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The rise and fall of the polluter-pays principle in developing countries

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ABSTRACT

The polluter-pays principle stipulates that the person who damages the environment must bear the cost of such damage. A number of developing countries have recently extended this principle to create an obligation on the state to compensate the victims of environmental harm. This variation of the polluter-pays principle is aimed at ensuring victims' compensation when polluters cannot be identified or are insolvent and at providing stronger incentives for local governments' monitoring of environmentally risky activities. These regimes hold local governments primarily or jointly-and-severally liable for environmental damage and allow them to act in subrogation against the polluters. In this paper we study the effect of these forms of governmental liability on the polluters' incentives and on aggregate levels of environmental harm. We develop an economic model to study the conditions under which governmental liability may be preferable to direct polluters' liability as an instrument of environmental protection. We conclude by suggesting that these variations of the polluter-pays regime may be desirable in environments characterized by widespread poverty, high interest rates, judicial delays and uncertainty in adjudication.

1. Introduction

The idea that a polluter should pay for the environmental harm it causes is well-rooted in Western legal history.[1] In present times, the polluter-pays principle stands as an international guideline for environmental policy stipulating that the person or firm who damages the environment must bear the cost of such damage. Since an environmental harm is often an externality, liability induces the responsible party to internalize the full social cost of his activity, thereby bringing the environmental harm down to the optimal level. In this paper, we shall consider a recent trend observed in developing countries such as India, Malaysia, Taiwan, Ecuador, Chile, Costa Rica, Kenya, and South Africa, who adopted a variation of the polluter-pays principle through judicial, legislative, and constitutional reforms focused on mitigation of harm through governmental liability. These new regimes purportedly ensure victims' compensation when polluters cannot be identified or are insolvent. Reframing the original rationale of the polluter-pays principle, these regimes suggest that the primary aim is to provide prompt compensation to the victims of environmental harm and only secondarily to impose liability on the responsible parties. In the last few decades several legal systems have recognized a primary obligation on local and central governments to provide prompt relief and compensation to victims of environmental harm. We refer to this reinterpretation of the polluter-pays regime as the *government-pays* regime. Local governments have proven quite responsive to the threat of direct liability and have boosted their monitoring of environmentally-risky activities to avoid the financial and political disruption associated with an environmental accident.

This paper is structured as follows. In Section 2 we provide a brief history of the polluter-pays principle and its recent reinterpretation and transformation, with special reference to the case of India and other developing countries. In Section 3 we develop a model to consider the incentive system created by a regime of direct governmental liability on prospective injurers and to evaluate the effects of this regime on aggregate levels of environmental harm. We develop a Stackelberg-type game where governments choose their levels of preventive monitoring effort and firms choose their level of care in response to the government's action. We compare the government's monitoring levels and the firms' care levels under the alternative polluter-pays and the government-pays regimes. We consider alternative governmental objective functions to allow

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[1] Already in a celebrated passage by Plato we find a statement of the principle according to which: "If anyone intentionally spoils the water of another . . . let him not only pay damages, but purify the stream or cistern which contains the water." The Dialogues of Plato: The Laws, vol. 4, book 8, section 485(e), translated by Jowett B, Oxford: Clarendon Press (4th ed.), 1953.

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for both benevolent welfare-maximizing governments and shirking cost-minimizing governments. In Section 4, we compare the polluter-pays and the government-pays regimes in the presence of legal and enforcement imperfections. We consider the welfare properties of the government-pays regime, comparing its effects to those that would be induced by a benevolent, welfare-maximizing government. Section 5 considers the comparative advantage of the two regimes as effective instruments of environmental protection. Section 6 concludes with some policy considerations.

2. The rise and fall of the polluter-pays principle

Academics have long recommended adoption of the polluter-pays principle which was the basis of formal recommendations of the Organization for Economic Cooperation and Development (OECD) since the early 1970s.[2] The extensive work of the OECD over the subsequent two decades was responsible for metamorphosing this economic principle into an established legal principle (OECD, 1992:9). The polluter-pays principle was formally adopted by the Europe Union in the Single European Act of 1987,[3] and in 1992 was recognized by the United Nations Conference on the Environment and Development delegates (so-called Rio Declaration).[4]

The implementation of the polluter-pays principle by sovereign states has enjoyed different incarnations in national legal systems (Finn, 1975). In some situations, the polluter-pays principle is implemented by state governments through direct regulation that creates economic incentives, leading the polluter to bear the cost of the environmental harm caused by its activity through regulation that imposes direct environmental liability on the polluting agents. In the context of environmental liability, over the last few decades international and national environmental liability laws have been invariably based on strict liability (Commission of the European Communities, 1993). The proponents of the strict liability rule also focus on "cost internalization," which requires charging a polluter for the social cost of an activity.[5] Furthermore, liability ensures that the price of commodities reflects the harm caused by non-negligent polluting activities, resulting in a more efficient allocation of resources (Krier & Stewart, 1978). Under the negligence rule, non-negligent harm is not internalized, and there could, therefore, be excessive entry of firms, resulting in an increase in the probability of pollution and/or environmental damage (Polinsky, 1980).[6] It should be noted that, while it is true that many countries embrace a strict polluter-pays principle with respect to prohibited emissions, several countries continue to treat permitted pollution as largely free.[7]

2.1. Recent departures from the polluter-pays principle

In cases of environmental pollution and degradation in developing countries, a different variation of the polluter-pays principle emerged focused primarily on the need to provide immediate compensation to victims of environmental harm.[8] Through legislation and judicial precedents, a number of countries have created an obligation on local governments to provide direct and prompt compensation to the victims of environmental harm.[9] These judicial and legislative reinterpretations of the polluter-pays principle hold states and local governments jointly-and-severally liable for the environmental damage caused by private parties, allowing these public bodies to act in subrogation against the individual polluters when possible. This variant of the polluter-pays principle generally sees a primary role for local and central governments to provide compensation to victims of environmental harm. This virtually subverts the logic of the principle by suggesting that the primary goal is to provide prompt compensation to the victims of environmental harm, and only secondarily to transfer the loss through subrogation on the responsible parties. This quite drastic shift away from the strict liability regime of the polluter-pays principle is motivated by the need to create direct monetary incentives on local environmental agencies augmenting their incentives to engage in monitoring of activities that create potential risk for the environment.

