

Environmental Protection in Latin America's Mining Countries : An Application of Game Theory to the Case of Bolivia

Nelson ALTAMIRANO*

Environmental regulation of mining industries is at large in place in most Latin American countries since the early 1990s. However, problems with enforcement and set of technical standards have limited the achievement of environmental improvements during the 1990s. This paper applies game theory to understand the problems of introducing environmental laws and the rational reactions of governments and firms once the laws are in place. It also suggests some solutions to overcome problems of enforcement under the common practices of auctions. The case of Bolivia is used to illustrate these points, but the results and suggestions could be generalized to other mining developing countries in Latin America, Africa or Asia.

Net Gains from Environmental Cooperation : A Background

Governments and firms have to consider the gains and costs when applying environmental protection in the mining industry.

Governments and countries can derive long-term gains from proper environmental policies. Consider the case of mining water contamination. It is demonstrated that accumulated contamination increases cleaning costs exponentially (Tietenberg, 1999). Bolivia is a case where exponential costs have no limit. After centuries of mining and lack of environmental protection, the Poopo Lake, one out of two lakes in the Bolivian Andes, had between 100 and 1,000 times more contamination—depending on which chemical we look at—than the most contaminated lake in Canada by 1993.¹ The accumulation of contamination is such that damage is irreversible. There is no budget huge enough to make this lake fishable again (Salinas, 1993). In other words, the benefits are best illustrated by the losses that can be insurmountable if governments take no action.

* Visiting Professor, Master's Program of Areas Studies, University of Tsukuba. Contact address : naltamir@sakura.cc.tsukuba.ac.jp ; naltamir@hotmail.com

¹ The other lake, Titicaca, is also contaminated but there is no data on it (Salinas, 1993)

Benefits can also be derived from policies of mining extraction that incorporate long term perspectives and the interests of future generations. In Bolivia, it is common practice to only exploit the richest deposits first. This policy has perverse effects for the country when the international price is very low. Since the tin crash in 1985 miners have desperately extracting exclusively minerals from the richest ores. As usual, they have made up very low prices with higher ore quality. Since this crash, however, tin miners have not been able to pay variable costs, and the government subsidized the activity. Thus, instead of gaining revenues from export taxation, the government lost revenues. Although from an individual firm perspective it was rational to resort to rich deposits and to avoid higher rates of unemployment, from the general country interests this was the most inefficient way to exploit a non-renewable resource.

The two benefits, less environmental costs with appropriate clean measures at the time of mining operations and more revenues with rational exploitation, are long-term benefits. However, visible short-term results may be the main focus of governments that last five years in power. When miners internalize environmental costs, their immediate profits decrease and the state receives lower income tax. Limited state budgets, cannot easily afford for time-delayed revenues. Similarly, foreign investors may threaten to invest less or nothing at all if governments decide to enforce environmental liabilities. As a result, public officials hesitate to enforce environmental regulations under short-term pressures.

There are also political gains and costs from environmental cleaning. Political pressures coming from environmental groups are weak in Bolivia. Nevertheless, when environmental concerns become a part of major labor group's political agenda, they can menace government's stability. Thus, protecting the environment reduces the risk of political instability. At the same time, however, it raises political opposition from another group, the industrialists. The industrialist's power has varied over time. Between 1982 and 1985 they had little power, but between 1985 and 1990 their power was overwhelming. Although it remained high during the 1990s, labor opposition has been able to mobilize people against the government since 1995. The point is that whatever the government decides to do respect to the environment, it will always face political costs.

In sum, the Bolivian government needs to evaluate the net gains derived from protecting the environment. In the long and medium term, the economic and ecological benefits are clear. However, there is some uncertainty in the short-term. Political and economic costs seem to be higher than gains. As a result, the government's actions depend on how short and long-term objectives are balanced out.

