

**OPTIMAL ENVIRONMENTAL LIABILITY POLICY:  
FOR CENTRAL AND EASTERN EUROPE**

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## **Optimal Environmental Liability Policy for Central and Eastern Europe**

It is estimated that the costs of cleanup associated with on-site contamination in Central and Eastern Europe (CEE) will easily be several hundred billion dollars. The existence of such a large pool of environmental liabilities has created major challenges as CEE countries attempt to privatize their capital stock, and it is also generally agreed that poor handling of these liabilities has greatly inhibited markets for state-owned enterprises in Central and Eastern Europe.

This research uses an analytical model to identify optimal policies for minimizing the damage caused to the privatization process by these liabilities. Policy simulations are conducted which evaluate the effects of the use of indemnifications and environmental audits on privatization sales, prices and government revenues net of environmental costs.

The major finding of the paper is that privatization and social welfare maximization goals require equivalent environmental liability policies. In particular, full indemnification of all enterprises being privatized maximizes both sales and government revenues net of environmental liabilities, and therefore is likely to be a socially optimal liability policy for CEE governments. The current emphasis on privatizing as quickly as possible in many countries in the region is therefore found to be optimal. It is also found that the use of environmental audits, which reduce adverse selection of enterprises by managers and improve the privatization pool, is likely to reduce costs on privatization markets and therefore reduce equilibrium prices. This finding suggests that the primary benefit derived by CEE governments investing in environmental audits is increased enterprise sales, rather than increased prices, as has been proposed in the past.

## I. Introduction

Since the countries of Central and Eastern Europe (CEE countries) experienced political and economic revolutions in the late 1980s and early 1990s, they have been faced with a variety of challenges simultaneously. Economic reform and transformation to market economies are proceeding throughout the region, and privatization is the cornerstone policy of that process. At the same time this adjustment is taking place, countries are attempting to clean up the severe site contamination generated under Communism, a task which, if addressed properly, is likely to be the most expensive one in the post-Communist era. In Eastern Germany, for example, the costs of remediation are expected to run into the hundreds of billions of dollars (Lari, 1992).

The sheer magnitude of the cleanup needs creates the potential for enormous liability problems for purchasers of state owned enterprises (SOEs). Toxic dumps can be anywhere and future liability rules are uncertain at best; SOE buyers therefore must face the possibility that they are purchasing major problems when they participate in privatization markets, and because of asymmetric information only those on the other side of the bargaining table, generally SOE managers, may know it. This fundamental quality uncertainty creates a need for policy instruments to mitigate potential damage to privatization caused by the existence of environmental liability.

This paper examines the major policy instruments available to Central and Eastern European governments in the context of a simple analytical model of privatization. Policy simulations are then presented in order to shed light on ways in which appropriate instruments can be used to minimize the deleterious effects of environmental liability.

## II. Background

The need to immediately address many severe site contamination issues exists simultaneously with structural economic transformation is unfortunate at best. Privatization of formerly state-owned enterprises, either to citizens or to foreigners, is a fundamental element of this transformation process, but the existence -- or mere suspicion -- of severe site remediation needs on properties to be privatized enormously complicates this ownership transfer.

That environmental liability is a concern for investors, and particularly foreigners, is now well accepted in the region. In a study of 1000 large North American and West European firms, of those which actually evaluated sites in CEE countries, half rejected them at least partly on environmental grounds (The Economist, 1993). Environmental issues were considered by these firms to be virtually as significant a factor deterring investment as legal and administrative uncertainties and risks associated with unstable economic reforms. Liability for past practices and inherited contamination risks then ranked as the most important environmental concern among surveyed firms (World Bank/OECD, 1992).

It also is becoming accepted that the lack of commercially available insurance (Goldenman *et al*, 1994) and the poor handling of these environmental liabilities in the past have severely impeded privatization in CEE countries (Simons, 1992). Even firms with valuable assets and significant market potential have attracted limited interest, surprisingly low price offers, or were the subject of protracted negotiations because governments had *ad hoc* and unclear policies toward environmental liability. In a number of cases, the parties reached inferior arrangements or negotiations broke down over the environmental liability issue.