The wisdom of these reforms lies in the idea that local governments respond particularly to threats of litigation and possess the necessary administrative and legal instruments for the effective monitoring of prospective polluters. Fiscal revenues heavily constrain the budgets of these local governments and environmental agencies and, if held liable for the direct compensation of environmental harm, these entities face a possibly disruptive shortfall with both political and financial consequences. Unlike insurance companies, local governments transmit the care incentives to potential polluters, not only through the threat of subrogation, but also through several other administrative instruments (permits, safety and emission controls, site inspections, etc.) and legal

[2] The Organization for Economic Co-operation and Development (OECD) expresses the economic function of the polluter-pays principle as forcing "prices of goods (depending on the quality and/or quantity of environmental resources) to reflect, more closely, their relative scarcity and that economic agents concerned react accordingly" (OECD, 1972; OECD, 1974).

[3] Single European Act, 17 February 1986, 1987 O.J. (L 169). Article 174(2) of the consolidated versions of the Treaty on European Union and of the Treaty Establishing the European Union, 2002 O.J. (C 325) 1 provides that: "Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay."

[4] Principle 16 of the Rio Declaration provides that: "[n]ational authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution."

[5] This is consistent with the economic rationale of the polluter-pays principle, which mandates the cost-internalization principle (Bergkamp, 2001). See also Ott and Schäfer (1996, 2004).

[6] The economic rationale for this is that strict liability is a preferable rule in situations of unilateral care and where only the injurer can take effective precautions to prevent the harm. Further, while both strict liability and negligence rules induce the injurer to take the optimal amount of care, the advantage of strict liability in environmental cases is that only the harm must be observable. The level of care is irrelevant and therefore need not be established in a court of law, thereby reducing evidentiary requirements. The other reason for the increased use of strict liability in environment protection, especially in an age where all governments are trying to curb industrial pollution, is that in a market setting, negligence may prove inefficient compared to strict liability, inasmuch as it does not create adequate incentives to reduce activity levels and to invest in research and development of new cleaner technology.

[7] Member states of the EU are still far from shifting the entire cost of environmental degradation on polluting firms. For example, with the possible exception of Sweden, member states have not developed a comprehensive set of fees on permitted discharges. The polluter-pays principle, therefore, only applies uniformly across the EU to imply that all prohibited and harmful discharge should be paid for. The extent to which the cost of permitted pollution is transferred onto actual polluters instead varies across member states. This is in many ways short of what a full implementation of the polluter-pays principle would require (Faure, 2009).

[8] Pigouvian taxation instruments, involving a direct tax on every unit of pollution or on every unit produced by the polluting activity, have also been considered as alternative implementations of the polluter-pays principle. A third way in which the polluter-pays principle has been interpreted and implemented by national governments is through the adoption of market-based instruments, such as pollution permits and bubble-type pollution allowances. In yet other situations, government interprets the polluter-pays principle broadly and implement it through command-and-control measures wherein the government may specifically prohibit certain environmentally dangerous activities or disallow certain products, methods, or scientific techniques.

[9] Faure, Goodwin, & Weber (2010) point out the importance of optimal design of environmental law in developing country, rather to import Northern regulation, in order to correct the enforcement problems affecting developing countries.

threats (fines, revocation and suspension of licenses, etc.).[10] These instruments can make the monitoring activity of local governments particularly effective.

2.2. From the polluter-pays to the government-pays principle: the case of India

India has undertaken a tranformative approach to environmental protection in recent years, at both the regulatory and judicial level (Faure et al., 2010).[11] Recent developments in environmental protection in India examplify a reinterpreting of the polluter-pays principle in the method discussed above (Jaswal, 2008).[12] India recently adopted a system of direct governmental liability requiring the state to pay damages to the victim of environmental harm and allowing the government to recover its disbursements from the polluter at a later time through an action for subrogation.[13]

The Stockholm Declaration in 1972 provided a touchstone for Indian environmental legislation. India agreed with 113 other nations on principles and planned to protect the environment resulting in an obligation to implement these domestically. In the fulfillment of the obligations arising from the Stockholm Declaration, India witnessed a proliferation of environmental laws and regulations. In keeping with international standards, the Indian government enacted legislation for environmental protection, water pollution, air pollution, and wildlife conservation. Most notably, the implementation of the Stockholm Declaration led to the amendment of the Indian Constitution,[14] which incorporated Articles 48A[15] and Article 51A(g).[16] On the basis of these constitutional provisions, the Indian Parliament enacted the Water Act, 1974, the Air Act, 1981, and the Environmental Protection Act, 1986 (Krishna Kumari, 2007). In conjunction with these regulations, India created specialized authorities with a grant of wide powers including closure of industries and the power to give any directions to protect the environment.[17] Yet these authorities suffer from administrative failures similar to those plaguing the rest of the Indian bureaucracy and executive. Cities and rivers in India, in particular, underwent unprecedented degradation. With rising environmental degradation, the increasingly activist Indian judiciary began to take greater note of these standards, creating an obligation on state governments to provide compensation to the victims of environmental harm that has not been successfully prevented by the proactive precautionary measures of the specialized authorities.

The Indian judiciary took special interest in this matter on counts of social justice, since most of the victims of such environmental degradation had no possible means of individually suing the polluters to enforce the polluter-pays principle.[18] In several instances, the Supreme Court issued orders to the relevant municipal authority to constitute mechanisms to clean environmental damage and compensate victims of pollution, giving the municipal authority an option to act in subrogation against the responsible parties. Even when an action was successfully brought against the polluting firm, it was established that the government would remain liable to pay for residual shortfalls.[19]

As a result of these developments, state authorities now play a much larger role. The state is now involved in all environmental matters, from creating the appropriate authority to clean the environment pollution, to actually stepping in for the polluter and paying damages. Many laud this model of governmental liability for environmental harm (the government-pays regime) as the savior of India's ecology.

2.3. The adoption of the government-pays principle in other developing countries

Similar incarnations of the government-pays principle have been observed in a handful of other developing countries, especially where ongoing economic development puts severe pressure on the environment. Countries like Malaysia, Taiwan, Ecuador, Chile, Costa Rica, South Africa, and Kenya adopted remedies focused on mitigation of the harm through governmental liability. These systems carried out reforms through judicial, legislative and constitutional intervention, to ensure victims' compensation when polluters cannot be identified or are insolvent.

Similar to the case of India, these regimes subverted the original rationale of the polluter-pays principle, imposing on governments and local agencies the obligation to provide prompt compensation to the victims of environmental harm, and only secondarily to recover costs from the responsible parties.

