries.*[25]

Proposition 2 shows a kind of vicious circle since less development calls for less efficiency of high cost types.[26]

[24] See Jones, Tandon and Vogelsang (1990).

[25] This conclusion is valid as long as the incentive scheme does not rely on accounting data difficult to get. In the Laffont-Tirole (1986) model incentive schemes require data on cost. Proposition 2 is then valid only if cost data are available. Otherwise, the regulator is obliged to use a high powered scheme (see Laffont (1996)).

[26] The reader may object that there is never corruption at the equilibrium. To have corruption at equilibrium it is enough to introduce some form of incompleteness in the contract that the regulator can use or to distinguish between regulators of different propensity to be corrupted as in Laffont and N'Guessan (1999).

Let us now separate powers, i.e., here, associate one regulator with each supervision technology.

5 Optimal Regulation with Two Regulators

When regulators are not benevolent, it is straightforward to show that optimal regulation entails, here too, collusion-proofness. It remains to write the collusion-proof constraints with two regulators.

Let r_1 and r_2 in $\{\phi, \underline{\theta}\}$ the reports made by the regulators and $t_1(r_1, r_2), t_2(r_1, r_2)$ the transfers made by the Government to the regulators as a function of their reports. The social maximizer wishes to induce truthtelling of regulators as a Nash equilibrium.

Consider regulator 1 who has observed $\sigma_1 = \underline{\theta}$. He does not know what regulator 2 has observed, but he anticipates that regulator 2 reveals truthfully his signal.

Given that he is of type $\underline{\theta}$, regulator 1's expected utility if $r_1 = \underline{\theta}$ is:

$$\Pr(\sigma_2 = \underline{\theta}/\sigma_1 = \underline{\theta})t_1(\underline{\theta}, \underline{\theta}) + \Pr(\sigma_2 = \phi/\sigma_1 = \underline{\theta})t_1(\underline{\theta}, \phi).$$

If he proposes to hide his signal for the maximal bribe that the firm can offer $(\Delta\theta\bar{q})$, his expected utility[27] is:

$$\Pr(\sigma_2 = \underline{\theta}/\sigma_1 = \underline{\theta})t_1(\phi, \underline{\theta}) + \Pr(\sigma_2 = \phi/\sigma_1 = \underline{\theta})(t_1(\phi, \phi) + k\Delta\theta\bar{q}).$$

Indeed, if the other regulator has observed $r_2 = \underline{\theta}$ and has informed the Government, the offer of collusion will be rejected. However, if the other regulator has observed $r_2 = \phi$, it will be accepted.

Given the limited liability constraints $(t(\cdot, \cdot) \geq 0)$, the Government will obviously set $t_1(\phi, \underline{\theta}) = t_1(\phi, \phi) = 0$ and the collusion-proof constraint reduces to

$$p_{11}t_1(\underline{\theta}, \underline{\theta}) + p_{12}t_1(\underline{\theta}, \phi) \geq p_{12}k\Delta\theta\bar{q}, \tag{10}$$

and similarly for regulator 2

$$p_{11}t_2(\underline{\theta}, \underline{\theta}) + p_{21}t_2(\phi, \underline{\theta}) \geq p_{21}k\Delta\theta\bar{q}. \tag{11}$$

These incentive payments for regulators produce the additional expected social costs

$$\lambda\nu k(p_{12} + p_{21})\Delta\theta\bar{q}.$$

[27] We assume that a regulator must decide his collusive behavior before knowing what the other regulator has observed. Otherwise, they could coordinate their collusive offers and collusion-proof constraints would write: $t_1(\underline{\theta}, \underline{\theta}) \geq \frac{1}{2}k\Delta\theta\bar{q}$; $t_1(\underline{\theta}, \phi) \geq k\Delta\theta\bar{q}$; $t_2(\phi, \underline{\theta}) \geq k\Delta\theta\bar{q}$. Then, the expected cost of ensuring collusion-proofness would be the same as with a single regulator. Here again we assume that the regulators have all the bargaining power in the side-contracts. This is without loss of generality —the firm could have the bargaining power— as long as the timing is as specified above.

This leads to the optimal collusion-proof regulation characterized[28] by

$$\begin{aligned} S'(\bar{q}_{II}^{\phi}) &= (1+\lambda)\bar{\theta} + \lambda\frac{\nu}{1-\nu}\Delta\theta(p_{22}+k(p_{12}+p_{21})) \\ \bar{t}_{II}^{\phi} &= \bar{\theta}\bar{q}_{II}^{\phi} \\ S(\underline{q}_{II}^{\phi}) &= (1+\lambda)\underline{\theta}\ ;\ \underline{t}_{II}^{\phi} = \underline{\theta}\underline{q}_{II}^{\phi} + \Delta\theta\bar{q}_{II}^{\phi}. \end{aligned}$$

The activity of each regulator creates a negative externality on the other regulator. Reporting the informative signal prevents the other regulator to strike a side-deal. It is not internalized when separation of powers occurs and it allows the Government to economize $\nu k p_{11}\Delta\theta\bar{q}$ in expected incentive social costs for regulators. This saving on regulatory costs enables the Government to afford a rent-efficiency trade-off more favorable to efficiency, hence a higher level of production for the inefficient type ($\bar{q}_{II}^{\phi} > \bar{q}_{I}^{\phi}$) and a higher information rent for the efficient type ($\Delta\theta\bar{q}_{II}^{\phi} > \Delta\theta\bar{q}_{I}^{\phi}$), when it is not identified.

Proposition 3 *Separation of powers saves on incentive payments for regulators and produces a higher-powered optimal regulation.*

It is worth stressing that the gain from separation is not only due to the eventual correlation of signals σ_1 and σ_2.

Suppose that the signals are independent, and $\Pr(\sigma_1 = \underline{\theta}) = \xi = \Pr(\sigma_2 = \underline{\theta})$. Then

$$p_{11} = \xi^2 \qquad p_{12} = p_{21} = (1-\xi)\xi \qquad p_{22} = (1-\xi)^2.$$

All propositions hold for this case. What does the correlation of signals change? Take a particular stochastic structure

$$p_{11} = \hat{\xi} - \varepsilon \qquad p_{12} = p_{21} = \varepsilon \qquad p_{22} = (1-\hat{\xi}) - \varepsilon.$$

When ε goes to 0, the correlation becomes perfect.

The gain from pure informational competition is related to p_{12} (compare (5) and (6)). It decreases as correlation of signals increases.

The gain from separation of powers is related to p_{11}. In this example it increases with the correlation of signals. But it needs not. Take for example

$$p_{11} = \hat{\xi} + \varepsilon \qquad p_{12} = p_{21} = \varepsilon \qquad p_{22} = (1-\hat{\xi}) - 3\varepsilon.$$

[28] We have considered an equilibrium in which it is profitable for a regulator to report truthfully when the other regulator also reports truthfully. One may wonder if there is also an equilibrium in which both regulators hide their signals. To avoid such a situation, it is enough to have, say for regulator 1,

$$p_{11}t_1(\underline{\theta},\phi) + p_{12}t_1(\underline{\theta},\phi) = t_1(\underline{\theta},\phi) \geq p_{12}k\Delta\theta\bar{q}.$$

In the payments characterized above ((10), (11))we can always choose $t_1(\underline{\theta},\underline{\theta})$ and $t_1(\underline{\theta},\phi)$ such that this inequality holds at no further cost (take $t_1(\underline{\theta},\underline{\theta}) = 0$ and $t_1(\underline{\theta},\phi) = k\Delta\theta\bar{q}$).

If we define the "quality" of the technology of the two signals as the probability to discover $\underline{\theta}$, i.e., $p_{11} + p_{12} + p_{21}$, then, for a given quality, the separation of powers effect increases with the correlation of signals. When the correlation becomes perfect, separation of powers achieves the optimal regulation with benevolent regulators i.e., eliminates completely the opportunism of regulators.

6 Separation of Powers in Developing Countries

Let us denote W^{II}, W^{I} the expected social welfares with two or one regulator, ignoring momentarily the cost of duplicating regulators. The question we ask is then, how does the gain from separation $\Delta W = W^{II} - W^{I}$ vary with the level of development.

Consider first the transaction cost of collusion k that, we argued, is higher in less developed countries. We obtain immediately:

Proposition 4 *The gain of separation increases with k for low values of k since*

$$\left.\frac{d\Delta W}{dk}\right|_{k=0} = \lambda\nu\Delta\theta p_{11}\bar{q}_I^{\phi} > 0.$$

In appendix 1 we show more generally that the gain increases as the transaction cost of collusion decreases.

We obtain a similar result for increases in $\bar{\theta}$ and λ.

Proposition 5 *The gain of separation increases with $\bar{\theta}$ for low values of $\bar{\theta}$ and with λ for low values of λ since*

$$\left.\frac{d\Delta W}{d\bar{\theta}}\right|_{\bar{\theta}=\underline{\theta}} = \lambda\nu p_{11}k\bar{q}_I^{\phi} > 0.$$

$$\left.\frac{d\Delta W}{d\lambda}\right|_{\lambda=0} = \nu p_{11}k\Delta\theta\bar{q}_I^{\phi} > 0.$$

(See Appendix 1).

On the contrary, the gain of separation decreases when the quality of the supervision technology decreases. To show this simply consider an increase of p_{11} which leaves $p_{12}+p_{21}$ constant. Then, we have:

Proposition 6 *The gain of separation increases with p_{11} since*

$$\left.\frac{d\Delta W}{dp_{11}}\right|_{p_{12}+p_{21}=Cte} = \lambda\nu\Delta\theta[\bar{q}_{II}^{\phi} - (1-k)\bar{q}_I^{\phi}] > 0.$$

We can conclude that the value of separation of powers to fight capture appears even higher in developing countries where regulators have supervision technologies of the same qualities.[29] The result becomes ambiguous when we take into account that developing countries have poorer supervision technologies. Furthermore, the cost of implementing such a structural policy varies also with the level of development.

7 Implementing Separation of Powers

Separation is successful only if regulators do not collude.[30] The probability of such collusion is not independent of the level of development. To model this problem simply suppose that the probability of collusion $\pi(k)$ depends on the transaction cost parameter k to express the fact that the less developed the country is, the higher k and the higher the probability of collusive behavior of regulators.[31]

When setting up two regulators the constitutional designer knows that with probability $1-\pi(k)$ the regulators will collude and behave as a single regulator.