In some cases, a price of zero is too high for investors. For example, in Germany the film manufacturer Agfa refused to accept restitution of its own previously-confiscated plant because of suspected site contamination (Simons, 1992). In the Czech Republic Phillips negotiated a joint-venture with Czech Tesla Strasnice, but it refused to accept liability for soil contamination of the site. In the end, Phillips chose to buy another building some one hundred meters away from the old site, a decision which was a sub-optimal outcome for both the investor and the state.

Similarly, negotiations of Czech ZPA Trutnov with the Swedish-Swiss corporation ABB resulted in an agreement that ABB will only lease ZPA in order to avoid possible liability for site contamination, a situation that is certain to limit the types and duration of investments that ABB

undertakes to modernize ZPA Trutnov. In 1992, talks with the German electrical and electronics company, Siemens, and the Czech conglomerate, Skoda Pilsen, on a joint venture broke down over a disagreement on how to deal with environmental and product liability. Siemens is concerned that it might inherit responsibility for Skoda Pilsen's past actions (The Prague Post, October 13-19, 1992).

Further evidence of concern comes from the United States Agency for International Development which reports that the governments of Hungary, Poland, Romania and the Slovak Republic have all requested foreign technical assistance on this issue because state property agency managers find it to be an important bottleneck in the privatization process (HIID, 1994).

### III. Policy Issues in Environmental Liability

In designing policies to deal efficiently with the existence of site contamination, CEE country governments must address several goals simultaneously. First, policies must be structured so that funds are allocated to cleanup projects which have the highest net present value for CEE societies (Jenkins and Harberger, 1992), and should also be formulated to include the likely possibility that some projects will simply not be worth the resources which must be expended on them. Governments must particularly resist the temptation to view investors as "deep pockets" to finance these marginal activities (Goldenman *et al*, 1994).

Second, contracts must be structured so private owners have incentives to engage in sound environmental practices in the future. Governments should particularly make clear when indemnifying investors the limits of their liability to avoid unnecessarily offering investors rights to pollute which they will then regret later.

A key feature of a sound set of policies is assurance that expenditures (either public or private) are focused on cleanup rather than on avoiding cleanup. This goal is particularly important, because policies toward environmental liabilities have significant distributional implications which are likely to provide powerful incentives for avoidance. In the United States, for example, despite massive expenditures associated with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund" Act), it is generally recognized that only a small fraction of total expenditures are actually devoted to remediation because of the confusing processes associated with assignment of liability and eventual remediation. By far, the bulk of expenditures are for various legal fees and charges to assign, demonstrate and contest liability (Menell, 1991; Kovacs, 1992).

Because property rights over pollution are being established at the same time that rights over firms are being negotiated in CEE countries, there is no incentive for investors to tie up the process of liability assignment as there is when firm ownership is well-established. This is a positive feature of carefully addressing liability concerns during the transition. However, investors are also likely to try to exaggerate on-site environmental problems to win concessions from governments, and will invest resources lobbying government officials for indemnifications and price breaks which may be expected to slow down the privatization process (Zylicz and Lehoczki, 1992). To avoid such rent-seeking behavior, it is particularly important that rules surrounding liability be clear from the onset.

Unfortunately, there are some important constraints to putting in place policies with these attributes. Though difficult under the best of circumstances,<sup>1</sup> a meaningful assignment of culpability becomes particularly difficult when the past owner is a cash-strapped national government. Second, faced with the prospect of enterprise restructuring and job losses when a firm is privatized, SOE managers may hide key information from both ministries of privatization and investors in order to scuttle deals. Anecdotal evidence from throughout the regions suggests that the "State" is certainly less than homogeneous in its interests and that managers are responsible for delays in privatization, particularly if sale prices are perceived as too low.