Let us now turn to the firms. Mining corporations apply the same cost minimization logic they apply to other costs, to environmental costs. They have two approaches to reduce mining contamination: at the end-of-pipe or at-the-source of contamination. The end-of-pipe solution is more expensive in the long-term because it means treating increased amounts of waste. Waste is significantly reduced using the at-the-source approach (Tietenberg, 1999). In many cases mining firms get total cost decline over time when they introduce mitigation technologies and pollution prevention policies (Gentry, 1995). In other words, costs go down when firms include the environment in their day-to-day operations, and when they are really committed to protect the environment. A firm's actual decision depends on local regulations and economic incentives (Tietenberg, 1999). Thus, clean technologies and environmental protection could increase profit margins rather than reduce them in the long-term.

Mining firms have also political stakes related to environmental protection. They can improve their image both locally and internationally by introducing clean technologies. Mining firms know that the international community can press local governments hard to close, for instance, parts of the Amazon to mining activities. Such a decision would be very costly to the world mining industry. In the late 1970s, the international community persuaded the Thai government to ban any economic activity in Thailand's endangered forest. Since then mining firms and investment groups have asked for reconsideration with limited success. They must show a real commitment to exploit deposits without harming the forest and invest more in the environment than they would do anywhere else. Mining multinationals have learned from the Thai experience, and since then, they have spent large amounts of money to change their bad polluter image worldwide. The last effort is their active involvement in the Mining Minerals and Sustainable Development Project (Lagos, 2001).

Summing up the firm's side, firms have positive economic and political gains in the medium and long-term. However, as in the government's case, short-term gains tend to be negative. Thus, for both the government and the mining firms, there are positive net gains in the medium and long-term. In this context and due to the fact that both players have publicly expressed their willingness to introduce environmental protection, how do we explain that environmental issues are not effectively introduced by both players?

The Prisoner's Dilemma of the Environment

Let us assume two rational players representing a government and a firm. There is an environmental law in place, but as happens frequently in Latin America, its interpreta-

tion and enforcement depends on who is in the government. The interpretation and enforcement, I assume, are part of the rational choice governments make. Therefore, the government chooses between pressing hard to enforce the law and not pressing at all. The firm has also two options: to follow the law or to trespass it.

The firm will try to find out how serious the government's commitment to the law is. Its response will depend on this evaluation. The firm knows how general and vague the environmental law is, and it is aware of the bureaucratic inefficiency about setting standards.² In addition to this, the firm knows that bureaucratic enforcement capacity is minimal. The effects on low level of enforcement because of low technological capabilities are increased by the remote locations of mine sites.

The firm also knows the government's main goal is to use the proceeds of mining privatization or to attract foreign direct investment. In 1994 the Bolivian government opted to repress people rather than to penalize an investor who had abandoned five hundred tons of antimony compounds (Altamirano, 1995). The government justified this choice by stating that it did not want to scare off foreign investors with 'hard' environmental requests. Therefore, historical tradition, bureaucratic limitations and recent government behavior, make the firm to believe the government will not press hard on environmental issues. In this context, what is the best firm's response?

The firm will not follow the environmental law. Because the government will not enforce the law, in the short-term it is more profitable for the firm to avoid environmental costs. However, this decision will provoke political reactions within and outside the country. The firm has to consider, then, how national opposition and international pressure will affect its image and its long-term profits.

The last thing the firm wants is to create conditions for nationalization and the setting of protected and restricted areas against mining activities. The firm has to find a way to satisfy public internal demands without really investing in the environment. Social expenditures, as for instance a school, a medical post or a playground close to the camp site are solutions to this dilemma. This is what some firms have been doing since the early 1990s in Bolivia, for instance Battle Mountain. The underlying logic seems to be as follows: environmental awareness is still low in Bolivia. Labor groups are much stronger than environmentalists. Thus, it is efficient to focus on social/labor conditions rather than environmental protection per-se, and most important to the firm, social

² Richard O'Connell, Battle Mountain's VP in 1995, sustained that firms cannot follow environmental regulation in Bolivia because of poor standards and technical irrationality. For the case of water, the government was considering to set drinkable standards in the mountains. But, water there is naturally acid (Interview at the Institute of the Americas, San Diego, January 22, 1995).

expenditures are cheaper than environmental costs.