Within this context, in the last few decades Taiwan witnessed much citizen activism leading to the recognition of a principle which entitles victims to receive government compensation for pollution. The 1986 protest against pollution by Du Pont and the 1988 protest against the Lunyuan Industrial Zone causing livestock deaths due to pollution spurred the government into action. The latter of the two causes took protests to the extent of violence and the government compensated the victims by providing $10 million. In subsequent years, protesters rallied against Taipower and China Petroleum Company, leading to a settlement of up to $250 million (Chen, 1994).

Another interesting example comes from the Malaysian Environmental Quality Act. The Director General of Malaysia has powers very similar to his Indian counterpart. Under Section 47 (1) of the Environmental Quality Act, the Director General may take such action necessary to remove, disperse, destroy or mitigate the pollution and may recover from the polluter all costs and expenses incurred in connection therewith (Mustafa, 1991).

[10] See also Nash (2000), Schäfer (2000) and Guelton (2002).

[11] See also OECD (1972, 1974, 1989, 1992) and Babu, Eger, Raja, Schäfer, and Somashekhar (2010).

[12] Further analysis of the various legislation and environmental cases can be found in Jaswal (2008), which has provided a comprehensive source of information for this section. The World Bank has predicted that India's water, air, soil, and forest resources will be under more human pressure than those of any other country by the year 2020.

[13] Faure and Raja (2010) discuss on the effectiveness of environmental regulation in India, with special reference to public interest litigation. See also Craig and Deshpande (1989), Prasad (2004) and Raja and Rathinam (2005).

[14] See Bakshi (2005) and Jain (2005) for studies on the Indian Constitution.

[15] Article 48A is a Directive Principle guiding the state for the "protection and improvement of environment and safeguarding of forests and wild life."

[16] Article 51A(g) is a Fundamental Duty for the citizens of India to "protect and improve the natural environment."

[17] The Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) were initially set up under the provisions of the Water Act, 1974, and now also carry out their functions under the Air Act, 1981. The CPCB and the SPCBs also perform all additional functions under the Environmental Protection Act and are the prime environmental authorities in India. They are supported by the relevant authorities for the supervision of coastal zone regulations: the National Coastal Zone Management Authority and State Coastal Zone Management Authorities.

[18] Although Indian law recognizes a class suit or a representative suit, wherein one or more members of a class having the same interest may sue or defend on behalf of themselves and all the other members of the class (Order 1 Rule 8 of the Civil Procedure Code of 1908), few cases used these actions and with little success and were not regarded as a viable solution to the problem at hand.

[19] For example, in the Bhopal Gas Tragedy, after five years of litigation, an out-of-court settlement was reached between the polluting company, Union Carbide, and the Government of India. The Supreme Court held that if the settlement fund that had been negotiated was exhausted, the Government of India should make good the deficiency for all the past, present and future claims arising from the gas leak. Bhopal Gas Leak Disaster (Processing of Claims) Act, 1985. *Union Carbide Corporation v. Union of India*, A.I.R. 1990 S.C. 273.

South Africa and Kenya exemplify two similar developments from the African continent (Bruch, Coker, & VanArsdale, 2001; Mustafa, 1991; Rabie, 1991). In the late 1980s South Africa witnessed a shift towards government compensation for environmental harm caused by private injurers, which led to legislative intervention. Section 19 of the Environmental Conservation Act 73 of 1989 empowers the government to take the necessary steps to repair the damage and to recover the cost from the polluter for its failure to take adequate measures (Rabie, 1991).[20] Following the footsteps of South Africa, in 2002 Kenya drafted a provision for citizen redress against pollution from the High Court in its Draft Constitution. If passed, this provision would empower citizens to directly approach the court to enforce the right to a clean environment (much like the judicial interpretation read into Article 21 of the Indian Constitution). The provision gives extensive powers to the court to compel the government or any public agency to take restorative measures and to provide compensation for any victim of pollution and to compensate the cost borne by victims for the lost use of natural resources as a result of an act of pollution.[21]

We also observe similar developments through legislative and judicial intervention in South American countries. In the *Fundación Natura contra Petro Ecuador* case, an Ecuadorian court, when approached by an environmental activist NGO, ordered the state agency to assess the damage and to compensate the community, holding that the state could sue the corporation once the assessment was completed.[22] In Chile, the Framework Law contains provisions for citizen-suits to redress environmental harm. The law allows individuals to commence legal actions against local governments to recover for environmental damages (Sullivan, 1996). It provides that victims of environmental harm may require the municipality in which the activity damaging the environment occurred to act on their behalf, holding the municipality jointly and severally liable for the environmental damage which the petitioner has suffered in case of government inaction.[23] Similarly Costa Rica penalizes government inaction through the Organic Law for the Environment (1995). It gives the authority the power to issue warnings, admonitions, restriction of any damaging activity, partial or total closing or facilities, partial or total cancellation of permits, patents, certification of incorporation in case of non fulfillment of the authority's orders. The law goes a step further and provides the above sanctions for government officials who violate the laws and regulations for action or omission (Santos, 1996).[24]

In Section 3, we will analyze the incentive system created by this regime of governmental liability for prospective injurers and its effect on the aggregate level of environmental harm.

3. Modeling government's and polluters' incentives

In this section, we present a formal model to compare the incentive and welfare effects of the environmental liability principles considered above. In Sections 3.1 and 3.2, we will identify some of the basic features of this regime with respect to government's and polluters' incentives.

Under each environmental principle, the government has an incentive to monitor ex ante the environmentally dangerous activities of private individuals and firms. Individual firms have an incentive to undertake care in order to minimize the likelihood of an accident. We develop a Stackelberg-type game where governments choose their levels of preventive monitoring effort in the first stage and firms choose their level of care in the second stage of the game. Parties (government and polluters) are assumed to be risk neutral, rational, and utility maximizing.