Third, there are important technical difficulties associated with separating *ex ante* pollution from that generated after privatization. Ideally, on-site pollution would be inventoried at the time of the transaction using an environmental audit. It would therefore be clear which remediation requirements were the responsibility of investors and which would either be the subject for negotiation or funded by the state.

In practice, it is unrealistic to expect that environmental audits of the caliber necessary to accurately separate *ex ante* from *ex post* pollution can be conducted at reasonable cost for even the most important SOEs to be privatized by CEE governments. Audits, while highly valuable, are typically imperfect tools, particularly in environments where important inputs, such as human capital for conducting risk assessment, are not available. Partial audits may also not fulfill the information needs of governments, because unless considered to be reasonably comprehensive, investors will still be reluctant to invest because of fear that some important liabilities may have been overlooked or poorly quantified during the audit.

Audits are also expensive, costing up to \$100,000 per large industrial site in the US (Boyd, 1993). Because of greater scarcity of resources necessary to conduct audits, costs are likely to be even higher in CEE countries, creating transaction costs which are significant barriers for both investors and governments. Given these difficulties associated with inventorying pollution, it seems likely that investors and, perhaps to a lesser degree, CEE governments will have substantially less than perfect information about on-site contamination when they negotiate the sale and purchase of an enterprise. Enterprise quality is therefore likely to be fundamentally uncertain.

How can privatization contracts be structured in such an uncertain environment? What are some likely costs of poorly-formed agreements? We know that with the level of residual

liability uncertain, asset transfer may be difficult, and if sales go forward in equilibrium firms will require a discount for the risk associated with unquantifiable environmental contamination. Enterprise prices will therefore not reflect true enterprise qualities unless some level of indemnification is given.

Given the complicated information imperfections associated with environmental liability, compromises must be made. What are some of these tradeoffs? First, CEE governments must invest in environmental audits even though they know they won't be perfect. Given the likely existence of diminishing returns to information; however, there should also exist some optimal level of investment in information. Because investors have imperfect and often asymmetric information vis-à-vis governments, risks are very high;<sup>2</sup> to assure that enterprises are not excessively risk-discounted it will typically be necessary for states to offer some indemnification. Most CEE governments have in fact pursued what might be characterized as a privatization maximization policy with regard to environmental liability. There has been liberal use of price reductions and indemnification to spur sales, but there has been a relatively unsystematic pursuit of this goal, creating an environment of *ad hoc*-ism, and little thought about whether this goal even makes sense.

With the goal to at least partially address these issues, the next section proposes a simple analytical model to examine the tradeoffs faced by CEE governments. Part V of this paper then presents results of this model, and in Section VI policy conclusions and directions for future work are derived based on these results.

#### IV. A Model of Privatization with Environmental Liability

The theoretical model we have developed applies the general approach of Akerlof (1970) to the problem of environmental liability in Central and Eastern Europe, and extends the model to explore some policy options available to governments. The model examines the interaction between a non-collusive group of potential SOE investors (either foreign or domestic) interested in purchasing existing enterprises, and a government wishing to sell. There are two agents in this model, the Ministry of Privatization (the State (S)) and a large group of uncoordinated foreign investors (I). The State has available  $K$  different types of enterprises (e.g. steel mills, chemical plants, trucking firms, etc.) to sell (subscripted by  $i$ ).

There exists asymmetric information regarding the extent of environmental liability ( $L_i$ ) associated with an individual enterprise (expressed in present discounted value terms), and this potential cost is assumed to be a major factor determining the desirability of enterprises as investments. The State in this model plays the role of guardian of social welfare, but only SOE managers know the real quality of individual firms. Managers therefore are assumed to have perfect knowledge of potential on-site liabilities. The State is assumed to not invest in cleanup if an enterprise is retained.