The international community is more demanding than the national community. But, there are ways to slow down international protests without increasing national costs. The firm can bring in the state-of-the-art technology to impress national and international communities. As generally new technologies are cleaner than old ones, the firm's green or clean image can be publicly displayed. Firms, like Battle Mountain, have clean operations in the US or Canada because of the strict environmental standards in these countries. For Battle Mountain it is more efficient to operate under the same basic technology due to economies of scale. By exporting clean technologies, the hundreds of millions invested in creating new technology compatible with US environmental regulations can be spread out around world operations. However, the firm is not investing to protect the Bolivian environment, is not restoring the mine at the end of operations and is not committed to reduce water contamination. The firm is just following its own short-term profit objectives.

In conclusion, if the firm expects the government not to press hard for the environment, the firm's most advantageous answer is not to comply with the environmental law.

Let us now jump to the government's best strategy. The government has to figure out what the firm's position will be before it formulates a strategy. The government is aware of its bureaucratic limitations, and also knows that these limitations are no secret to the firm. With a weak enforcement power, the government knows that the firm will not voluntarily comply to environmental law. The Bolivian government knows the mining industry has introduced clean technologies in the US, only after the US administration had been capable of enforcing the law. Before that, mining firms had blatantly ignored the law and skipped their environmental responsibilities. The Bolivian government expects the same behavior in Bolivia. Furthermore, there is a historically based perception that foreign firms usually inflate costs and overprice imports to reduce book-profits, and then pay less taxes. Consequently, the government rationally expects that the firm will trespass environmental law. So, what the government should do?

If the government presses hard for the environment it will have to argue with the firm. The government knows the firm will reject any damage responsibility, and that the firm could even reject to recognize any environmental damage. Such responses are possible because of the uncertain nature of environmental damages and the controversial results of environmental assessments. If this is the case, the firm controls much more information and technical capacity, and this allows the firm to argue against the government. Such a confrontation can turn into a political scandal. Arguing may go back and forth over many months, allowing political opposition to discredit the government.

Critics will raise their voices and criticisms may well reach beyond accusations of bureaucratic incapacity and negligence.

The government also knows that once it confronts a foreign firm, momentarily other foreign investors stop their investments in the country. Some firms will wait to see the outcome of the conflict, others will move their assets to another country with similar endowment of mining resources. When firms take such options the government is risking the 'capitalization' process –the Bolivian privatization process. A failure of this privatization plan has enormous political costs.

In the context described, it is rational for the government to minimize political risks. Therefore, when the government expects firms resist the application of environmental laws, the government's best choice is not to press hard the enforcement of environmental regulation.

The equilibrium for both players is reached at a point in which both sides reject environmental actions, in spite of the fact that in the long-term both players and society at large would be better off if the law is enforced. How can this outcome be changed?

Breaking the Dilemma : Government Commitment

The main limitation is the lack of government commitment. The government needs to show, in the best way possible, that environmental regulations will be enforced, and that there are conditions that underlay any possible cooperation. Given the historical inconsistency of Bolivian governments, one action will not be enough to change long-lasting bad reputation images. Three complementary strategies can break this lack of credibility.

1. Contractual Agreements

The Bolivian environmental law states that mining exploitation should consider the treatment of waste mineral, disposal of tailings, the efficient use of energy as well as the rational exploitation of deposits. The Law also states the obligation to restore the exploited areas once mining activities have come to end. Closure should prevent erosion, soil instability and protect underground waters from contamination (Ministry of Capitalization, 1995). Clearly the Law needs complementary norms in order to be applicable to contractual agreements.