In the following we characterize the optimal monitoring level of the government and the optimal care level of an individual firm under the alternative polluter-pays and the government-pays regimes. We describe the effects of the polluter-pays and the government-pays regimes, identifying the conditions under which one or the other is a more effective instrument of environmental protection.[25]

3.1. Starting from Stage 2: the care choice of prospective polluters

We assume that the principal's (government) best strategy incorporates the agent's (prospective polluter) best reaction to the government's action. Using backward induction, we start by identifying the agent's choice. The agent carries out an activity, with a fixed value V,[26] that may cause environmental harm. The agent can invest in care to reduce the probability of environmental harm. Denote with x the agent's level of care, where $x \in [0,\infty($. With a level of care x, environmental damage occurs with probability $p(x)$, where $p(x) \in (0,1)$. We assume unilateral care, such that the probability of the environmental damage can only be effectively controlled by the polluter's level of care. The government can affect the polluter's level of care through monitoring but cannot directly reduce the environmental risk by taking precautions on its own. Likewise, the victims bear the harm without being able to reduce the probability of its occurrence with their own precautions. We assume that the agent's care decreases the probability of environmental damage, $p_x < 0$, at a decreasing rate, $p_{xx} > 0$. When

[20] Section 19 and 20 Environmental Conservation Act 73 of 1989.

[21] Article 241, Chapter 12, Draft Constitution of the Republic of Kenya 2002.

[22] *Fundación Natura contra Petro Ecuador de la Provincia de Buenos Aires*, Expediente No. 221-98-RA Corte Constitucional de Ecuador, 1998), upholding *Fundación Natura contra Petro Ecuador*, Expediente No 1314 (Juzgado decimo primero de lo civil de Pichincga, April 15, 1998).

[23] Framework Law, Tit. III, Art. 54.

[24] Although the trend towards the government-pays regime is a frequent phenomenon in developing countries, some industrialized countries also provide scattered examples of state funds for environmental protection, most notably in the United States, Japan and France (Cole, 1991; Lin, 2005). These pieces of regulation are rather exceptional in nature and, as noted below, represent variations of the polluter-pays principle, rather than an embodiment of the government-pays principle observed in developing countries. In the United States, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, (CERCLA) is the main federal law of the United States that addresses the clean-up of hazardous substances. The Superfund created under the Act intended to pay for the cleanup of hazardous-waste dump sites and spills, financed by a combination of general revenues and taxes on polluting industries. The Environmental Protection Agency was directed to create a list of the most dangerous sites; it would then compel the polluter to pay for the cleanup or would pay for the cleanup itself through the Superfund and sue for reimbursement. Preceding this sweeping legislation was the Deepwater Port Act of 1974 which held the owners and operators of vessels strictly liable for damages caused. However the Deepwater Port Liability Fund was created to be liable for damages and the cost of cleaning the environment when such clean-up was not compensated by the private polluter. In 1973, France allocated environmental damage funds to controlling noise pollution. In Japan, the 1967 Basic Law for Environmental Pollution Control is the bedrock for all the legislation that followed to protect both the environment and pollution victims. In keeping with the European trends the Japanese government enacted laws to protect air and water, regulate the production of chemical substances, and conserve and protect the natural surroundings. The Japanese government created two types of compensation structures under the Law for the Compensation of Pollution-Related Health Injuries. The first follows the polluter-pays principle and mandates that victims be compensated by the private injurer. And a second category of victims are those whose injuries cannot be traced to specific polluters and are compensated by the Pollution-Related Health Damage Compensation Association, financed by pollution levies (Gresser, Fujikura, & Morishima, 1981). The compensation system adopted in Japan uses taxes collected from emissions to pay compensation to victims, hence representing a Pigouvian-tax variation of the polluter-pays principle, rather than an application of the government-pays regime.

[25] For a recent analysis of the tradeoff between direct and indirect incentives in the context of state liability, see Dari-Mattiacci, Garoupa, and Gomez-Pomar (2010).

[26] The assumption of a fixed level of activity increases analytical tractability and results do not depend on this assumption. Results with a variable activity level are available from the authors upon requests.

environmental damage occurs, an exogenous loss denoted by L is created, where $L > 0$. In the simple economy considered here, there are two types of agents (potential polluters), $i = R, P$. Rich agents, R, are characterized by the fact that they have a level of wealth A_R sufficient to compensate for the environmental harm L caused by their activity. Poor agents, P, have a lower level of wealth, denoted by A_P, where $A_P < L$. It follows that in this framework, the damages paid by a type-R agent equal the loss L, since $A_R \geq L$, while a representative type-P agent will pay damages equal at most to his wealth level A_P, since $A_P < D$. We shall refer to γ_i as the proportion of type-i agents in the population, $i = R, P$.[27]

Each prospective polluter chooses the level of care to minimize the expected cost of liability and precaution costs.[28] Additionally, the government can engage in monitoring of the firms' activities through ex ante safety controls and sanctions that impose a cost on firms that deviate from the socially optimal level of care. The government is assumed to impose a per unit cost on deviating firms, equal to $m(e)$.

The objective function for a prospective polluter i is:

$$\min_{\{x_i\}} p(x_i)D_i + x_i + m(e)(x^{**} - x_i) \quad (1)$$

Proposition 1. *The privately optimal level of care chosen by type-P agents is lower than the level of care chosen by type-R agents: $x_P^* \leq x_R^*$. Type-R agents exert the socially optimal level of effort.*

Proof: See Appendix A.

This result should not be surprising. The limited wealth of type-P agents reduces their expected liability, hence diminishing the (private) marginal benefit of care. Type-P agents will, therefore, have a lower incentive to invest in care (Dari-Mattiacci & De Geest, 2005; Shavell, 1986, 1987). On the contrary, fully liable agents will exert the socially optimal level of care.

3.2. Stage 1: the monitoring decision of the government

Having identified the best reaction of prospective polluters, we can identify the government's best monitoring strategy through backward induction. We do so by considering the government's decision under the polluter-pays regime and the government-pays regime. When investing to contain environmental harm through monitoring, the government faces a monitoring cost, which depends on the effort level, $e \in [0,\infty($. This effort level should be thought as the incremental monitoring effort of local governments and environmental agencies in response to the risk of environmental harm and the threat of direct liability.[29]

The government has information on the financial wealth, A_i, $i = R, P$, of the agents and can undertake different monitoring levels for the two types of agents. The monitoring expenditure equals the total monitoring effort exerted on rich and poor agents, where e_i denotes the effort per individual type of agent, $i = R, P$ and γ_i denotes the fraction of the population of type i, $i = R, P$.

3.2.1. Benevolent government

The objective function of a benevolent government is to minimize the expected environmental loss, the monitoring cost and the care costs of each type of agent.

$$\min_{(e_i)i=R,P} p(x_i)\gamma_i L + \sum_{i=R;P} \gamma_i(c(e_i) + x_i) \quad (2)$$

Proposition 2. *A benevolent government undertakes a higher level of monitoring for type-P agents than for type-R agents: $e_P^{SO} > e_R^{SO}$. The level of care chosen by type-P agents, however, is lower than the level of care chosen by type-R agents: $x_P^{SO} < x_R^{SO}$.*

Proof: See Appendix A.