The investors know only the distribution of qualities for each type of enterprise and must assess the risk based on some available statistic. It is assumed that the extent of environmental liability is deduced from the mean quality ( $\mu$ ) for all  $i$ . Other aspects of quality, within and across enterprise types, are treated as part of a standard profit function. Investors are not completely clueless regarding mean quality, however. First, the State wants to develop privatization markets. To some degree it will therefore allow negotiations with investors to begin with obviously best quality enterprises and proceed only later to enterprises of more dubious and presumably lower quality. Anecdotal evidence from throughout the region seems to confirm the existence of this type of "cherry picking."

Second, in privatization markets there also exists the same adverse selection problem highlighted by Akerlof (1970) with regard to used car markets. Because of asymmetric information, enterprise prices are not quality adjusted and may be substantially risk-discounted, particularly in the case of just above-average enterprises which are not perceived as cherries. Managers know their enterprises are not receiving full value, and they use that information by

controlling the privatization pool. Managers therefore essentially reorder enterprises to sell more of the poorer quality enterprises than would occur if information was perfect.

With such an information structure, as the pool changes average quality declines and in the limit the market either disappears or becomes dominated by lemons. In previous work (Balaban, Bluffstone and Panayotou, 1994) the details of this analysis have been worked out, and therefore in this paper we simply use these results by assuming Akerlof-type behavior is occurring. A social planner acting in the interests of the CEE populace then attempts to select optimal policies given these tendencies. To make the model more policy relevant, in this paper we do not assume that the Akerlof equilibrium occurs. We merely suppose a tendency as sales progress for above average enterprises to be held off the market.

The pool of enterprises is therefore likely to be always changing as privatization occurs, and this feature causes the mean quality ( $\mu$ ) to constantly be in flux. Is there a systematic pattern to changes in  $\mu$  which can be viewed as common knowledge? We believe the answer is yes, because both effects discussed above tend to depress mean quality as privatization occurs. The degree to which this is important, of course, depends on the amount and type of information available about enterprise qualities. Clearly, if information is excellent, prices will reflect quality; with perfect information prices reflect qualities accurately and the link between the mean quality of the pool ( $\mu$ ) and the number of enterprises of a given type privatized ( $Q_i$ ) evaporates.

#### FIGURE 1 HERE

An illustration of what might be an expected relationship between enterprise qualities and the supply of enterprises in a representative industry where there are no policy interventions is given in Figure 1. In the region B - A, extremely low quality firms command only negative prices and either are stripped of their assets or continue in State hands. In the region  $\mu$  - B a number of enterprises are offered for sale because lower-than-average quality firms can potentially receive average prices. In the quality interval D -  $\mu$  managers pull enterprises off the market because they know those firms are above average but are viewed as average by the market. In essence, these firms have not made the cutoff where cherries are clearly identifiable. At point D quality is more easily discernible and prices therefore reflect quality.

Given this environment, investors maximize (over  $Q_i$ ) the expected stream of discounted profits. The State maximizes rents from enterprise sales, taking into account a constant opportunity cost for each enterprise sold ( $O_i$ ).<sup>3</sup> The State knows investors demand functions

because average quality determination is common knowledge. The State will then, of course, incorporate demand information into its own maximization exercise. In this model the equilibrium concept is therefore Nash, because each agent optimizes while incorporating the reactions of his/her counterpart.<sup>1</sup>

Before moving on, we would like to comment on the objective function of the State. From a social welfare perspective, if investors are foreigners then rent maximization corresponds neatly with national welfare maximization. If investors are nationals, though, one may argue that rent maximization merely implies a transfer from the private to public sector.