Let $W^{II}(\bar{q}^{\phi})$ and $W^{I}(\bar{q}^{\phi})$ be expected social welfare with two or one regulator as a function of the production level required from the inefficient type, $\bar{q}^{\phi}$. The optimal design entails a level of $\hat{\bar{q}}^{\phi}_{II}$ which maximizes

$$(1-\pi(k))W^{II}(\bar{q}^{\phi}_{II})+\pi(k)W^{I}(\bar{q}^{\phi}_{II}).$$

With one regulator we have $W^{I}(\bar{q}^{\phi}_{I})$ with $\bar{q}^{\phi}_{I}$ determined by (9).

So far we have neglected the direct cost of regulators. If K is such a direct cost, including the social cost of one regulator $(1+\lambda)K$, or two regulators, $2(1+\lambda)K$, helps us determine when the welfare gain brought about by one or two regulators is worth it.

It has also been argued[32] that the transaction costs of collusion decrease when the regulator is more specialized. Let us denote $\delta k, \delta > 1$, the transaction cost parameter of side contracts with two regulators. Finally, let us index also K and λ on k ($\lambda'(k) > 0, K'(k) > 0$) to have a single parameter.

When we differentiate with respect to k the gain in welfare due to the presence of two regulators, we have in addition to terms similar to these of Section 6 (and therefore)

[29] This conclusion was also obtained in Laffont and Martimort (1999) in a model with no yardstick effect.

[30] This is particularly bothering because the symmetry of the situation makes reciprocal favors easy (see Laffont and Meleu (1997)).

[31] One can also argue that the probability of collusion between regulators should increase with the stake of collusion which is $p_{11}k\Delta\theta\bar{q}^{\phi}_{II}$. This would reinforce the result below except when we take into account the regulatory response which entails a level $\bar{q}^{\phi}_{II}$ which decreases with k.

[32] See Neven, Nuttall and Seabright (1993).

positive, several negative terms

$$\begin{aligned} &- \quad \pi'(k)[W^{II}(\hat{\tilde{q}}^{\phi}_{II}) - W^{I}(\hat{\tilde{q}}^{\phi}_{II})] - \lambda'(k)K \\ &- \quad (1+\lambda)K'(k) \\ &- \quad (\delta-1)[p_{12}+p_{21}+\pi(k)p_{11}]\lambda\nu\Delta\theta\hat{\tilde{q}}^{\phi}_{II}. \end{aligned}$$

Indeed, in a less developed country the likelihood that separation will be bypassed by colluding regulators is higher (first term), the financial burden of another regulator is higher (second and third terms) and the higher transaction costs of collusion for specialized regulators are magnified (fourth term). Hence

Proposition 7 *The implementation of separation of powers is more costly in a developing country.*

This last result is important to moderate the enthousiasm of recent development economics which sees (rightly) institution building as key to development. Even though improvements in institutions are even more valuable in developing countries than developed ones, it is unfortunately more difficult to implement them in such countries and they are bound to be less efficient.

8 Separation of Powers as an Endogenous Institution

Separation of powers can be sometimes recommended as an institutional change which increases expected social welfare. However, this normative approach is somewhat naive and one may want to model the political economy constraints imposed to such institutional changes. We will assume that institutional changes are chosen by the majority in power and we consider for this purpose the random majority model (Laffont (1996)).

There are two types of voters and the proportions of these two types fluctuate. Type 1 voters are stakeholders in the regulated firm and share the information rent. They will be less inclined to decrease the information rent than an utilitarian social welfare maximizer would be. Type 2 voters are not stakeholders on the regulated firm and will want to decrease the information rent more than socially desirable.

With probability 1/2, type 1 is in proportion $\alpha > 1/2$ and it is in proportion $1-\alpha$, also with probability 1/2.

Then, under majority 1 and a single regulator. The following objective function is maximized

$$\begin{aligned} &\alpha[\nu(p_{11}+p_{12}+p_{21})(S(\underline{q})-(1+\lambda)\underline{\theta q}-\lambda k\Delta\theta\bar{q}) \\ &+\nu p_{22}(S(\underline{q})-(1+\lambda)\underline{\theta q}) \\ &+(1-\nu)(S(\bar{q})-(1+\lambda)\bar{\theta}\bar{q}]+[1-(1+\lambda)\alpha]\nu p_{22}\Delta\theta\bar{q}. \end{aligned}$$

Member of the majority share the expected information rent $\nu p_{22}\Delta\theta\bar{q}$ between themselves and therefore overvalue it socially. We obtain ($\underline{q} = \underline{q}^*$) and

$$S'(\bar{q}_I^1) = (1+\lambda)\bar{\theta} + \frac{\lambda\nu}{1-\nu}\Delta\theta\left[(p_{11}+p_{12}+p_{21})k + p_{22}\frac{(1-(1+\lambda)\alpha)}{\alpha}\right],$$

if we assume $(1+\lambda)\alpha < 1$ for simplicity, so that majority 1 still wants to minimize the firm's rent.

Similarly with majority 2 we have:

$$S'(\bar{q}_{II}^1) = (1+\lambda)\bar{\theta} + \frac{\lambda\nu}{1-\nu}\Delta\theta\left[(p_{12}+p_{21})k + p_{22}\left(\frac{1-(1+\lambda)\alpha}{\alpha}\right)\right].$$

On the contrary, with majority 2 in power, the objective function with one regulator is

$$\begin{aligned}&\alpha[\nu(p_{11}+p_{12}+p_{21})(S(\underline{q}) - (1+\lambda)\underline{\theta}\underline{q} - \lambda k\Delta\theta\bar{q})\\ &+\nu p_{22}[S(\underline{q}) - (1+\lambda)\underline{\theta}\underline{q} - (1+\lambda)\Delta\theta\bar{q}]\\ &+(1-\nu)(S(\bar{q}) - (1+\lambda)\bar{\theta}\bar{q})],\end{aligned}$$

hence

$$S'(\bar{q}_I^2) = (1+\lambda)\bar{\theta} + \frac{\lambda\nu}{1-\nu}\Delta\theta\left[(p_{11}+p_{12}+p_{21})k + \frac{(1+\lambda)}{\lambda}p_{22}\right],$$

and similarly with two regulators

$$S'(\bar{q}_{II}^2) = (1+\lambda)\bar{\theta} + \frac{\lambda\nu}{1-\nu}\Delta\theta\left[(p_{12}+p_{21})k + \frac{(1+\lambda)}{\lambda}p_{22}\right].$$

If we now include the direct costs of regulators it is clear that majority 2 which is more interested in cutting down information rents will choose separation of regulators more often than majority 1 which overvalues socially information rents.

Consequently, the way to promote separation of powers when it is socially useful is not to advocate it from a normative point of view, but to favor the emergence of majority 2. However, it is clearly a form of political interference.

9 Conclusion

We have shown that the institution "separation of powers" which can be useful to mitigate the costs created by the opportunism of regulators is even more valuable in developing countries. This is because these countries suffer from high costs of public funds (due to inefficient tax systems), from low transaction costs of collusion (due to poor auditing and monitoring) and less efficient technologies. However, the implementation of this institution is more difficult and more costly for the same reasons, leaving us with an

ambiguous overall net result if the various weaknesses of these countries are not addressed simultaneously.

We believe that this type of result is quite general,[33] but more research is needed to go beyond the indeterminacy stressed in this paper. Also, by making the analysis static, we have lost an essential dimension of institutions, namely the credibility they are associated with. We hope to pursue our analysis in dynamic contexts to assess the difficulties of implementing credible long term institutions in developing countries.

[33]Laffont(1999) argues similarly that competition policy is also more useful in developing countries but more difficult to implement.

Appendix 1

$$\begin{aligned} W^I &= (p_{11}+p_{12}+p_{21})\nu(S(\underline{q}^*)-(1+\lambda)\underline{\theta}\underline{q}^*) \\ &+ p_{22}\nu(S(\underline{q}^*)-(1+\lambda)\underline{\theta}\underline{q}^*-\lambda\Delta\theta\bar{q}_I^{\phi}) \\ &+ (1-\nu)(S(\bar{q}_I^{\phi})-(1+\lambda)\bar{\theta}\bar{q}_I^{\phi}) \\ &- \lambda\nu(p_{11}+p_{12}+p_{21})k\Delta\theta\bar{q}_I^{\phi} \end{aligned}$$

$$\begin{aligned} W^{II} &= (p_{11}+p_{12}+p_{21})\nu(S(\underline{q}^*)-(1+\lambda)\underline{\theta}\underline{q}^*) \\ &+ p_{22}\nu(S(\underline{q}^*)-(1+\lambda)\underline{\theta}\underline{q}^*-\lambda\Delta\theta\bar{q}_{II}^{\phi}) \\ &+ (1-\nu)(S(\bar{q}_{II}^{\phi})-(1+\lambda)\bar{\theta}\bar{q}_{II}^{\phi}) \\ &- \lambda\nu(p_{12}+p_{21})k\Delta\theta\bar{q}_{II}^{\phi} \end{aligned}$$

From the envelop theorem

$$\begin{aligned} \frac{dW^I}{dk} &= -\lambda\nu(p_{11}+p_{12}+p_{21})\Delta\theta\bar{q}_I^{\phi} \\ \frac{dW^{II}}{dk} &= -\lambda\nu(p_{12}+p_{21})\Delta\theta\bar{q}_{II}^{\phi} \\ \frac{dW^{II}}{dk}-\frac{dW^I}{dk} &= \lambda\nu\Delta\theta p_{11}\bar{q}_I^{\phi}+\lambda\nu\Delta\theta(p_{12}+p_{21})(\bar{q}_I^{\phi}-\bar{q}_{II}^{\phi}). \end{aligned}$$

There is a first order effect $\lambda\nu\Delta\theta p_{11}\bar{q}_{II}^{\phi}$ which represents the gains from saving incentive costs for regulators with probability p_{11}. However, this savings leads to a higher production level with two regulators than with one regulator and therefore to a countervailing effect

$$\lambda\nu\Delta\theta(p_{12}+p_{21})(\bar{q}_I^{\phi}-\bar{q}_{II}^{\phi})<0.$$

However, this effect is of the second order in $\Delta\theta$ while the other is of the first order.