3.2.2. Introducing imperfect governments: the relevance of legal regimes

When the incentives of government officials misalign with those of the community, the government may experience agency problems. In choosing their course of action, government officials may not perfectly internalize the social loss caused by a pollution accident, equal to L. Given the imperfect internalization of the accident loss, the government's monitoring effort will be suboptimal. The introduction of governmental liability remedies can correct the dilution of incentives caused by agency problems. Under a government-pays regime, government's monitoring levels will reflect the residual loss borne by governments unable to collect damages from insolvent or disappearing polluters, $L - A_P$. Under a government-pays regime, the welfare function of the government is equal to the sum of a weighted average of the social loss (weighted by α) and the government financial loss (weighted by β) and the monitoring and care costs. Analytically, the welfare function of the government takes the following form:

$$\min_{(e_i)i=R,P} p(x_i)\gamma_i[\alpha L + \beta(L - \min\{L, A_i\})] + \sum_{i=R,P} \gamma_i(c(e_i) + x_i) \quad (3)$$

Agency problems in governmental action are present when $\alpha \leq 1$. The welfare function collapses to the one of a benevolent government when $\alpha = 1$ and $\beta = 0$. We can now study the monitoring incentives created by the application of the government-pays regime on the two types of agents considered above.

As discussed in Section 2, in a government-pays regime, all cases of environmental torts and environmental accidents can be either filed through public interest litigation directly against state and local governments or brought against these governmental bodies through joint-and-several liability actions in torts.[30] In either case, the determined amount of damages will be paid by the state to the victims. The state has an opportunity to act in subrogation against the actual polluters to recover damages paid to the victims and the cost of environmental restoration.

In these regimes of governmental liability, primary liability for environmental damage caused by private firms and individuals falls on the state and local governments. We assume that local governments and environmental agencies are constrained by fiscal revenues and respond to the threat of primary liability, which would cause financial disruption with political and electoral consequences.

Under the government-pays principle, we assume that the government's right of subrogation transfers the loss to the responsible party only to solvent parties, but leaves the loss on the government in case of insolvency. Under the government-pays principle, we assume $\beta \geq 1$, i.e. the government fully internalizes the portion of the damage compensation paid out to environmental victims and faces cost for administering such funds, since the government bears not only the portion of the loss unrecoverable from insolvent parties but also legal and administrative costs. We assume that under the polluter-pays principal, the government does not fully internalize the victims' loss ($\beta < 1$), when the victim remains uncompensated due to insolvency.

[27] Without loss of generality, the size of the population is normalized to one and $\gamma_R + \gamma_P = 1$.

[28] This is equivalent to the problem of maximizing the agent's objective function equal to the value of activity net of the expected liability and precaution costs, due to the assumption of fixed activity level.

[29] This is compatible with a fixed monitoring level on each type of agent.

[30] In the case of environmental protection in India, this involves filing a writ petition under Article 32 of the Indian Constitution against the state and the polluters.

Proposition 3. *The introduction of governmental liability leads to an increase of the monitoring of type-P agents. The monitoring exherted on type-R agents is not affected by the choice of legal regime.*

Proof: See Appendix A.

Proposition 4. *The monitoring exherted on type-P agents under the government-pays regime may exceed the level chosen by a benevolent government,* i.e. $e_P^* > e_P^{SO}$, *for sufficiently high* α *and* β.

Corollary. *In a government-pays regime, type-P [type-R] agents undertake a higher [lower] level of care than what would be chosen when monitoring is carried out by a benevolent government:* $x_R^{SO} > x_R^*$ *and* $x_P^{SO} < x_P^*$ *for sufficiently high* α *and* β.

Proof: See Appendix A.

The government-pays regime may trigger an overshooting of monitoring incentives with respect to type-*P* agents. This overshooting effect results from the fact that the government internalizes the benefit of its monitoring but does not fully internalize a portion (equal to $1-\alpha$) of social loss L and the higher precaution costs that agents face. 7). We observe excessive monitoring of type-*P* agents in a number of situations. For example, this occurs whenever the government weighs consistently more its loss than the social loss (i.e. $\beta > 1$ if $A_P = 0$ and $\beta > \bar{\beta} > 1$ if $A_P > 0$), or when the government fully internalizes the social loss, but faces also a loss at the stage of subrogation ($\beta > 0$ for any $A_P \geq 0$). A rational government will engage in stricter monitoring of type-*P* agents in order to reduce its exposure in the face of insolvent tortfeasors. This may trigger higher (and possibly, excessively high) levels of care by type-*P* agents.

Comparing the effects of monitoring on the level of care in Propositions 2 and 4 yields an intriguing result. As stated in Proposition 2, when monitoring is carried out by a benevolent government, type-*P* agents will choose a lower level of care than the level of care chosen by type-*R* agents: $x_P^{SO} < x_R^{SO}$. This result runs contrary to the observation in Proposition 4 in the government-pays regime, where $x_R^* < x_P^*$. Governmental monitoring of type-*P* agents remains high in all cases, but the monitoring carried out by a welfare-maximizing government does not lead to the paradox observed in Proposition 2, where type-*P* agents take higher care than type-*R* agents in spite of their limited liability. A benevolent government will induce lower care levels for type-*P* agents than for type-R agents because the precautions of type-P agents are socially more costly than those of type-*R* agents. Although direct precaution costs are the same for type-*P* and type-*R* agents, the inducement of precautions for type-*P* agents necessitate higher monitoring costs given the reduced direct incentives they face because of their limited liability.

3.3. Summary results

In Table 1, we summarize the results of the previous analysis evaluating the efficiency of the levels of care and governmental monitoring for type-*P* and type-*R* agents in the government-pays regime. We do so by comparing the levels of monitoring and care in a government-pays regime to those that would be induced by a benevolent government, as discussed in Section 3.2.1.

Intuitively, in both regimes type-*P* agents are monitored more closely than type-*R* agents. In fact, in both regimes, type-*P* agents face reduced direct incentives through liability and necessitate higher governmental monitoring. The extent of monitoring of type-*P* agents, however, differs between the two regimes, $e_P^{SO} < e_P^*$.