It should also be pointed out, however, that CEE governments are interested in constructing properly-functioning markets where disequilibria, including in the market for SOEs, are eliminated by proper pricing. If governments do not maximize rents given the demand for enterprises, there will exist excess demand for enterprises which will require non-price rationing and related transactions costs.<sup>4</sup>

Given the uncertainty facing investors, the state may want to offer some indemnification. For simplicity of exposition, this insurance is a fraction ( $q_i$ ) of the total cleanup eventually realized which the state agrees to accept. This formulation presumes that the decisions regarding the structure of privatization contracts are separate from those pertaining to the future assignment of liabilities.<sup>5</sup>

The investors then maximize the following profit function:

$$Max \pi_i = \int_{i-1}^k \pi_i(O_i) - (1 - a_i) L_i(\mu_i(O_i)) - \int_{i-1}^k P_i O_i \quad (1)$$

$$\frac{d \mathbf{p}_i}{d Q_i} > 0, \quad \frac{d L_i}{d \mathbf{m}_i} < 0$$

$$\frac{d \mathbf{m}_i}{d Q_i} < 0, \quad 0 < q_i < 1$$

Where  $\pi(Q_i)$ ,  $P_i$  and  $L_i$  are respectively the present value profit function, the price at which enterprises of type  $i$  are sold and the present value of environmental liabilities incurred. Maximizing this profit function with respect to  $Q_i$  and rearranging yields (2), the first order condition which holds for all enterprise types. This result says that investors are willing to pay a price just equal to the present value of the stream of profits from the investment less any environmental costs; this is the expected competitive equilibrium condition.

$$P_i \frac{d \mathbf{p}_i}{d Q_i} - (1 - q_i) \left( \frac{d L_i}{d \mathbf{m}_i} \right) \left( \frac{d \mathbf{m}_i}{d Q_i} \right) \quad (2)$$

To simplify the analysis the following assumptions are made:

$$\frac{d \mathbf{p}_i(Q_i)}{d Q_i} = \mathbf{p}_i \quad (3)$$

$$L_i(\mathbf{m}) = e \mathbf{m}^{-a}$$

$$a > 0, \quad e > 0$$

The first assumption says that marginal profits are always constant despite changes in the numbers of firms of type  $i$  purchased. This simplification is made purely to structure the analysis so that on the margin profitability depends on the State's handling of the environmental liability issue. The second assumption says that the total liability declines continuously in the average quality of all enterprises and that it asymptotically reaches zero.

For the reasons discussed above (cherry picking and adverse selection), an inverse relationship between average quality ( $\mu$ ) and the number of enterprises sold ( $Q_i$ ) is assumed. For generality, convexity is also assumed (4).

$$\begin{aligned}
\mathbf{m}_i &= \mathbf{d} \mathbf{Q}^{-b} \\
\mathbf{d} &> 0, \quad \mathbf{b} > 0
\end{aligned}
\tag{4}$$

The parameter  $\beta$  represents the degree of adverse selection and cherry picking occurring in the privatization market. It is a policy variable in the sense that if the State eliminates such behavior through, for example, expenditures on environmental audits or reductions in the power of managers to control the privatization pool, investors will be able to judge enterprise qualities accurately. There is then no incentive for cherry picking on the demand side and/or no possibility for manipulating the pool of enterprises by enterprise managers.

When the parameter  $\beta$  goes to zero, the link between the mean enterprise quality and the number of firms privatized is completely broken. Substituting (4) into (3) we see that the total liability cost anticipated by investors in industry  $i$  is then a constant unrelated to the number of enterprises privatized. As one might expect, because information should improve the privatization pool, with such a policy intervention the total industry liability is reduced.

$$\begin{aligned}
\text{Max } p_i &= \sum_{i=1}^K [p_i Q_i - (1 - q_i) g Q_i^f] - \sum_{i=1}^K P_i Q_i \\
\mathbf{f} &> 1
\end{aligned}
\tag{5}$$

Substituting (3) and (4) into (1) and combining parameters yields (5), the explicit-form counterpart to the investors' maximization problem. In this equation we therefore define  $\mathbf{g} = \mathbf{d}^{-a} \mathbf{e}$  and  $\mathbf{f} = \mathbf{a} * \mathbf{b}$ . To assure that average liability ( $L_i/Q_i$ ) is increasing in privatizations and therefore that the pool is indeed deteriorating, it is necessary that we restrict the parameter  $\mathbf{f}$  to values greater than one. this restriction assures consistency with the assumption that average quality is declining in the number of firms privatized.