Furthermore this second effect is of the order of the difference in transaction costs between the two types of regulation while the first one of the order of the level of production.

For example if $S(q)=q-\frac{q^2}{2}$

$$\frac{dW^{II}}{dk}-\frac{dW^I}{dk}\propto\bar{q}_I^{\phi}-\frac{\lambda\nu}{1-\nu}k\Delta\theta(p_{12}+p_{21}).$$

Therefore, it is fair to say that Propositions 4 to 7 are valid in general and not only locally.

Similarly

$$\begin{aligned}
\frac{dW^{II}}{d\bar{\theta}} - \frac{dW^{I}}{d\bar{\theta}} &= \lambda\nu p_{11} k \bar{q}_I^{\phi} + (\bar{q}_I^{\phi} - \bar{q}_{II}^{\phi})((1+\lambda)(1-\nu) + \lambda\nu(p_{22} + k(p_{12} + p_{21}))) \\
\frac{dW^{II}}{d\lambda} - \frac{dW^{I}}{d\lambda} &= \lambda p_{11} k \Delta\theta \bar{q}_I^{\phi} + (\bar{q}_I^{\phi} - \bar{q}_{II}^{\phi})((1-\nu)\bar{\theta} + \nu(p_{22} + k(p_{12} + p_{21}))\Delta\theta).
\end{aligned}$$

APPENDIX 3
The Subsidiarity Bias in Regulation
with Jérôme Pouyet

1 Introduction

What is the proper level of decentralization for public policy and in particular regulation? This question is very lively debated in federal states such as the USA or Brazil, as well as in the European Union. It is a special case of a more general debate about the desirability of multiple governments, with spatial specialization when we deal with decentralization, with domain specialization when we are concerned with a regulator per industry, or with functional specialization when we discuss the separation of regulation and competition policy. In Europe, the concept of subsidiarity has been put forward to express the idea that decentralization is desirable unless it entails too high coordination costs.

The optimality of the decentralization of public decision-making is an empty question in a world of complete contracts with benevolent decision-makers. Indeed, in such a setting, a centralized organization can always replicate the outcome of a decentralized one. We must introduce a degree of incompleteness (in the informational structures, in the sets of instruments or in the objectives) to create a trade-off between centralization and decentralization. Some recent papers have discussed this trade-off with a clear view of its foundation in terms of contractual limitations.[34]

In Caillaud, Jullien and Picard (1996) the focus is on the decentralization of industrial policies from the European level to the national level. If some variables are more likely to be observed at the national level they show that it is always optimal to decentralize part of the activities even in the presence of externalities between countries. Seabright (1996) introduces the notion of accountability to justify the possible superiority of decentralization. In his model, decentralization increases the accountability of the politicians in charge of decision-making and this effect can balance the non internalized externalities. Klibanoff and Poitevin (1997) rely on the lack of commitment power of the central government to favor decentralization which induces a direct bargaining between regions. Also, Olson and Torsvick (1993) and Martimort (1999) show that several regulators who leave more rents to the regulated agent carrying substitute activities is a commitment device. Laffont and Martimort (1998) show that the threat of collusion may lead the central government to delegate its authority when communication constraints alone would not yield this result. Laffont and Zantman (1999) base the trade-off on the better informational structures of local politicians which are the joint products of local politics. Dewatripont and Tirole (1999) and Laffont and Martimort (1998) show in different contexts how a duality of regulators or supervisors is useful to provide incentives for regulators in charge of tasks which create negative externalities the ones on the others.

In this paper we develop a simple regulatory model to debate some pros and cons of decentralization or subsidiarity for the regulation of natural monopolies. Local favoritism,

[34]See also Sah and Stiglitz (1986), Hart and Moore (1999), Gilbert and Picard (1996) for organizational theories based on bounded rationality or implicit communication costs.

multiprincipal externalities and political economy under incomplete information are the main ingredients of the trade-offs we study. More precisely, we use the regulatory setting of Laffont and Tirole (1993) in which a firm is in charge of two procurement activities.[35] Each regulator wants the firm to realize a country-specific project, and each project requires a specific effort from the firm which has private information about its cost characteristics. This informational advantage yields an (information) rent to the firm.

Under centralization, a unique regulator coordinates both decisions, whereas under decentralization each activity is regulated independently. With benevolent regulators suffering from asymmetric information with respect to the firm, decentralization suffers from two distortions. The first one is related to the multiprincipal design of the model. Because the actions taken by the firms are substitutes, each regulator is led to increase the effort he requires from the firm in equilibrium: this is the competition effect. The second effect is due to our specification of the ownership structure of the firm. We assume that in each country some of the citizens hold some shares in the firm. Hence, the rent of the firm goes back to the shareholders of each country. Under centralization, the regulator takes into account the effect of his regulation on the whole rent of the firm that belongs to the consumers of both countries. However, under decentralization, each regulator cares only about the consumers and shareholders of his country. As a result, decentralization leads the regulators to induce a too low effort level: this is the shared-rent externality.

When efforts are sufficiently substitutable we show that the competition effect is dominant and in the limit this can lead the regulators to offer fixed-price contracts in equilibrium: decentralization makes rent extraction impossible and the firm earns a large rent from the non coordination of the regulations.

Next, we consider that regulators may be captured. As in Laffont (1996) we consider a random majority model and assume that the regulators act in favor of the majority in power. In this case, we show that decentralization might be preferred as it reduces the discretionary power of the decision-makers.

The structure of the paper is as follows. The next section introduces the model with benevolent regulators. In Section 3, we show that decentralization is equivalent to centralization when regulators are under complete information vis-à-vis the firm. In Sections 4 and 5 we compare centralization and decentralization under asymmetric information. Section 6 does the same comparison when the objectives of the regulators are biased in favor of some citizens. Section 7 concludes. All the proofs are gathered in appendices.

2 The model

We take a partial equilibrium approach and consider two countries (or regions) $i = 1, 2$ in which a firm is realizing a project with (gross) value S_i for the consumers of country i[36].

[35] Similar results could be obtained with a regulation model with variable quantities as Laffont-Tirole (1986) as well as with oligopolistic industries such as Auriol-Laffont (1992).

[36] Throughout the paper, we will assume that S_i is sufficiently large so that each regulator does not want to shut down the realization of the project for some types of firm.

The firm can provide an effort e_i in order to reduce the cost associated with project i. The cost function of the firm for project i is $C_i = \beta - e_i$ where β is the intrinsic efficiency parameter of the firm. We assume that the efficiency of the firm is the same for both projects. Parameter β can take values in $[\underline{\beta}, \overline{\beta}]$ according to a common knowledge probability distribution with density $f(.)$ and cdf $F(.)$ satisfying the monotone hazard rate condition ($\frac{d}{d\beta}\frac{F(\beta)}{f(\beta)} \geq 0$). In order to obtain explicit solutions we will sometimes illustrate our solutions in the case of a uniform distribution on $[0, 1]$.

The cost reducing efforts create a disutility to the firm equal to

$$\psi(e_1, e_2) = \frac{1}{2}(e_1^2 + e_2^2) + \gamma e_1 e_2.$$

We assume that $\frac{\partial^2 \psi}{\partial e_1 \partial e_2} = \gamma > 0$, or equivalently that the two efforts are substitutes from the point of view of the firm. Note that the firm cannot manipulate costs[37]. Accounting separation can be perfectly implemented but the firm can decide to allocate unobservable effort in a way that maximizes its rent. Parameter γ belongs to $[0, 1]$ and a high value of this substitutability index means that effort can be easily substituted from one project to the other (and conversely). Note that the disutility function is increasing and convex in both efforts. We also assume that regulator i, denoted by P_i, fully reimburses the (observable) cost C_i of activity i[38]and does not observe the realized cost on the other activity. The gain of the firm is then given by

$$U = t_1 + t_2 - \psi(e_1, e_2)$$

where t_i is the net transfer given by P_i.

In country i, P_i contracts with the firm for the realization of the (country specific) project. When the regulatory structure is splitted like that, we assume that the contracts are secret (P_i does not observe the contract proposed by regulator P_j to the firm), and that regulators offer simultaneously contracts to the firm.

Each regulator must finance the realization of his project. In our partial equilibrium approach, the shadow cost of public funds $\lambda > 0$ captures the distortionary effects of taxation[39]. Regulator P_i maximizes the welfare in country i, equal to the net surplus of the consumers/taxpayers plus a (so far) arbitrary sharing of the firm's rent, given by

$$SW_i = S_i - (1 + \lambda)(t_i + C_i) + \delta_i U \quad i = 1, 2$$

with $\delta_1 + \delta_2 = 1$. These shares reflect the distribution of ownership between the consumers of the two countries. We assume that $1 + \lambda - \delta_i > 0$, $i = 1, 2$, for rent extraction to be desirable in both countries. Otherwise we would have to take into account individual rationality constraints of consumers.

As is usual in the multiprincipal literature, we assume that if the firm decides to realize a project, it must also realize the other project. If it refuses to participate at all then the firm receives a reservation utility normalized to 0[40].

[37]See Laffont and Tirole (1993), chapter 12, for a model of regulation with cost padding.

[38]This is just an accounting convention.

[39]We assume it is the same for both countries.

[40]This is the intrinsic common agency setting as coined by Bernheim and Whinston (1986).

3 Full information benchmarks

In this section, we assume that the firm's efficiency is publicly known; this implies that the effort provided by the firm is also observable. We start with the case of a common regulator (centralization) and then proceed with the situation where the two regulators behave in a non cooperative way (decentralization).

3.1 Centralized regulation

In this situation, a single regulator called P_c wants to maximize the sum of the welfares in the two countries. Since he knows the efficiency parameter of the firm, he has only to ensure that the firm is willing to participate. In other words, this regulator solves the following program

$$\begin{cases} \max\limits_{\{t,e_1,e_2\}} \sum_{i=1}^{2} SW_i \\ \text{subject to } U \geq 0 \quad \forall \beta \in [\underline{\beta}, \overline{\beta}]. \end{cases}$$

Immediate algebra yields the solution to this program:

Proposition 1 *Under centralization and complete information the optimal levels of effort are symmetric*[41] *and are given by*

$$e_1(\beta) = e_2(\beta) = e_*(\beta) = \frac{1}{1+\gamma}.$$

Moreover, the firm gets no rent.