Technical norms have to clarify the level of waste treatment, what 'efficient use of energy' means, and what 'rational exploitation' is. Technical norms have to define the

maximum permissible level of water and air contamination by region and by project. To set up this kind of norms the regulator requires scientific data and years of technical observation, preconditions that are not present in Bolivia. In 1995 the National Mining Secretariat started the first regional environmental assessment in the Oruro area. Results are limited and controversial mainly because of the nature of environmental data.

The best the government should do is to make clear that setting standards is a dynamic trial-and-error process. Environmental standards cannot be copied from other countries because these standards must respond to the specific environment in Bolivian mountains. Definite standards cannot be established at the time of signing contracts because there is no data. These standards must come from a partnership between the government and firms. The worst alternative for the government is to pretend it has a complete set of minimum standards. In doing so, the government unavoidably damages its credibility even further.

During the last decade Bolivian authorities have been following the wrong strategy. They have promised standards to ensure 'fair profits' and an equilibrium between mining development and environmental protection. Bolivian authorities thought they could develop a standard system by just having environmental audits. Quite erroneously the government have trusted the accuracy of audits and overestimated its own enforcement power, without realizing that the weakness of technical bureaucracy and lack of enforcement lies at the heart of the prisoner's dilemma.

2. Repetitive Interaction

One reason for inefficient outcomes is the government's short-minded objectives. The latter restriction could be removed if contracts clearly state that any future contract renewal must be subject to environmental protection performance.

The first step towards this aim is the inclusion of a third agent, one without the restriction of being in power for only five years in a context in which mining contracts usually last for more than 15 years. Thus, this third agent needs to be free of short-term political interests. This agent would periodically evaluate environmental progress based on initially stipulated conditions and preliminary objectives. Following these results, the third agent would prepare follow-up environmental targets. The objective of this agent is to push firms towards efficient environmental protection, rather than to scare them off.

The firms for its part will think it twice whether to cheat the government if the firm knows that contract renewal depends on periodical environmental performance and evaluation.

3. Self Punishment

The government has to show that it is not possible to reverse or undo environmental commitments. It has to assert that the non-enforcement of the law harms its reputation and also its short-term interests. Firms often consider that short-term needs, as for instance tax revenues, preclude the government's ability to enforce environmental laws. Thus, the government needs to change this perception

The Bolivian congress could pass a law prohibiting governmental use of revenues coming from the mining industry unless there is evidence of environmental law enforcement. Given that most of the government's budget comes from the mining and oil industries, this self enforcement will show that it is in the government's interest to protect the environment.

Self enforcement, repetitive scheme and contractual clauses are complementary instruments that enhance the government's bargaining power at a time of privatization or leasing mining rights. Both processes are done in public auctions. The recommendations discussed above are necessary pre-steps to any bidding process. However, there is another strategy the government could follow in the bidding stage itself. It is possible to explicitly separate environmental issues from investment, and put such issues under a parallel auction.

Privatization and the Environment

The privatization process started in 1985, when the Bolivian government allowed full foreign ownership in the mining sector and no tax discrimination against foreign investors. These norms were not enough to attract foreign investment because of other restrictions. The most important the Bolivian nationalistic image originated by 1952. To change this image, the government developed an aggressive liberal environment in the early 1990s. Between 1990 and 1991, the government approved a new investment law, new mining and hydrocarbon laws, as well as a new tax system. These laws guarantee free currency conversion to all foreign investors, unrestricted remittances and the opportunity to obtain tax credits in their home countries. These laws also allow foreigners to operate within the 50-kilometer border belt in joint ventures with national firms. In 1993 the congress passed laws regarding banking and exports, and in 1994 it approved the capitalization law (Ewing and Goldmark, 1994). There were other additional laws. The point is almost 10 years were required just to set the starting conditions of privatization,

and this process for the mining industry is not yet finished by the 2001.