Because  $\phi$  is merely a multiple of the parameter  $\beta$ , it can be interpreted to represent the degree of information imperfection in the market; as this parameter increases, the total liability ( $L_i$ ) becomes more closely linked with enterprise sales ( $Q_i$ ), indicating the extent to which cherry picking and adverse selection are present.

The incentives can, of course, be altered by improving the information structure. The parameter  $\phi$  is therefore a policy variable representing such instruments as improvements in environmental audits and reductions in the power of enterprise managers. It should be noted that this policy instrument is quite different from indemnification ( $q_i$ ) which attempts to improve the functioning of the market through *insurance* rather than *information*.

Substituting (4) into (3), differentiating and substituting the result into (2) then yields the following investor demand function (6).

$$p_i^I - (p_i - (1 - q) f g Q^{f-1})$$

The State maximizes its rents net of environmental costs incurred in the future ( $\pi_s$ ) by choosing optimally its level of sales ( $Q_i$ ) given the inverse demand function in (6). Its problem is therefore given by (7).

$$\text{Max } p_s = \sum_{i=1}^K [ (p_i - (1 - q_i) f g Q_i^{f-1}) Q_i - O_i Q_i - q_i g Q_i^f ] \quad (7)$$

Because maximizing profits from enterprise sales is equivalent to maximizing the net returns for each type of enterprise, we will not integrate over all  $i$ . Noting that the solutions to (7) must hold for all firm types, we drop the subscripts for clarity of exposition.

Maximizing (7) with respect to  $Q_i$ , and solving for  $Q_i$  yields the equilibrium sales of each firm type as a function of the technological parameters of the system and the policy instruments employed by the State.

$$Q = \left[ \frac{p - 0}{f g (f - q (f - 1))} \right]^{\frac{1}{f-1}} \quad (8)$$

## V. Results and Policy Implications of the Model

### *Effects on Privatizations*

Reaching privatization goals is extremely important to CEE country governments, and we see from (8) that the state will sell more enterprises as the difference between the expected enterprise profits after privatization ( $\pi$ ) and the State's opportunity cost of sales ( $O$ ) increase; sales are therefore increasing in the degree to which private investors can operate a firm better than the state.

From a policy perspective perhaps the most important point is that in (8) and in simulations presented in Figure 2, equilibrium sales are strictly increasing in the percentage of indemnification ( $q_i$ ) the State is willing to offer; the State therefore can always sell more enterprises if it increases its level of indemnification.

Furthermore, it can sell more enterprises by pursuing policies which reduce  $\phi$ . As discussed above,  $\phi$  is decreasing in the amount of information provided by the State. Privatization goals are therefore likely to be supported by increasing the quality of environmental audits being conducted. This policy will typically involve increased expenditures and therefore should be considered a costly step which should be weighed against the benefits derived. A likely high value area for this type of intervention is the quality range  $D - \mu$  in Figure 1. Instead of pulling these potentially high value firms off the market and losing the revenues and macroeconomic benefits associated with privatizations, targeting environmental audits on these firms may have the effect of moving the cutoff for perception of cherries to the left of  $D$ .

### *Effects on Privatization Prices*

Substituting (8) into (6) we derive equilibrium prices for all levels of firm profitability, information provision and indemnification.<sup>6</sup>

$$p - p - (1 - q) \frac{(p - 0)}{(f - q(f - 1))}$$

It is found, as shown in Figure 3, that the prices of enterprises are strictly increasing in the level of indemnification given ( $q_i$ ). When  $q_i$  reaches a value of one, for all values of  $\phi$  prices converge to a level equal to the present discounted value of profits to be earned from running the enterprise when there is no adverse selection or cherry picking going on.