The intuition is clear: the marginal disutility of each effort must be equal to its marginal cost saving effect. Because the public funds are costly it is optimal to leave no rent to the firm: the (unique) transfer is designed in such a way that the rent of the firm is equal to its reservation utility.

3.2 Decentralized regulation

When each regulator P_i knows the private information of the firm and when regulators behave in a non cooperative way, we are back to the previous situation. Indeed, each regulator can make the firm residual claimant of their relation, whatever the contract proposed to the firm by the other regulator. We conclude this subsection with the following proposition.

Proposition 2 *Under complete information, decentralization is equivalent to centralization*[42].

[41] Under centralization, when $\gamma = 1$ only the sum of the efforts is determined in equilibrium. This holds under complete and incomplete information.

The coordination between regulators on how to share the payments to the firm is not described by the model: only the sum of the transfers is determined[43].

4 Centralized regulation under asymmetric information

Asymmetric information has been recognized as being a major obstacle to first-best efficient regulation. Following the new regulatory economics, we model the regulatory process as a principal-agent problem in which the firm has a superior knowledge on its efficiency.

When the two regulators cooperate perfectly the problem is equivalent to a usual adverse selection problem with a two-dimensional action[44]. According to the Revelation Principle[45], we can restrict ourselves to direct and truthful contracts: the outcome of any regulation stipulating a transfer depending on the realized costs can be replicated by a regulatory contract in which the firm reveals truthfully its private information. These additional incentive compatibility constraints will undermine the efficiency of the regulation and force the regulators to move away from the first-best (full information) contract.

Let us now determine the requirements of incentive compatibility. We denote by

$$U(\beta;\tilde{\beta}) = t(\tilde{\beta}) - \frac{1}{2}[(\beta - C_1(\tilde{\beta}))^2 + (\beta - C_2(\tilde{\beta}))^2] - \gamma(\beta - C_1(\tilde{\beta}))(\beta - C_2(\tilde{\beta}))$$

the gain of a firm with true cost parameter β when it announces $\tilde{\beta}$ to the unique regulator. The firm will reveal truthfully its private information if

$$\beta \in \arg\max_{\tilde{\beta}} \quad U(\beta;\tilde{\beta}) \text{ or } \begin{cases} \dot{U}(\beta) = -(1+\gamma)[e_1(\beta) + e_2(\beta)] \\ \dot{e}_1(\beta) + \dot{e}_2(\beta) \leq 2 \end{cases}$$

where $U(\beta)$ is the rent of the firm with type β when it announces the truth to the regulator.

The centralized regulator must still ensure that the firm is willing to participate to the regulatory process, or that the firm earns a greater rent than its outside opportunity.

As is usual, we rewrite the objective function of the regulator in terms of efforts and rent instead of costs and transfer. The program of the centralized regulator can then be

[42]When the action taken by a regulator directly affects the welfare of the other regulator (not just through the rent of the firm), Martimort and Stole (1998) show that decentralization leads to multiple equilibria (under complete and asymmetric information). Hence, in this case decentralization yields different outcomes than centralization, even under complete information.

[43]This is due to the intrinsic common agency assumption. Had we assumed that the firm could decide to realize a project for only one country, the optimal efforts would not have been changed; however, each transfer would have been defined uniquely.

[44]See Laffont and Tirole (1993) for instance.

[45]See Gibbard (1973), Green and Laffont (1977) or Myerson (1979).

stated as follows:

$$\begin{cases} \max\limits_{\{U(.),e_1(.),e_2(.)\}} \mathbf{E}_\beta\{S_1+S_2-(1+\lambda)[2\beta-e_1(\beta)-e_2(\beta)+\psi(e_1(\beta),e_2(\beta))]-\lambda U(\beta)\} \\ \text{subject to } \forall\beta\in[\underline{\beta},\overline{\beta}] \\ \dot{U}(\beta)=-(1+\gamma)[e_1(\beta)+e_2(\beta)] \\ \dot{e}_1(\beta)+\dot{e}_2(\beta)\leq 2 \\ U(\beta)\geq 0. \end{cases}$$

We give the solution in the following proposition.

Proposition 3 *Under asymmetric information and centralized regulation, the optimal levels of effort are symmetric and are given by*

$$e_1(\beta)=e_2(\beta)=e_c(\beta)=\frac{1}{1+\gamma}[1-(1+\gamma)\frac{\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}].$$

Effort is distorted downwards, except for the most efficient firm. Indeed, because the rent decreases with the efficiency parameter, the effort provided by less efficient firms must be decreased in order to limit the rents of the more efficient ones. This is the standard trade-off between rent extraction and incentive to effort: on the one hand, for efficiency reasons the regulator would like to implement effort levels that are not too distorted with respect to their first-best levels; on the other hand, the higher the effort required from the firm, the larger the rent given up to the firm, and consequently the larger the social cost due to this rent. Also, all firms, except the most inefficient one, earn a positive rent. Asymmetric information forces the unique regulator to leave a positive, and socially costly, rent to the firm in order to obtain truthful revelation of the private information.

5 Decentralized regulation under asymmetric information

We first start with a description of the way we solve this multiprincipal problem. The methodology is borrowed from Martimort and Stole (1998). Then we compute the optimal contracts.

The literature on common agency has exhibited many failures of a direct application of the Revelation Principle. Once it becomes impossible to rely on direct mechanisms to characterize the outcome of the common agency game, one has to consider indirect mechanisms. A priori, these mechanisms are based on very general (and untractable) spaces. However, Martimort and Stole (1998) have shown that there is no loss of generality in restricting regulator P_i to use a non linear transfer based on the observable cost C_i incurred by the firm on activity i[46]. Otherwise stated, it is useless to consider a more complicated contract (that would include an extra-message sent by the firm).

[46]They call this result the *Taxation Principle*. This result hinges on the quasi-linearity of the firm's utility function with respect to monetary transfers.

Importantly, we know now that the optimal contract of a regulator for a given contract proposed to the firm by the other regulator belongs to this class of mechanisms. Also, from now on we will restrict ourselves to twice differentiable non linear deterministic transfers[47].

5.1 The problem of regulator P_1

In this subsection, we characterize the best-response of the regulator in country 1 to any contract proposed by the other regulator. First, for any non linear transfer $t_2(C_2)$ offered by P_2 we can apply the Revelation Principle to find P_1's best-response. However, different contracts proposed by P_2 affect differently the firm's incentives to produce for P_1 and therefore P_1's best-response. Consequently let us define the firm's indirect utility function as

$$\hat{U}^1(C_1,\beta) = \max_{C_2} \quad \{t_2(C_2) - \frac{1}{2}[(\beta - C_1)^2 + (\beta - C_2)^2] - \gamma(\beta - C_1)(\beta - C_2)\}.$$

This indirect utility function gives the maximal gain of a β-type firm (excluding the transfer received from regulator P_1) for a given cost C_1 on activity 1 when the firm chooses optimally its cost level C_2 on activity 2. Rewriting this function as $\hat{U}^1(\beta - e_1, \beta)$ we see that it determines the rate at which the firm must incur effort to compensate for a lie on β, and therefore its information rent. Hence, under decentralization there is an informational externality created by one regulator which affects the way the rival regulator must design his contract. For further reference, we denote by $C_2^*(C_1,\beta)$ the cost on activity 2 which satisfies the first-order condition[48]associated with the previous problem, that is

$$t_2'(C_2^*(C_1,\beta)) + \beta - C_2^*(C_1,\beta) + \gamma(\beta - C_1) = 0. \tag{1}$$

Given a contract offered to the firm by P_2, we can apply the Revelation Principle to find the implementable contracts from the point of view of P_1. A firm with type β will reveal its private information if

$$\beta \in \arg\max_{\tilde{\beta}} \quad U(\tilde{\beta};\beta) = t_1(\tilde{\beta}) + \hat{U}^1(C_1(\tilde{\beta}),\beta).$$

Local incentive compatibility implies[49]

$$\begin{cases} \dot{U}(\beta) = \hat{U}^1_\beta(C_1(\beta),\beta) \\ \dot{C}_1(\beta)\hat{U}^1_{1\beta}(C_1(\beta),\beta) \geq 0 \end{cases}$$

[47]This restriction is standard in the common agency literature.

[48]To consider the out of equilibrium behavior of the firm, the transfer $t_2(C_2)$ has to be extended for costs which may lie outside the set of equilibrium allocations in order that $C_2^*(C_1,\beta)$ be always defined by the first-order condition (1). See Martimort (1992) for the construction of such extensions.

[49]Subscripts on the indirect utility function denote without ambiguity partial derivatives.

where $U(\beta)$ is now the rent of the firm in a truthful equilibrium. Immediate manipulations enable us to rewrite P_1's problem as

$$\begin{cases} \max\limits_{\{U(.),C_1(.)\}} \mathbf{E}_\beta\{S_1 - (1+\lambda)[C_1(\beta) - \hat{U}^1(C_1(\beta),\beta)] - (1+\lambda-\delta_1)U(\beta)\} \\ \text{subject to } \forall\beta \in [\underline{\beta},\overline{\beta}] \\ \dot{U}(\beta) = \hat{U}^1_\beta(C_1(\beta),\beta) \\ \dot{C}_1(\beta)\hat{U}^1_{1\beta}(C_1(\beta),\beta) \geq 0 \\ U(\beta) \geq 0. \end{cases}$$

If the equivalent of the Spence-Mirrlees condition, $\hat{U}^1_{1\beta}(C_1(\beta),\beta) \geq 0$, is satisfied, then the local second-order condition reduces to $\dot{C}_1(\beta) \geq 0$ and local incentive conditions are sufficient for global incentive compatibility. This condition cannot be postulated a priori as it depends endogenously on the contract proposed by the rival regulator. Hence, it must be checked ex post at the equilibrium.

Moreover, we have expressed the optimization behavior of the firm with respect to each regulator. It remains to check that it defines a global maximum for the firm (i.e. that the firm is effectively willing to accept simultaneously both contracts in equilibrium).

5.2 The ambiguous effect of decentralization

When regulators do not cooperate we obtain the following proposition. To obtain a symmetric equilibrium, we assume $\delta_1 = \delta_2 = \frac{1}{2}$.