This brings to light an important effect. It is possible to see that in the government-pays regime, governmental monitoring may lead to an overshooting in care incentives, inducing type-P agents to adopt higher levels of care than type-*R* agents, $x_R^* < x_P^*$. This overshooting effect is not observed under a benevolent government, $x_R^{SO} > x_P^{SO}$. The reason for this overshooting effect is that governments choose a level of monitoring that minimizes their financial exposure in the face of potentially insolvent agents, without internalizing the cost that type-*P* agents face in terms of higher care. A benevolent government, on the other hand, undertakes a level of monitoring that internalizes both the costs and benefits of the agents' care.

The government-pays regime corrects the misalignment of governmental incentives but may lead to a biased governmental action, with stricter monitoring and enforcement against type-P agents. These results are consistent with the anedoctal evidence discussed in Section 2, where the media criticized local governments for applying double standards in environmental protection towards small local firms rather than larger and wealthier industries.

4. Comparing regimes in the presence of enforcement imperfections

We extend the model discussed in Section 3 to consider the workings of the two-liability regimes in the presence of enforcement imperfections, such as insolvency, court delays, and errors.

Enforcement imperfections create an undesirable dilution of deterrence under all liability regimes. As it will be discussed in this section, polluter-pays and government-pays regimes respond differently to the presence of enforcement imperfections. We assume that in a government-pays regime, the government recovers compensation payments from the responsible parties through subrogation. When successful in a subrogation action, the government can obtain full recovery from type-*R* agents, but only partial recovery from type-*P* agents. Recovery through subrogation is not instantaneous; trials are lengthy and repayment occurs with a delay equal to t. Furthermore, due to the possibility of court errors, judicial outcomes are affected by some degree of uncertainty, and governments can obtain a subrogation judgment against the responsible party only with probability p_s.

We denote with δ the overall effectiveness of adjudication in a subrogation action, capturing the combined impact of judicial delays and court errors. The effectiveness of adjudication, δ, can be thought to decrease from the interest rate r and delays in adjudication t, and to increase from the probability of success of the government in the subrogation p_S. In analytical terms, $\delta = p_S/(1+r)^t$. A perfectly effective adjudication occurs only in the limiting case with no delays in adjudication, $t = 0$ (repayment to the government is collected immediately), or where the responsible parties gain no financial benefit from judicial delays, $r = 0$, (zero interest rate), and where there are no judicial errors, $p_S = 1$ (repayment occurs with certainty). The dilution effect from ineffective adjudication can be reduced or eliminated by increasing the damage award in an action for subrogation to offset the discounting from judicial delays and legal uncertainty.

In the presence of legal and enforcement imperfections, the objective function of a representative type-i agent, $i = R, P$, becomes[31]:

$$\min_{\{x_i\}} p(x_i)\delta D_i + x_i + m(e)(x^{**} - x_i) \qquad (1')$$

[31] The dilution applies only to the damage D and not to the fine $m(e)$. This implies that the polluter's insolvency may shield the polluter from (large) environmental liability, but not from the payment of a fine (i.e. insolvency is not as severe as to make the polluter unable to pay a fine). Likewise, we assume that governments are able to collect fines without delays. Note however that our results do not depend on this modeling assumptions. Results are available upon requests by the authors.

Table 1
Monitoring and care in a government-pays regime.

	Government-pays regime	Benevolent government	A comparison	
			Type-P	Type-R
Monitoring effort	$e_R^* < e_P^*$	$e_R^{SO} < e_P^{SO}$	$e_P^{SO} < e_P^*$	$e_R^{SO} > e_R^*$
Level of care	$x_R^* < x_P^*$	$x_R^{SO} > x_P^{SO}$	$x_P^{SO} < x_P^*$	$x_R^{SO} > x_R^*$

The objective function of a benevolent government is unchanged, while the objective function of a government affected by agency problem becomes:

$$\min_{(e_i)i=R,P} p(x_i)\gamma_i[\alpha L + \beta(L - \delta \min\{L, A_i\})] + \sum_{i=R,P} \gamma_i(c(e_i) + x_i) \quad (3')$$

Legal and enforcement imperfections dilute the agent's care incentives in the second stage of the game.[32] Now even type-R prospective polluters may exert an effort level lower than socially optimal depending on the severity of the legal and enforcement imperfections and the size of the penalty $m(e)$.

Proposition 5. *The government exerts higher monitoring on type-P agents than type-R agents. The government-pays regime further increases the level of governmental monitoring on type-P agents compared to the polluter-pays regime.*

Proof: See Appendix A.

In a polluter-pays regime, the government always exerts a positive effort on type-P agents. Monitoring of type-*R* agents only takes place if the dilution of the direct incentives is sufficiently high. In a government-pays regime, the government exerts a positive monitoring effort on both types of agents, but monitoring is higher for type-*P* agents. This can be explained by the fact that type-*P* agents expose governments to larger financial liabilities which heightens governments' marginal return on monitoring efforts. This result holds even in the ideal world of perfect adjudication, with $t = 0$ (repayment to the government is collected immediately), $p_s = 1$ (the repayment to the government is made with certainty), and $r = 0$ (zero interest rate). A higher level of monitoring for type-*P* agents also occurs when repayment in subrogation is increased by courts (as a sort of punitive damage multiplier) to offset the effects of discount rates and uncertainty. The wedge between e_R^* and e_P^* increases as the wealth of type-*P* agents, A_P, lowers.

Proposition 6. *The government-pays regime leads to an overshooting of care incentives, such that the level of care chosen by type-P agents is higher than the level of care chosen by type-R agents when the monitoring effect dominates for the limited liability effect.*

Proof: See Appendix A.

In a government-pays regime, enforcement imperfections create two countervailing effects on agents' care. On the one hand, the government exerts higher levels of monitoring on both types of agents, inducing a possible increase in their level of care. On the other hand, the replacement of direct liability with indirect liability through subrogation can dilute care incentives. The net effect on each type of agents' optimal level of care, e_i is therefore indeterminate. For type-*P* agents, the impact of monitoring is more likely to dominate the dilution from imperfect adjudication, since the advantage of imperfect adjudication is smaller for type-*P* agents, due to their limited liability. This can be seen in the limiting case of judgment-proof defendants (i.e. for values of $a \to 0$), for which the government-pays regime only creates positive effects through monitoring, with no dilution effect. The opposite may be true for type-*R* agents, since governments will likely concentrate most of their monitoring efforts on type-*P* agents.