While the effectiveness of indemnification in "moving" enterprises has received wide attention, the result suggested here, that indemnification also increases sale prices has been less often cited. With both equilibrium quantity and price increasing in the level of indemnification, it also means that gross revenues from privatization increase in  $q_i$ .

As shown in Figure 3, price levels are also positively related to changes in the parameter  $\phi$ . This result merely reflects the fact that substitution of low quality for above average enterprises in the privatization pool increases industry total and marginal costs.<sup>7</sup> If the market is competitive, the results here suggest that in equilibrium the government will pass some of the benefits of the improved pool (and the lower level of liabilities) on to investors in the form of lower prices. The result also suggests that the revenue benefit derived by the State from such instruments as environmental audits comes from increased privatizations rather than increased prices.

#### *Effects on Revenues Accruing to the State Net of Environmental Costs*

Though by offering indemnifications, the State takes on the responsibility and expense of cleanup at a later date, it will also typically find that some positive level of indemnification is optimal, particularly if  $\phi$  is small. Even if the State chooses not to indemnify, however, as shown in (8), as long as private firms can do better than the State  $\phi$  is not too large and if the quantity multiplier ( $\gamma$ ) does not approximate infinity, enterprise sales will occur.

In Figures 4 and 5, the net present value of enterprise sales and the percentage change in net revenues are plotted against the degree of indemnification. We see that *if average quality is decreasing in firm sales for all firms which are in the pool, it makes budgetary sense for the State to absorb all of the environmental liability.*<sup>8</sup>

Another way to state this result is that in this model sales maximization and profit maximization goals coincide, which is fully consistent with qualitative results presented by Goldenmann et al (1994) in which they argue for full indemnification of all enterprises to be privatized. In other words:

For all  $i$  s.t.  $p_i \geq 0$

$$Q_{\max} - Q_{\max}^s$$

As shown in Figure 4, at low levels of  $\phi$  indemnifications have their maximum impact, but in all cases we see increasing returns to indemnification; the State should therefore fully indemnify buyers. If it is not too costly, this result also suggests that it will be optimal to offer a comprehensive environmental audit (a policy to depress  $\phi$ ) along with a 100% indemnification to any firm in the privatization pool.<sup>9</sup> The point to be made, therefore, is that if we consider the two instruments analyzed here, with an objective to maximize profits there is a surprising level of complementarity between the two policies and between outcomes.

## VI. Conclusions and Directions for Further Research

This paper reviewed and analyzed the main issues associated with privatization policy when there exist environmental liabilities. We have identified conditions for the optimal use of environmental audits and liability indemnification followed by cleanup by CEE governments. In particular, the finding that full indemnification of any firm put up for privatization is likely to be an optimal policy for CEE governments strongly suggests that the emphasis of CEE governments on indemnifications to maximize privatizations is generally correct. It argues for policies which ignore the sunk costs of past environmental mistakes and which do not distort privatization markets in order to deal with those costs. Of course, to avoid problems later, on a case-by-case basis levels of remediation associated with full indemnification must be clearly defined for potential investors.