Proposition 4 *Under decentralization with asymmetric information the optimal profiles of effort in a symmetric equilibrium are characterized by*

$$e_1(\beta) = e_2(\beta) = e_d(\beta) = \frac{1}{1+\gamma}[1 - (1+\gamma)\frac{\frac{1}{2}+\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}\frac{1-\gamma+2\gamma\dot{e}_d(\beta)}{1+\gamma\dot{e}_d(\beta)}]$$

with initial condition $e_d(\underline{\beta}) = e_*(\underline{\beta})$ and $e_d(\beta) \leq e_*(\beta)$ for all β.

- *If efforts are strongly substitutable ($\gamma \geq \frac{1}{1+2\lambda}$) then all the optimality conditions are satisfied and, moreover, $e_d(\beta) \geq e_c(\beta)$ for all β; therefore the rent of the firm is larger under decentralization than under centralization.*
- *If efforts are weakly substitutable ($\gamma < \frac{1}{1+2\lambda}$) then the optimality conditions cannot be checked directly and $e_d(\beta)$ might be larger or smaller than $e_c(\beta)$.*

To understand in depth the two effects at work, let us first consider the case of unrelated efforts (i.e. $\gamma = 0$). In this situation, the multiprincipal aspect disappears as the contract offered by one regulator does not affect the choice of effort (or cost) by the firm for the other regulator and the problems of the regulators become separable (up to the participation constraint of the firm).

However, even in this case, decentralization is not equivalent to centralization for the following reason. Under centralization, the regulator fully internalizes the impact of his regulation on the rent of the firm that entirely goes to the consumers of both countries: one unit of rent left to the firm has a social cost of $(1+\lambda)-1=\lambda$.

Under decentralization, this is no longer the case. As a given regulator is only interested in the welfare of the consumers in his country, he does not internalize the effect of his regulation on the fraction of the rent that accrues to the shareholders of the other country. As a consequence, under decentralization, P_i's perceived cost of one unit of rent given up to the firm is $(1+\lambda)-\delta_i$ which is larger than the social evaluation of the firm's rent under centralization. We call this effect the *shared-rent externality.*[50]

Let alone, the shared-rent externality has a clear impact on the regulatory contracts offered to the firm under decentralization. Indeed, as the centralized regulator attaches more weight to the firm's rent than each decentralized regulator, the efforts under centralization tend to be higher than those under decentralization (as rent extraction is more important under decentralization because the firm's rent is more costly for each regulator). Hence, the larger the firm's rent the larger the distortion due to decentralization. Obviously, this externality is present whatever the degree of substitutability of efforts.

Notice also that the larger the shadow cost of public funds λ, the less important the shared-rent externality becomes as the discrepancy between the weight attached to the firm's rent under centralization and decentralization decreases (relatively to the weight of the consumers' surplus).

Finally, notice that this effect would have disappeared had we assumed that the shareholders were not in the countries where the projects are realized[51].

Secondly, let us explain the effect of decentralization on the power of the incentive contracts when efforts are related (i.e. $\gamma \neq 0$). Under centralization, the unique regulator completely coordinates the choice of efforts and anticipates that a firm maximizing its profit will substitute one effort to the other in order to increase its rent.

Under decentralization, when regulator P_1 requires an effort from the firm he also anticipates, but cannot control for, that the firm will try to take advantage of the uncoordinated regulations by substituting one effort to the other. Then P_1 will require from the firm to exert more effort than under a centralized regulation. In equilibrium, these anticipations realize and indeed more effort is required by each regulator. Roughly speaking, regulators are competing for the firm and this behavior leads to an increase in the power of the incentive contracts offered in equilibrium. This is the *competition effect.*[52]

Obviously, the more substitutable the efforts from the point of view of the firm are, the larger the competition effect is and the larger the distortion due to decentralization is.

[50] Decentralization fails to internalize shared-rent externalities. It is an example of coordination failure due to decentralization.

[51] This assumption is often made in the multiprincipal literature.

[52] It is a second type of coordination failure due to decentralization.

When both effects are taken simultaneously into account, the total distortion due to decentralization is ambiguous as the two effects previously mentioned go in opposite directions. The shared-rent externality leads the decentralized regulators to offer lower-powered contracts while the competition effect induces them to propose higher-powered incentive regulations.

As stated in the proposition, one can nonetheless show that when $\gamma \geq \frac{1}{1+2\lambda}$, i.e., when efforts are sufficiently substitutable and/or the shadow cost of public funds is sufficiently large, decentralization always results in larger efforts than centralization: the competition effect dominates the shared-rent externality, and the firm earns a larger rent under decentralization. We give a surprising illustration of this in the next subsection.

Finally, the last part of the proposition is more technical and indicates that the verification of the optimality conditions becomes complex when the ranking of efforts is ambiguous. In the appendices, we show that these conditions are always satisfied in the uniform case. For this case efforts are linear[53]in the efficiency parameter and take the same value for the most efficient firm. Comparing these efforts by computing the difference between their slopes, we obtain

$$\dot{e}_d(\beta) - \dot{e}_c(\beta) \propto \gamma(1+4\lambda) - 1 \quad \text{(uniform case)}$$

which illustrates our discussion: for large values of the substitutability index, decentralization leads to larger efforts than centralization (competition effect) whereas for low values of the shadow cost of public funds, the reverse always holds (shared-rent externality).

5.3 The role of efforts allocation and the drift of regulatory contracts towards fixed-price contracts

As explained earlier, the competition effect depends mainly on the substitutability of efforts at the firm's level. When efforts are sufficiently substitutable, then decentralization leads to too large efforts.

One can also show that an increase in the degree of substitutability locally increases the effort of the more efficient firms. The possibility to allocate easily its efforts on one activity or the other hardens the competition effect. Competition between regulatory authorities attains then its paroxysm when efforts are perfectly substitutable and in this case, we can even prove the following result.

Proposition 5 *When efforts are perfectly substitutable ($\gamma = 1$) there exists an equilibrium in which both regulators offer a fixed-price contract to the firm*[54]*.*

When P_2 offers a fixed-price contract to the firm, and when $\gamma = 1$, we show in the appendices that $\hat{U}^1_{1\beta}(C_1(\beta), \beta)$ is equal to 0. This implies that the second-order condition for implementability is (weakly) satisfied; however, this also implies that regulator P_1 can

[53]In general, the solutions are not linear and it could be possible that for some values of the efficiency parameter $e_d(\beta)$ be larger than $e_c(\beta)$ whereas for other values the reverse would hold.

no longer distort the effort he requires to limit the firm's rent, and cannot trade-off rent extraction and efficiency.

This is a striking illustration of the drift of the regulatory contract. Efforts are equal to the first-best efforts but the rent given up to the firm by the regulators becomes very large. Competition between regulatory authorities leads to large inefficiencies and prevent them from distorting their policy.

In the next section, we shall build on this insight.

6 The choice of the regulatory structure under political uncertainty

Political economy has often challenged the view that the regulatory authority acts as a benevolent planner[55]. The goal of this section is to recognize that the authority in charge of the regulation in each country has a private agenda; we take the example of politicians who only seek to maximize their probability of being reelected[56]and look at the impact of decentralization in such a setting. Another interpretation would be that the regulator(s) can be captured by some interest groups that try to distort the regulation in their own interest[57].

Let us assume now that in the two regions there is a random proportion of shareholders (resp. non shareholders) denoted by α_i (resp. $1-\alpha_i$) $\in [0,1]$. The shareholders of the firm benefit from the rent of the firm while the non shareholders do not.

Before the value of α_i, $i=1,2$, is known, the constitution decides which regulatory structure (centralization or decentralization) to set up. However, this choice has to take into account that the regulators in place will act in a distortive way. In our static framework, we model this divergence between the objective of the regulator(s) and the interests of all the citizens by recognizing that the regulator(s) only care(s) about the majority in place.

Under decentralization, if $\alpha_i > \frac{1}{2}$, then there will be a (local) shareholder majority in region i. In this case the objective of the regulator in region i will take into account only the surplus of the shareholders in this region and the part of the rent of the firm that accrues to these shareholders. On the contrary, when $\alpha_i < \frac{1}{2}$ there will be a non shareholder majority and the regulator in place will only care about the surplus of the non shareholders. Accordingly, the objective function of the regulator of region i under

[54]In the uniform case with perfectly substitutable efforts that we use in the next section there will be two candidate solutions to the differential equation characterizing the optimal effort under decentralization. However, for this case, the one that does not correspond to the fixed-price contract violates the implementability conditions. It is immediate to show that this is also the case for all the probability distributions with a linear hazard rate ($\frac{F(\beta)}{f(\beta)} = l(\beta - \underline{\beta})$, $l > 0$).

[55]See Buchanan(1965), Noll (1983) and Olson (1963) among others.

[56]See Laffont (1996).

[57]See Stigler (1971) for example and Bardhan and Mookherjee (1999) for a discussion of decentralization in terms of relative captures of local and central government.

decentralization is given by[58]

$$SW_{i,d} = \begin{cases} \alpha_i[S_i - (1+\lambda)(t_i + C_i)] + \frac{\alpha_i}{\alpha_1+\alpha_2}U & \text{if } \alpha_i > \frac{1}{2}, \\ (1-\alpha_i)[S_i - (1+\lambda)(t_i + C_i)] & \text{if } \alpha_i < \frac{1}{2}. \end{cases}$$

Under centralization, the unique regulator cares only about the (national) majority over both regions. His objective function will be

$$SW_c = \begin{cases} \sum_{i=1}^{2} \alpha_i[S_i - (1+\lambda)(t_i + C_i)] + U & \text{if } \alpha_1 + \alpha_2 > 1, \\ \sum_{i=1}^{2}(1-\alpha_i)[S_i - (1+\lambda)(t_i + C_i)] & \text{if } \alpha_1 + \alpha_2 < 1. \end{cases}$$

To summarize, the different majorities have different stakes in the information rent of the firm, and the regulators have private agendas depending on the majority in power. Under centralization, the regulator will bias his regulation to favor the majority over both regions; on the contrary, decentralization makes the regulators compete against each other and act only in favor of the local majority. Notice also that both types of majority only differ in their treatment of the firm's rent.