5. The comparative advantage of the government-pays regime as an instrument of environmental protection

In Section 4 above, we examined incentives created by the polluter-pays and the government-pays regimes on prospective polluters. In the following, we will build on these results to examine the comparative advantage and the welfare properties of the government-pays regime as an instrument of environmental control. In a recent paper, Faure and Raja (2010), have argued that one of the primary reasons for regulatory failure in environmental protection in developing countries is that policymakers do pay sufficient attention to the design of regulatory solutions that are appropriate to the legal, economic, political, and social situations in which they will need to operate. In this section we consider the polluter show that the government-pays regime through the lens of regulatory design suggested by Faure et al. showing that this regulatory solution may become a preferable method of environmental control in situations characterized by widespread poverty, high interest rates, and judicial delays and uncertainty. Our comparative evaluation of alternative legal regimes considers the welfare properties and the biases created by the government-pays regime relative to the alternative polluter-pays regime, mapping the optimal scope of application of each regime.

The effects of the government-pays regime on the aggregate level of environmental harm can be evaluated by considering the expected harm caused by type-*R* and type-*P* agents. The total social cost of environmental accidents equals the sum of the expected environmental loss caused by type-*R* and type-*P* agents, plus the precaution and monitoring costs, as found in Eq. (2). We denote with S^{PP} the total social cost of environmental accidents under the polluter-pays regime when government and prospective polluters act optimally. Similarly, we denote with S^{GP} total social cost of environmental accidents under the government-pays regime. According to the analysis discussed in Section 4, the optimal choice of care level of type-*i* agent, $i = R, P$ is a function of:

$$x_i^* = f(\delta, \mu, \rho) \cdot i = R, P$$

where $\delta \in [0,1]$ measures the effectiveness of adjudication, defined as $\delta = p_S/(1+r)^t$, $\mu \in [0,\infty]$ the cost-effectiveness of monitoring defined as $\mu = c_e/p_x x_e$, and $\rho = \gamma_R A_P/L$ the wealth level, given by the percentage of type-*R* agents in society multiplied by the wealth level of type-*P* agents.

In order to understand the optimal scope of application of the government-pays principle for controlling environmental harm, we define an iso-social-cost boundary between the two regimes as follows:

$$S^{PP} = S^{GP} \quad (4)$$

The iso-social-cost boundary in (4) represents combinations of parameters (δ, μ, ρ) for which the polluter-pays and government-pays regimes prove equally efficient in containing total environmental loss. Fig. 1 below depicts the iso-social-cost boundary which helps us compare the polluter-pays and the government-pays regimes as instruments of environmental

[32] The proof follows trivially from Eqs. (10) and (11) in Appendix A and is omitted for brevity reasons.

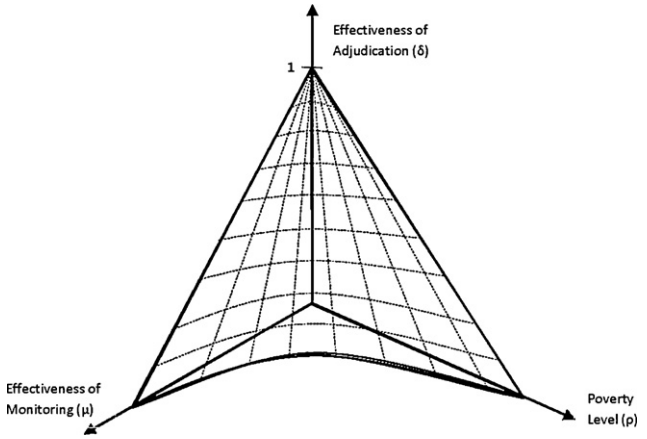

Fig. 1. Optimal scope of application of the government-pays regime.

control. The parameters δ, μ and ρ are represented respectively on the vertical, horizontal-left, and horizontal-right axes of Fig. 1.

Points that fall below the sloped iso-social-cost function represent combinations of our three parameters for which the government-pays regime proves more efficient. Points above the iso-social cost function instead represent combinations of parameters that render the polluter-pays regime preferable as an instrument of environmental control. In all points below the iso-social cost function, the benefits of shifting the incentives to government outweigh the problems created by the government-pays regime.

The intuition behind this graphical representation explains the following. A reduction of the wealth level of prospective polluters, ρ, has a positive effect on the total social cost of environmental accidents under both liability regimes. However, the polluter-pays regime is more sensitive than the government-pays regime to a decrease in ρ (measured by an decrease in γ_R or A_P or an increase in L). The slopes along the east-west and north-west dimensions in Fig. 1 imply that, for sufficiently low level of wealth (i.e. large values of poverty), the government-pays regime may also become preferable when government is more effective in monitoring and/or when adjudication is imperfect and plagued with judicial delays and uncertainty.

The polluter-pays regime becomes a more desirable alternative when the effectiveness of adjudication, δ, increases or the effectiveness of monitoring, μ, decreases especially when combined with low poverty levels.

In a government-pays regime, for values $\rho = 1$ the loss to the government is associated with the delays and uncertainties in the subrogation action. These costs increase with the time necessary to recover from the responsible parties through subrogation (i.e. higher t) and with the interest rate, r, and decreases with the probability of success in the subrogation action, p_S. Governments may choose some positive level of monitoring to minimize these costs. The government will exert the same level of monitoring on both types of agents, because for values $\rho = 1$ the agents' wealth differences do not affect their ability to repay in subrogation and are not relevant for the government's choice of monitoring effort.

These results shed light on some possible policy issues for the adoption of the government-pays regime. A first point concerns the best institutional allocation of oversight powers for the monitoring of prospective polluters under the government-pays regime. The private and social value of the risk-creating activities is generally opaque to courts and governmental agencies. For this reason, these values do not generally play a direct role in tort law. In the absence of a well-functioning liability system, however, when care incentives are driven by governmental monitoring, the evaluation of the private and social value of the risk-creating activity becomes relevant. The government-pays regime does not create immediate incentives on the government to take into account the value of the risk-creating activity when choosing a monitoring level. As we have seen, this may lead to a myopic governmental action that leads to an excessive monitoring of type-*P* and type-*R* agents. A possible way to induce monitoring agencies to consider the value of the risk-creating activities would be to facilitate a coordinated action between branches of government entrusted with environmental protection and tax revenue collection. Monitoring that distorts care and activity level incentives reduces the value and the tax-revenue potential of those activities—a cost that would be internalized and somewhat corrected through coordinated governmental action.