Legal changes did not only respond to internal conditions, but also to international competition for foreign investors. Although Bolivia is still rich in minerals, it is no longer a world top producer of tin, tungsten and antimony. The country has no other large proved reserves but natural gas deposits. It has no monopoly advantages over neighbor countries. Firms were looking for zinc, gold and silver during the 1990s, resources also available in Peru and Chile. Bolivia's investment attractiveness resides in its polymetallic structure, a feature that facilitates diversification and reduces market risks. However, this advantage is difficult to evaluate before starting operations and is subject to the uncertain nature of the mining industry. Consequently, the polymetallic structure argument does not provide the government with a better bargaining position.

Internal conditions and international competition not only explain why the Bolivian economy is one of the most liberal in Latin America, but also why capitalization is the way chosen by the government. In the context of international competition, capitalization is a compromise between internal opposition and the urgent need of foreign capital and technology. In the capitalization scheme, foreign investors may acquire at most 50 percent of equity, but acquire total control of day-to-day operations and long-term management. The total bid amount is considered an investment that doubles the firm's value, i. e., the bid is working capital and the foreign investor does not need additional capital to run the firm. Finally, in capitalization, the state distributes its 50 percent of shares among all adult citizens. With this distribution of shares the government expected to give a sense of real ownership to people and reduce income inequality. The latter would not only reduce social conflict and pressure on governments, but also attract foreign investors that would prefer this scenario to potentially more explosive societies (Ewing and Goldmark, 1994).

Like in any privatization process or auction to lease mining rights, the Bolivian government under capitalization seeks the highest price possible. Competition among bidders can increase this price, and the government should attract these bidders. The government can use information on specific minerals and industry players to create competitive auctions. For instance, the government can release all technical information that shows how valuable are some deposits. This information will attract more bidders and generate competition (MacMillan, 1992). Empirical evidence suggests the Bolivian government was aware of the role of competition and the power of sharing information. During the 1990s, the government hired international consultants to prepare auctions and instructed that at least six bidders per auction should be present. The government also promised to release all available financial and geological information. We know by

game theory that sharing information in common-value cases, like the mine bids, reduces the bidder's risk of winning with a bid higher than the true value, i. e., avoids the winner's curse. In addition, the government requested sealed bid auctions. This kind of bids prevent from colliding. Therefore, the government did something to increase competition.

How did the government incorporate the environment in the capitalization process? It introduced contractual clauses about the government's historical responsibility on past pollution and the firm's responsibility on new pollution, called stock and variable pollution respectively (Ministry of Capitalization, 1995). Given the technical and bureaucratic limitations mentioned before, it is not hard to understand why these contractual clauses did not stop mining contamination. Contractual clauses cannot change the prisoner's dilemma described early because firms perceive the government lacks of enforcement capability. At the end, regulatory changes and contractual clauses it self cannot increase credibility.

There is another way to introduced environmental protection into mining operations. Firms know governments frequently stress their desire to create jobs, receive new investment, increase exports and receive technology. However, the auction winner is usually the one who pays the highest price. Bidders know that all other categories, including the environment, must be discussed in the bid, but most resources must be devoted to price (Business International Corporation, 1993). Price is perceived by both the government and the bidders as the key issue. If price is so important, what is the price of environment?

If the government wants to force firms to introduce environmental costs into their operations, the best thing to do is to force them to reveal how much they are expecting to spend on environmental restoration. Firms have a better understanding of technical problems and more experience to predict environmental costs than the government.

Putting the environmental issues on the table right away enhances the government's bargaining power. If technical and financial issues of environmental protection are postponed after the bidding process is over, the government will face only one player at that stage. In this situation, the winning firm will take advantage of the government bureaucratic limitations. Most of the gains will go to the firm, and the firm will be in a better position to reduce its commitment to environmental protection.

How to use auctions to force firms to reveal not only the value of mine deposits but also how much environmental restoration would cost?