The performances of these different regulatory structures have to be compared with respect to the utilitarian criterion defined as usual by

$$SW^u = \sum_{i=1}^{2}\{S_i - (1+\lambda)(t_i + C_i)\} + U.$$

In the following, we shall determine the profiles of effort implemented by each constitution. Observe that under a shareholder majority the rent of the firm is overvalued while under a non shareholder majority the rent of the firm is undervalued with respect to the utilitarian criterion.

For expositional purposes, we restrict attention to the uniform case, with $\alpha_1 = \alpha_2 = \alpha$ and with efforts perfectly substitutable for the firm ($\gamma = 1$)[59]. We also assume that under a shareholder majority $(1+\lambda)\alpha - \frac{1}{2} > (1+\lambda)\alpha - 1 > 0$ for rent extraction to be desirable under decentralization and centralization.

6.1 The profiles of effort

We can adapt our previous computations since only the weight of the firm's rent is changed in the objective function of the regulators. The optimal efforts are given in the next proposition.

[58] Letter 'd' (resp. 'c') stands for decentralization (resp. centralization).

[59] In a previous draft, we did not restrict ourselves to the case $\gamma = 1$. One can show that our insights carry over (qualitatively) to the situations in which efforts are sufficiently substitutable. When the proportion of shareholders in both regions can be different, decentralization may lead to non monotonic profiles of efforts, but once again our argument could be extended to such cases.

Proposition 6 *The optimal profiles of effort are given by:*

- *Under centralization* $e_c(\beta) = \frac{1}{2}[1 - 2r_c\beta]$ *where* $r_c = 1$ *under a non shareholder majority and* $r_c = \frac{(1+\lambda)\alpha-1}{(1+\lambda)\alpha}$ *under a shareholder majority.*
- *Under decentralization* $e_d(\beta) = \frac{1}{2}$ *whatever the majority.*
- *With the utilitarian criterion* $e_u(\beta) = \frac{1}{2}[1 - 2\frac{\lambda}{1+\lambda}\beta]$.

This proposition calls for some comments. Under centralization, the optimal profile of effort fluctuates with the majority in place. Under a shareholder majority the effort is larger than the one corresponding to the utilitarian criterion as the regulator in place accounts for the share of the firm's rent that goes to the actual majority[60]. On the contrary, under a non shareholder majority effort is downward distorted with respect to its utilitarian level.

The decentralization of the regulatory powers leads to the striking result that the implemented efforts become insensitive to the majority in place. As explained earlier, this result comes from the perfect substitutability of the efforts provided by the firms which exacerbates the tension between the non cooperative regulators. This competition between institutions finally ends up with the regulators being forced to offer fixed-price contracts without the possibility to match the will of the majority in place with the effort required from the firm: decentralization leads to uniform policies with respect to the political majority.

When the non shareholders have the majority, the effort is too low under centralization and too high under decentralization. However, immediate computations show that decentralization distorts less the effort than centralization when the shadow cost of public funds is small ($\lambda < 1$). Hence, if the efficiency consideration is more important than the rent extraction one, it is intuitive that under a non shareholder majority decentralization is preferred. This will be confirmed in the next subsection in which we perform some welfare comparisons.

Under a shareholder majority, both constitutions lead to too high effort levels. However, immediate computations show that centralization distorts less the effort than centralization under the assumption $(1 + \lambda)\alpha > 1$. Notice that when the proportion of shareholders is large (i.e. α close to 1) then the objective of the centralized regulator almost coincides with the utilitarian criterion, and the loss entailed by decentralization is large. In a similar way, the larger the social cost of public funds is, the more desirable centralization is.

Hence, the comparison between centralization and decentralization is ambiguous. On the one hand, centralization enables to implement efforts that limit the rent earned by the firm while decentralization always leaves too large rent to the firm. On the other hand, centralization is sensitive to the majority in place and leads to fluctuations in the levels of

[60]More precisely, this is due to the fact that the centralized regulator only cares about the shareholders which implies that the relative weight of the firm's rent (with respect to the weight attached to the net consumers' surplus) is larger under centralization than with the utilitarian criterion.

effort that favor the members of the majority. The comparison between centralization and decentralization hinges simultaneously on the proportion of shareholders/non shareholders and on the shadow cost of public funds, which gives a measure of the social cost of the firm's rent. Effort levels are represented in Figure 1.

Insert Figure 1 here

6.2 Welfare analysis

To assess the performances of centralization and decentralization, we must then compare the expected welfares of both countries under the different constitutions. For a given majority with size α that implements the profile of efforts $e(\beta, \alpha)$, the expected social welfare is given by

$$\mathbf{E}_\beta\{SW^u(e(\beta,\alpha))\} = \int_{\underline{\beta}}^{\overline{\beta}} \{S_1 + S_2 - (1+\lambda)[\psi(e(\beta,\alpha)) + 2(\beta - e(\beta,\alpha))] - \lambda U(\beta)\} dF(\beta).$$

Whatever the regulatory structure, the rent of the firm in a symmetric equilibrium is given by

$$\dot{U}(\beta) = -4e(\beta,\alpha)$$

which gives (after an integration by parts) in the uniform case

$$\mathbf{E}_\beta\{SW^u(e(\beta,\alpha))\} = S_1 + S_2 - (1+\lambda) - 2\int_0^1 \{(1+\lambda)e(\beta,\alpha)[e(\beta,\alpha) - 1] + 2\lambda\beta e(\beta,\alpha)\} d\beta.$$

Depending on the majority in place, the expected welfare under centralization is given by[61]

$$\begin{cases} SW^u_{c,s} & = S_1 + S_2 - (1+\lambda) + \frac{4(2\alpha-1) - \alpha^2(1-\lambda^2)}{6\alpha^2(1+\lambda)} \text{ with a shareholder majority,} \\ SW^u_{c,ns} & = S_1 + S_2 - (1+\lambda) - \frac{1-\lambda}{6} \text{ with a non shareholder majority.} \end{cases}$$

Under decentralization, because efforts are not dependent on the majority in place, the expected welfare of both countries is

$$SW^u_{d,s} = SW^u_{d,ns} = S_1 + S_2 - (1+\lambda) + \frac{1-\lambda}{2} \text{ whatever the majority.}$$

Then, the difference between the welfare under centralization and the one under decentralization is

$$\begin{cases} SW^u_{d,s} - SW^u_{c,s} & = \frac{2}{3}\frac{(1-\alpha)^2 - \alpha^2\lambda^2}{\alpha^2(1+\lambda)} \text{ under a shareholder majority,} \quad (\alpha > 1/2) \\ SW^u_{d,ns} - SW^u_{c,ns} & = \frac{2}{3}(1-\lambda) \text{ under a non shareholder majority.} \quad (\alpha < 1/2) \end{cases}$$

[61] Letter 's' (resp. 'ns') stands for shareholder (resp. non shareholder) majority.

We assume that the probabilities to have a shareholder majority and a non shareholder majority are the same (equal to $\frac{1}{2}$). This enables us to state the following proposition.[62]

Proposition 7 *If the shadow cost of public funds is large ($\lambda \geq 1$) then centralization is preferred to decentralization. On the contrary, when the shadow cost of public funds is low ($\lambda \leq 1/\sqrt{2}$) then decentralization is preferred to centralization.*
For intermediate values of the shadow cost of public funds ($1/\sqrt{2} < \lambda < 1$), then decentralization (resp. centralization) is preferred to centralization (resp. decentralization) when the shareholder majority is weak (resp. large).[63]

This proposition confirms the intuitions derived from the comparison of the effort levels. Indeed, when the shadow cost of public funds is large, then the rent left to the firm has a large social cost. Moreover, under decentralization the competition between regulatory authorities provides the firm with excessive rent. These two effects work in favor of centralization and give the rationale for the first part of the proposition.

When the shadow cost of public funds is small then decentralization is preferred under a non shareholder majority. Moreover, even if centralization is preferred under a shareholder majority, the loss entailed by decentralization tends to be small. Hence, the former effect more than offsets the latter, and decentralization is preferred.

For intermediate values, the trade-off also depends on the size of the majority in power. The drawback of centralization is that the unique regulator only cares about the majority. Hence, when the size of the majority is small, the proportion of consumers disadvantaged by the centralized regulator tends to be relatively large and decentralization becomes the preferred constitution even though it provides the firm with too much rent (which has a low social cost if λ is not too large). Decentralization serves to limit the discretionary power of the regulators.

7 Conclusion

We have compared the performances of centralization and decentralization of the regulatory powers using the new regulatory economics and without appealing to any informational advantage under decentralization or externalities between countries.

In this setting, the benefit of centralization of the regulatory power at a supranational level is to coordinate the regulations and to take into account the informational externality created by the link between both activities at the firm's level.

Decentralization is plagued by two opposite distortions. The first relates to the informational externality which translates into a competition effect when efforts are substitutes. The second comes from the fact that a regulator does not internalize the impact of his regulation and the fraction of the firm's rent that accrues to the shareholders of the other country.

[62] Under a shareholder majority, the assumption $(1+\lambda)\alpha > 1$ implies that $(1-\alpha)^2 - \alpha^2\lambda^2 < 0$.
[63] The size of the non shareholder majority does not affect the effort levels.

If efforts were complements instead of substitutes then the competition effect would be reversed[64]: a regulator would free-ride on the incentives provided to the firm by the other regulator and this would lead to too low-powered incentive contracts in equilibrium. Moreover, this under-provision of incentives would be reinforced by the shared-rent externality.

Then, we introduced a bias in the objective of the regulator. Using the random majority model, in which the regulator only cares about the majority in place, we show that decentralization could perform better than centralization. Indeed, decentralizing the decision power modifies the political rules of the game played by the decision-makers and creates a competition between regulators. In our setting, this competition eliminates the negative discretionary power of the regulators at the cost of providing the firm with excessive rent. This effect would be still present if efforts were complements as decentralization would still reduce the distortion under a shareholder majority. In the same vein, introducing a degree of 'competitiveness' (through, say, an unregulated fringe in each country producing an imperfectly differentiated product) in our model would just modify the equilibrium rent of the regulated firm but would not alter qualitatively our conclusions.

[64]With complements, there exists a continuum of equilibria that always lead to lower effort than centralization.

8 Appendices

8.1 Complete information

Under centralization, because the rent is socially costly, the regulator sets $U = 0$. Then replacing the value of the transfer in the objective function and optimizing with respect to efforts we obtain the first-best efforts.

Under decentralization the same methodology can be applied directly.