6. Conclusions

In this paper we have evaluated the differences between two types of environmental regulation: the traditional polluter-pays principle, where the polluter is directly liable for environmental harm, and a variation of the polluter-pays principle, adopted by a number of developing countries, including India, Malaysia, Taiwan, Ecuador, Chile, Costa Rica, Kenya, and South Africa, among others, where the government instead is directly responsible for payment and environmental monitoring. We have compared the incentives for both the polluter and the government under both regimes, as well as the welfare outcomes.

Recently enacted legislation and judicial precedents create an obligation on the state to compensate the victims of environmental harm. These reinterpretations of the polluter-pays principle hold state and local governments jointly-and-severally liable for environmental damage caused by private parties, allowing these public bodies to act in subrogation against the individual polluters when possible. These solutions aim to ensure an effective and timely compensation of victims, which guarantees relief even when polluters cannot be identified or are financially insolvent. In addition, we have examined the incentives created by this regime of governmental liability on prospective polluters. We built on those results to examine the comparative advantage and the welfare properties of the polluter-pays and government-pays regimes as instruments of environmental control. We have shown that government-pays regimes may be preferable in situations characterized by widespread poverty, high interest rates, and judicial delays and uncertainty. We further considered the welfare properties of the government-pays regime, comparing its effects to those that would be induced by the actions of a benevolent, welfare-maximizing government. The government-pays regime may lead local governments to act myopically, choosing a level of monitoring that minimizes the financial exposure of the local government but does not fully internalize the costs as well as the benefits of the agents' care. The study of the advantages and the limits of these alternative instruments of environmental liability provides a valuable viewpoint to understand the interaction between legal remedies and institutional solutions for environmental protection in both developing and industrialized countries.

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Appendix A. Mathematical appendix

Proof of Proposition 1. The type-R agent chooses x_R to minimize (1) according to the following FOC:

$$\begin{array}{ll} -p_x L = 1 - m(e) & \text{if } x_R < x^{**} \\ -p_x L = 1 & \text{if } x_R \geq x^{**} \end{array} \quad (4')$$

It follows immediately that $x_R^* = x^{**}$

The type-P agent chooses x_P to minimize (1) according to the following FOC:

$$\begin{array}{ll} -p_x A_P = 1 - m(e) & \text{if } x_P < x^{**} \\ -p_x A_P = 1 & \text{if } x_P \geq x^{**} \end{array} \quad (5)$$

It follows immediately that $x_P^* \leq x^{**}$.

Proof of Proposition 2. The government chooses (e_R, e_P) to minimize (2) according to the following FOCs:

$$\frac{dx_i}{de_i}(p_x L + 1) + c_{e_i} = 0 \quad i = R, P \quad (6)$$

From (6) i = R, $e_R^{SO} = 0$ since $p_x(x_R^*)L + 1 = 0$ from Proposition 1. From (6) $i = P$, $e_P^* > 0$ since $p_x(x_P^*)L + 1 < 0$ from Proposition 1.

Taking the ratio of (4) and (5), since $p_{xx} > 0$, it follows that $x_P^*(e_P^{SO}) < x_R^*(e_R^{SO})$

Proof of Proposition 3. The government chooses (e_R, e_P) to minimize (3) according to the following FOCs:

$$\frac{dx_R}{de_R}[p_x(x_R^*)\alpha L + 1] + c_{e_R} = 0 \quad (7)$$

$$\frac{dx_P}{de_P}[p_x(x_P^*)(\alpha L + \beta(L - A_P)) + 1] + c_{e_P} = 0 \quad (8)$$

where $dx_R/de_R = m_e/p_{xx}L > 0$ and $dx_P/de_P = m_e/p_{xx}A_P > 0$.

From (7) since e_R cannot be negative. From total differential of (8), e_P^* is increasing in β, where $de_P^*/d\beta = -p_x(L - A_P)/(p_{xx} + A_P p_{xxx}\gamma_R m_e)(dx/de) - A_P p_{xx}\gamma_R m_{ee}$

Proof of Proposition 4. The benevolent government chooses according to the following FOC:

$$\frac{dx_P}{de_P}(p_x(x_P^{SO})L + 1) + c_e = 0$$

Compare (7) and (8) under the assumption that second-order effect dx_P/de_P are negligible. As shown in Proof of Proposition 3, LHS of (8) is increasing in β. Hence, we need to impose that $L < \alpha L + \beta(L - A_P)$. It follows that under the condition $(1-\alpha)L < \beta(L - A_P)$, $e_P^* > e_P^{SO}$.

Proof of Corollary. Assume the condition $(1-\alpha)L < \beta(L - A_P)$ holds. Taking the ratio of (5) evaluated at e_P^{SO} and e_P^*, since $p_{xx} > 0$, it follows that $x_R^*(e_R^{SO}) > x_R^*(e_R^*)$. Same proof applies to type-P agent.

Proof of Proposition 5. The type-R agent chooses x_R to minimize (1′) according to the following FOC:

$$\begin{array}{ll} -p_x \delta L = 1 - m(e) & \text{if } x_R < x^{**} \\ -p_x \delta L = 1 & \text{if } x_R \geq x^{**} \end{array} \quad (10)$$

It follows immediately that $x_R^* \leq x^{**}$

The type-P agent chooses x_P to minimize (1′) according to the following FOC:

$$\begin{array}{ll} -p_x \delta A_P = 1 - m(e) & \text{if } x_P < x^{**} \\ -p_x \delta A_P = 1 & \text{if } x_P \geq x^{**} \end{array} \quad (11)$$

It follows immediately that $x_P^* \leq x^{**}$.

The government chooses (e_R, e_P) to minimize (3′) according to the following FOCs:

$$\frac{dx_R}{de_R}\left[p_x(x_R^*)[\alpha L + \beta(1-\delta)L] + 1\right] + c_{e_R} = 0 \quad (12)$$

$$\frac{dx_P}{de_P}\left[p_x(x_P^*)(\alpha L + \beta(L - \delta A_P)) + 1\right] + c_{e_P} = 0 \quad (13)$$

where $dx_R/de_R = m_e/p_{xx}\delta L > 0$ and $dx_P/de_P = m_e/p_{xx}\delta A_P > 0$.

From total differential of (8), e_P^* is increasing in β and decreasing in α. From the comparison of (12) and (13), $e_P^* > e_R^*$, under the assumption that second-order effect dx_P/de_P are negligible.

Proof of Proposition 6. From the comparison of (10) and (11) under the assumption of high levels of monitoring on type-P agent with respect to type-R agent, i.e. $e_P^* > e_R^*$.

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