There are standard models in game theory to make firms compete against each other and reveal the true value of the asset they want to acquire, for instance, a sealed-bid

auction. This auction implies the highest bidder wins the auction, but pays a price equal to the second highest bid (MacMillan, 1992, p. 222). Bidders rationally find that it is better to bid an amount close to what they really believe is the value of say oil deposits. Bidding a lower amount creates the risk that someone could bid a higher amount and win the auction. Bidding a higher amount than her own valuation creates the risk the second highest bid is higher than it, and the winner could win with a loss. To avoid both risks, bidders must bid exactly their own valuations.

Governments, the Bolivian government in particular, could design an auction that includes the value of the deposit and the value of environmental restoration. Bidders should explicitly bid for the mine and environment, the latter in the form of an escrow account. This design should follow the logic of the previously mentioned auction. The winner should be the bidder with the highest combined bid, and he should pay the second largest bid.

In the case of environmental costs, firms have more information and experience than governments to guess how much would be necessary to restore the mine site to its original condition. The purpose of the auction is not to reveal the exact environmental cost, which no body really knows, but to set a fund that could be used to cover for such expenses.

The logic of this auction resides in current practices to protect the environment that ask for front money, the so called environmental funds. Thailand and other South-East Asian countries developed environmental funds to restore environmental damages. Successful experiences are those where governments designed escrow accounts managed by independent bodies. The escrow account plus the interests go back to the investor, if and only if, after closure of operations, water contamination, dumping sites, as well as land restoration meets initial agreements. Otherwise, the government can use the escrow account to cover for the damages. The environmental auction is just a design to create the initial capital for the environmental fund in the context of privatization or leasing mining rights. The firm has to put the environmental cost at front. The firm cannot cheat the government because of the auction design, and most important, the government receives the full amount without any enforcement problem.

Conclusions

Introducing standards and enforcing environmental regulation in the mining industry may be understood as a game between the government and the mining firms. Both players obtain net positive gains in the long-term from environmental commitment.

However, because of short-term costs and mutual perceptions about the opponent's behavior, both players find their best answer is to leave the environment aside. This is a result based on the experience of Bolivia's mining and environment results during the 1990s.

This dilemma can be solved if the government shows commitment. The government can show commitment if it combines three strategies: contractual agreements, repetitive interaction and self-punishment. The contractual agreements should emphasize cooperation rather than confrontation. The repetitive interaction and self-punishment enhance the government's credibility.

Under the common auction practices, not only in Bolivia, but also in other Latin American countries, governments can push for environmental protection. Competition among bidders gives governments the necessary bargaining power to set up an auction: that explicitly ask a bid for the mine itself, and other for the environmental costs. Such a setting provides at least three advantages over practices that want to leave environmental conditions after the bid is over: 1) the government does not need bureaucratic enforcement to protect the environment; 2) the firm cannot cheat as it could do if the environment is negotiated later; and 3) the government could receive more money than from a single bid auction.

Bibliography

- Andrew Ewing and Susan Goldmark, 1994. *Privatization by Capitalization*, FDP Note No. 31, World Bank.
- Business International Corporation, 1993. *Privatization in Latin America*, Business International Corp., Washington D. C..
- Donald Gentry, 1995. 'To Protect and Preserve,' in *Mining in Latin America*, pp. 16-17. Gustavo Lagos and Luke Danielson, 2001. *The Role of the Minerals Sector in the Transition to Sustainable Development*, International Institute for Environment and Development (IIED).
- John McMillan, 1992. *Games Strategies and Managers*, Oxford University Press.
- Ministry of Capitalization, 1995. *Bolivian Mining Corporation*. La Paz
- Javier Salinas Romero, 1993. *Mineria y Gestion Ambiental en Bolivia*, Ministerio de Minería, La Paz.
- Tom Tietenberg, 1999. *Environment and Natural Resource Economics*, 5th Edition, Addison-Wesley Publishing.