8.2 Centralized regulation under asymmetric information

As the rent is (strictly) decreasing in the efficiency parameter and because the rent is socially costly, the participation constraint amounts to $U(\overline{\beta}) = 0$. The Hamiltonian associated with the corresponding optimal control problem is

$$H = f(\beta)[S_1 + S_2 - (1+\lambda)(2\beta - (e_1(\beta) + e_2(\beta)) + \frac{1}{2}(e_1(\beta)^2 + e_2(\beta)^2) + \gamma e_1(\beta)e_2(\beta)) - \lambda U(\beta)] - \eta(\beta)(1+\gamma)[e_1(\beta) + e_2(\beta)].$$

Applying the Maximum Principle we get $\dot{\eta}(\beta) = \lambda f(\beta)$. Because there is no transversality condition at $\underline{\beta}$, $\eta(\underline{\beta}) = 0$ and we obtain $\eta(\beta) = \lambda F(\beta)$. Then optimizing with respect to $e_i(\beta)$ we obtain the optimal profiles of effort. Finally, under the monotone hazard rate assumption, $\frac{d}{d\beta}\frac{F(\beta)}{f(\beta)} \geq 0$, the second-order condition for implementability is satisfied.

8.3 Decentralized regulation under asymmetric information

8.3.1 Preliminary results

Immediate computations yield

- $\hat{U}_1^1(C_1, \beta) = (\beta - C_1) + \gamma(\beta - C_2^*(C_1, \beta))$,
- $\hat{U}_\beta^1(C_1, \beta) = -(1+\gamma)(\beta - C_1 + \beta - C_2^*(C_1, \beta))$,
- $\hat{U}_{1\beta}^1(C_1, \beta) = (1+\gamma)(1 + \frac{\partial C_2^*(C_1,\beta)}{\partial C_1})$,

where $C_2^*(C_1, \beta)$ is defined by the first-order condition (1) associated with the indirect utility function of the firm vis à vis regulator P_2.

Differentiating this condition with respect to C_1 we obtain

$$[t_2''(C_2^*(C_1(\beta), \beta)) - 1]\frac{\partial C_2^*(C_1(\beta), \beta)}{\partial C_1} = \gamma. \quad (2)$$

In equilibrium, $C_2^*(C_1(\beta),\beta) = C_2(\beta)$. Substituting in (1) and differentiating with respect to β we also get

$$[t_2''(C_2(\beta)) - 1]\dot{C}_2(\beta) = -1 - \gamma(1 - \dot{C}_1(\beta)). \tag{3}$$

Using (2) and (3), we obtain

$$\hat{U}^1_{1\beta}(C_1(\beta),\beta) = (1+\gamma)\frac{1+\gamma-\gamma(\dot{C}_1(\beta)+\dot{C}_2(\beta))}{1+\gamma(1-\dot{C}_1(\beta))}.$$

8.3.2 The symmetric equilibrium

The optimal schedules of effort As $\hat{U}^1_\beta(C_1,\beta) < 0$ and because the rent is socially costly, the participation constraint amounts to $U(\overline{\beta}) = 0$. The Hamiltonian associated with the problem of regulator P_1 is

$$f(\beta)[S_1 - (1+\lambda)(C_1(\beta) - \hat{U}^1(C_1(\beta),\beta)) - (\frac{1}{2}+\lambda)U(\beta)] + \eta(\beta)\hat{U}^1_\beta(C_1(\beta),\beta).$$

Applying the Maximum Principle and using the fact that there is no transversality condition at $\underline{\beta}$ ($\eta(\underline{\beta}) = 0$), we obtain $\eta(\beta) = (\frac{1}{2}+\lambda)F(\beta)$. Finally, optimizing with respect to $C_1(\beta)$, considering a symmetric equilibrium and rearranging terms we obtain the optimal effort profiles.

Behavior of the solution in the neighborhood of $\underline{\beta}$ In order to compare the efforts under centralization and decentralization, we must first linearize the solution to the differential equation in the neighborhood of $\underline{\beta}$. We have

$$\dot{e}_d(\beta) = -\frac{1}{\gamma}\frac{(1+\gamma)e_d(\beta) - 1 + (1+\gamma)(1-\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}}{(1+\gamma)e_d(\beta) - 1 + 2(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}}. \tag{4}$$

Let us use the following notations: $X = e_d(\beta) - e_d(\underline{\beta})$ and $Y = \beta - \underline{\beta}$. Immediate computations show that (4) can be rewritten as

$$\frac{dX}{dY} = -\frac{1}{\gamma}\frac{X + (1-\gamma)\frac{\frac{1}{2}+\lambda}{1+\lambda}Y}{X + 2\frac{\frac{1}{2}+\lambda}{1+\lambda}Y}.$$

Looking for a solution of the form $X = tY$, we must solve the following equation: $\gamma t^2 + (2\frac{\frac{1}{2}+\lambda}{1+\lambda}\gamma + 1)t + (1-\gamma)\frac{\frac{1}{2}+\lambda}{1+\lambda} = 0$. The two roots are given by

$$\underline{t}_d = -\frac{1 + 2\gamma\frac{\frac{1}{2}+\lambda}{1+\lambda} + \sqrt{\Delta}}{2\gamma} \text{ and } \overline{t}_d = \frac{-1 - 2\gamma\frac{\frac{1}{2}+\lambda}{1+\lambda} + \sqrt{\Delta}}{2\gamma}.$$

where $\Delta = 1 + 4\gamma^2\frac{\frac{1}{2}+\lambda}{1+\lambda}(1+\frac{\frac{1}{2}+\lambda}{1+\lambda}) > 0$ is the discriminant. It is immediate to show that

- $\underline{t}_d$ does not satisfy the optimality conditions of the firm's maximization problem given by (5),
- $\overline{t}_d < \dot{e}_*(\underline{\beta})$,
- $\overline{t}_d > \dot{e}_c(\underline{\beta}) = -\frac{\lambda}{1+\lambda} \Leftrightarrow \gamma > \frac{1}{1+4\lambda}$.

Comparative statics Let us consider the effect of an increase in the substitutability index γ on the optimal effort under non cooperative regulations. In the neighborhood of $\underline{\beta}$ immediate computations yield $Sg(\frac{d\overline{t}}{d\gamma}) = Sg(1-\frac{1}{\sqrt{\Delta}}) > 0$. Hence efforts increase locally, and globally in the uniform case, around $\underline{\beta}$ when γ increases.

Let us now prove that $e_d(\beta) \leq e_*(\beta)$. First consider $\hat{\beta}$ such that $e_d(\hat{\beta}) = e_*(\hat{\beta})$. At $\hat{\beta}$ we have $\dot{e}_d(\hat{\beta}) = -\frac{1-\gamma}{2\gamma} \leq \dot{e}_*(\hat{\beta}) = 0$. Hence, for $\beta \in (\hat{\beta}-\epsilon, \hat{\beta})$ we have $e_d(\beta) > e_*(\beta)$, a contradiction.

Let us find the conditions such that $e_d(\beta) \geq e_c(\beta)\ \forall \beta$. Consider $\hat{\beta}$ such that $e_d(\hat{\beta}) = e_c(\hat{\beta})$. Equation (4) gives

$$\dot{e}_d(\hat{\beta}) = \frac{\gamma\lambda - \frac{1}{2}(1-\gamma)}{\gamma(1+\lambda)}.$$

Now assume that $\gamma\lambda - \frac{1}{2}(1-\gamma) \geq 0$ or $\gamma \geq \frac{1}{1+2\lambda}$. Then $\dot{e}_d(\hat{\beta}) \geq 0$ while $\dot{e}_c(\hat{\beta}) \leq 0$ which in turn implies that $\forall \beta \in (\hat{\beta}-\epsilon, \hat{\beta})$, $e_d(\beta) < e_c(\beta)$. However, this contradicts the fact that if $\gamma \geq \frac{1}{1+2\lambda} \geq \frac{1}{1+4\lambda}$ then $\overline{t}_d > \dot{e}_c(\underline{\beta})$. Note finally that this a sufficient condition only.

The implementability conditions Let us check that the indirect utility function satisfies the Spence-Mirrlees property at the equilibrium. We have $\hat{U}^1_{1\beta}(C_1(\beta),\beta) = (1+\gamma)(1+\frac{\partial C_2^*(C_1(\beta),\beta)}{\partial C_1}) = (1+\gamma)\frac{1-\gamma+2\gamma\dot{e}_d(\beta)}{1+\gamma\dot{e}_d(\beta)} = -(1+\gamma)\frac{(1+\gamma)e_d(\beta)-1}{(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}} \geq 0$ because $e_d(\beta) \leq e_*(\beta)$ $\forall \beta$.

We check now for the monotonicity of the cost profile:

$$\dot{C}_d(\beta) \geq 0 \Leftrightarrow 1-\dot{e}_d(\beta) \geq 0 \Leftrightarrow \frac{1+\gamma}{\gamma}\frac{(1+\gamma)e_d(\beta) - 1 + (1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}}{(1+\gamma)e_d(\beta) - 1 + 2(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}} \geq 0,$$

which is satisfied if $\gamma \geq \frac{1}{1+2\lambda}$, since we have shown that under this condition $e_d(\beta) \geq e_c(\beta)$.

The optimality conditions for the firm We also must check that the problem of the firm is globally concave, or that the Hessian associated with the following maximization problem

$$\max_{C_1(\beta),C_2(\beta)} \{t_1(C_1(\beta)) + t_2(C_2(\beta)) - \frac{1}{2}[(\beta - C_1(\beta))^2 + (\beta - C_2(\beta))^2] - \gamma(\beta - C_1(\beta))(\beta - C_2(\beta))\}$$

is definite semi-negative at the equilibrium. This is equivalent to the following two conditions

$$\begin{cases} t''(C(\beta)) - 1 & \leq 0 \\ (t''(C(\beta)) - 1)^2 - \gamma^2 & \geq 0 \end{cases} \Leftrightarrow \begin{cases} 1 + \gamma \dot{e}_d(\beta) & \geq 0 \\ 1 - \gamma + 2\gamma \dot{e}_d(\beta) & \geq 0. \end{cases} \tag{5}$$

We have

$$1 - \gamma + 2\gamma \dot{e}_d(\beta) = -(1+\gamma) \frac{(1+\gamma)e_d(\beta) - 1}{(1+\gamma)e_d(\beta) - 1 + 2(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}}$$

which is positive since we have shown that $e_*(\beta) \geq e_d(\beta)$.

Simple computations yield

$$1 + \gamma \dot{e}_d(\beta) = \frac{(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}}{(1+\gamma)e_d(\beta) - 1 + 2(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{\frac{1}{2}+\lambda}{1+\lambda}}$$

which is positive under the assumption $\gamma \geq \frac{1}{1+2\lambda}$ since we have shown that in this case $e_d(\beta) \geq e_c(\beta)$.

8.3.3 Solution in the uniform case

The methodology used to compute the solution under decentralization in the uniform case is explained in the general case in section 8.4.1. It suffices to take $r_d = \frac{\frac{1}{2}+\lambda}{1+\lambda}$ in equations (6). The comparisons with the solution under centralization is immediate and left to the reader.

8.3.4 The fixed-price contract equilibrium

Assume that R_2 offers a fixed-price contract to the firm and that $\gamma = 1$. Then $\frac{\partial C_2^*(C_1,\beta)}{\partial C_1} = -1$ implying $\hat{U}_{1\beta}^1(C_1, \beta) = 0$ and $e_d(\beta) = e_*(\beta)$. This profile of efforts can be implemented with a fixed-price contract.

8.4 The choice of the regulatory structure under political uncertainty

8.4.1 Decentralization

For region i with a majority of δ_i the social welfare function of the local regulator can be rewritten as follows:

$$SW_i = \delta_i[S_i - (1+\lambda)(C_i(\beta) - \hat{U}^i(C_i(\beta), \beta))] - [(1+\lambda)\delta_i - \frac{\alpha_i}{\alpha_1 + \alpha_2}\mathcal{I}_{\{\alpha_i > \frac{1}{2}\}}]U(\beta).$$

where $\mathcal{I}$ is the indicator function. Define $r_{d,i} = \frac{(1+\lambda)\delta_i - \frac{\alpha_i}{\alpha_1+\alpha_2}\mathcal{I}_{\{\alpha_i > \frac{1}{2}\}}}{(1+\lambda)\delta_i}$ and $\delta_i = \alpha_i$ if $\alpha_i > \frac{1}{2}$ or $\delta_i = 1-\alpha_i$ if $\alpha_i < \frac{1}{2}$. Then, up to coefficient of the rent $U(\beta)$ in the social welfare function, the computations of the optimal profiles of efforts are similar. The implementability conditions are unchanged.

Lemma 1 *With decentralization, the optimal profiles of effort under asymmetric information are characterized by*

$$\begin{cases} e_1(\beta) + \gamma e_2(\beta) &= 1 - r_{d,i}(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{1-\gamma+\gamma[\dot{e}_1(\beta)+\dot{e}_2(\beta)]}{1+\gamma\dot{e}_1(\beta)} \\ \gamma e_1(\beta) + e_2(\beta) &= 1 - r_{d,i}(1+\gamma)\frac{F(\beta)}{f(\beta)}\frac{1-\gamma+\gamma[\dot{e}_1(\beta)+\dot{e}_2(\beta)]}{1+\gamma\dot{e}_2(\beta)} \end{cases}$$

with the initial conditions $e_1(\underline{\beta}) = e_2(\underline{\beta}) = e_*(\underline{\beta})$.

In the uniform case, when $\alpha_1 = \alpha_2 = \alpha$ then $r_{d,1} = r_{d,2} = r_d$. When assume that $(1+\lambda)\alpha > \frac{1}{2}$ for rent extraction to be desirable under a shareholder majority. We will look for linear and symmetric solutions of the form $e_i = a\beta + b$. Differentiating the optimality conditions, we obtain the following condition

$$a = -r_d \frac{1-\gamma+2\gamma a}{1+\gamma a}. \tag{6}$$

Solving (6) yields two candidate solutions. One can then show that one solution always fails to satisfy the optimality conditions of the firm's maximization problem (5) and can then be discarded from the analysis. We end up with

$$a = \frac{-1-2\gamma r_d + \sqrt{\Delta}}{2\gamma},$$

where $\Delta = 1 + 4\gamma^2 r_d(r_d+1) > 0$. We deduce then that $b = \frac{1}{1+\gamma}$.

Now we check that $1 + \gamma a \geq 0$. If $1 - 2\gamma r_d \geq 0$ then this condition is automatically satisfied. Otherwise this condition can be rewritten as $\gamma(1+\gamma)r_d \geq 0$ which obviously holds.

Now we must check that $1 - \gamma + 2\gamma a \geq 0$. This condition is equivalent to $1 - \gamma^2 \geq 0$ which obviously holds.

Now we check that $\dot{C}(\beta) \geq 0$ or equivalently $a \leq 1$. This amounts to $\gamma(1+\gamma)(1+r_d) \geq 0$ which obviously holds.

Finally, when $\gamma = 1$, one can check immediately that the solutions are $a = 0$ or $a = -1 - 2r_d$. The last solution does not satisfy the optimality conditions of the firm's maximization problem (5).

8.4.2 Centralization

In the uniform case, with $\alpha_1 = \alpha_2 = \alpha$ and $(1+\lambda)\alpha > 1$ for rent extraction to be desirable under a shareholder majority, immediate computations (adapted from section 8.2) show

that the optimal profiles of effort are given by

$$e_1(\beta) = e_2(\beta) = e_c(\beta) = \frac{1}{1+\gamma}[1 - (1+\gamma)r_c\beta],$$

where $r_c = \frac{(1+\lambda)\alpha - 1}{(1+\lambda)\alpha}$ under a shareholder majority and $r_c = 1$ under a nonshareholder majority.

8.4.3 Expected welfares comparison

Notice first that the proportion of shareholders appears only under a shareholder majority. With a slight abuse of notations, α represents now the proportion of shareholders under a shareholder majority (i.e. $\alpha > \frac{1}{2}$).

If $\lambda \geq 1$ then centralization is preferred whatever the majority.

Assume now that $\lambda < 1$. If both types of majority have the same probabilities ($\frac{1}{2}$), then the difference between the expected welfare under decentralization and the expected welfare under centralization is proportional to

$$P(\alpha) = 2\alpha^2(1-\lambda^2) - 2\alpha + 1. \tag{7}$$

We must have $(1+\lambda)\alpha > 1$ or $\lambda > \frac{1-\alpha}{\alpha}$, with $\alpha > 1/2$.

The discriminant associated to $P(\alpha)$ is $4(2\lambda^2 - 1)$. Consequently, if $\lambda^2 < 1/2$ then the discriminant is negative and $P(\alpha) > 0$ for all values of α and λ (as $1 - \lambda^2 > 0$ by assumption).

Assume now that $\lambda^2 > 1/2$. The largest of the two roots associated to P is

$$\frac{1 + \sqrt{2\lambda^2 - 1}}{2(1-\lambda^2)}$$

which is larger than 1 when $\lambda < 1$. On the contrary, the smallest of the two roots is

$$\frac{1 - \sqrt{2\lambda^2 - 1}}{2(1-\lambda^2)},$$

and is smaller than 1. It is larger than $1/2$ because $1 - \sqrt{2\lambda^2 - 1} \geq 1 - \lambda^2 \Leftrightarrow \lambda^2 \geq \sqrt{2\lambda^2 - 1}$ $\Leftrightarrow (1-\lambda^2)^2 \geq 0$, which obviously holds. Finally notice that $P(1/2) = 1/2(1-\lambda^2) > 0$ and $P(1) = 1 - 2\lambda^2 < 0$ from our assumptions.

If $\lambda^2 = 1/2$ then there is a unique solution: $\alpha = 1$.

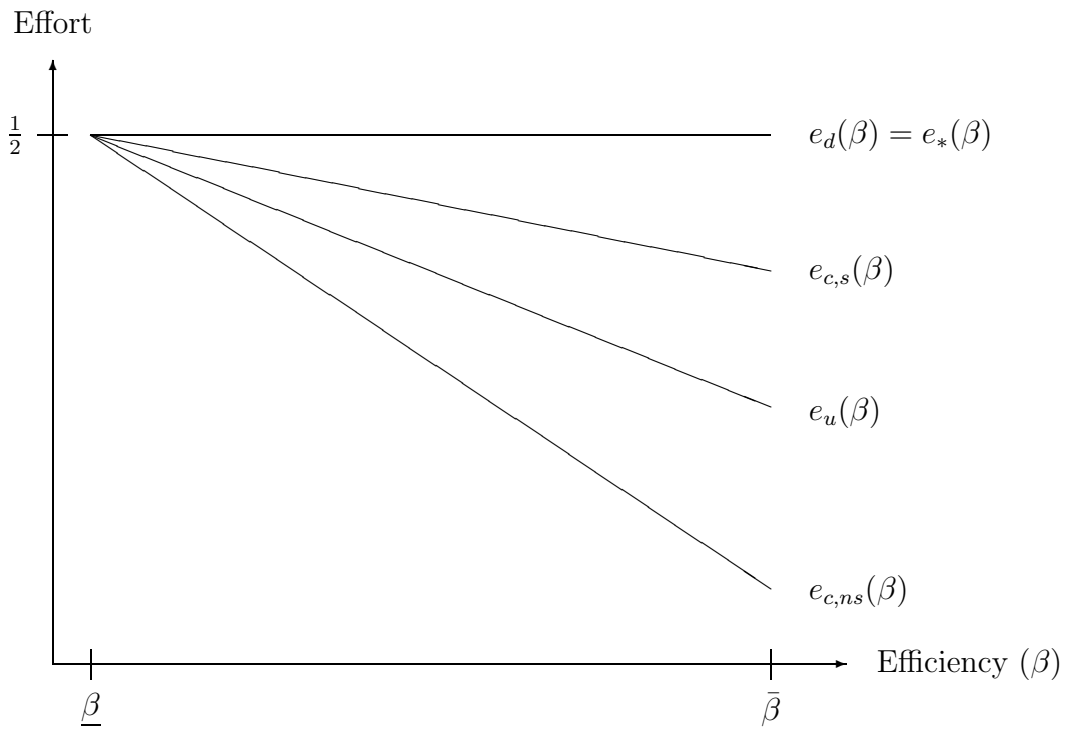

Figure 1: The profiles of effort.

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