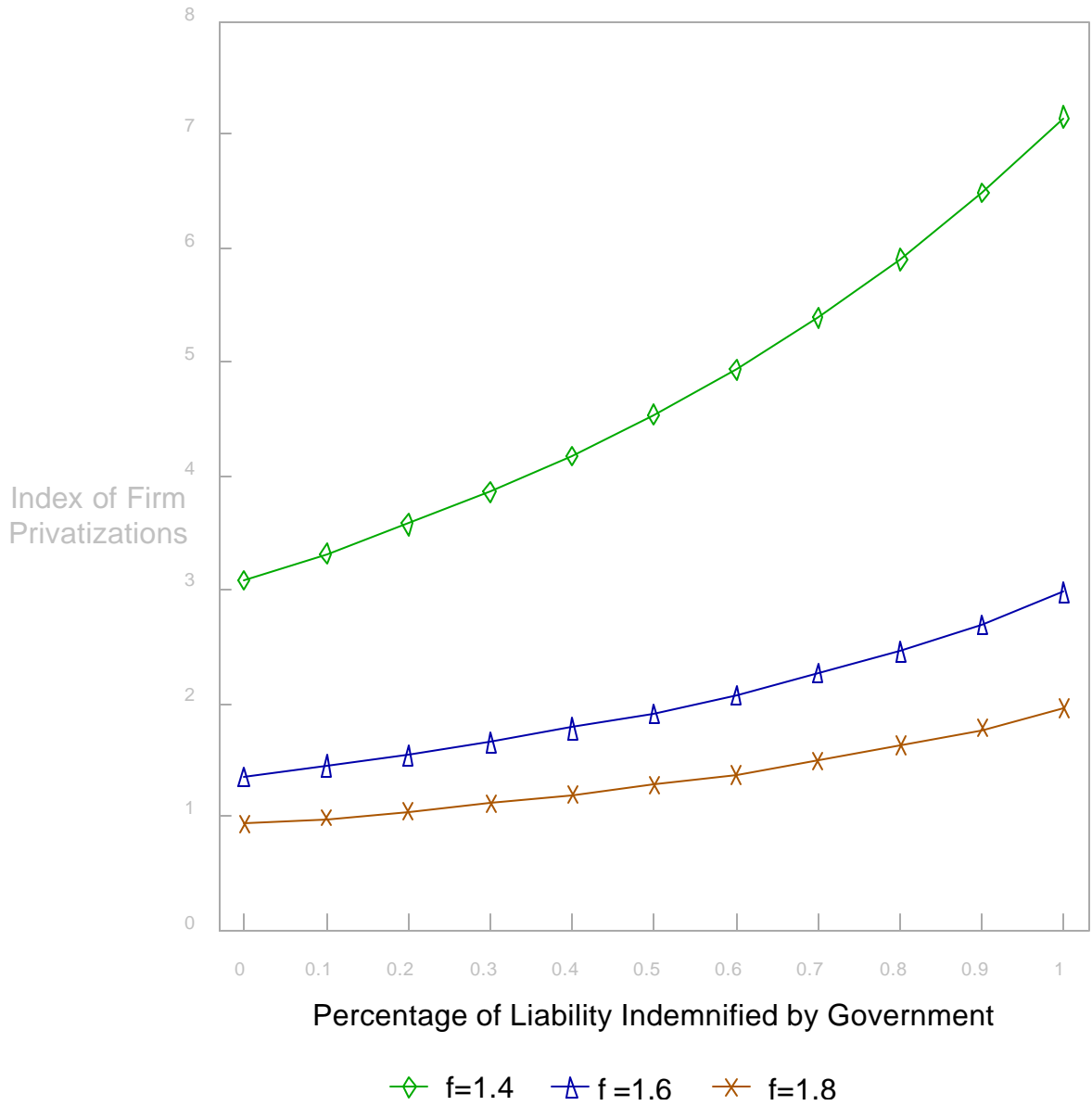
It was also found that a primary benefit of both indemnification and information is the higher equilibrium privatization levels which should be observed. These results somewhat call into question the focus which is typically placed on increased firm prices as the primary source of State benefits from the use of these instruments; indeed, in highly distorted markets where the pool is deteriorating very rapidly, prices may change very little as the level of indemnification increases. It also has to be recalled that adverse selection increases the total liability in privatization markets, and therefore costs and prices will be higher to reflect the lower quality enterprise pool; information imperfections are therefore found to essentially be a tax on privatization sales.

There are several important issues which are not raised in this paper. There are more complicated ways to model the problem of inferring firm qualities under imperfect information, and it is likely that insight could be gained from a more complex formulation. As mentioned above, the level of remediation is taken as given, but in reality this level is also endogenous and a

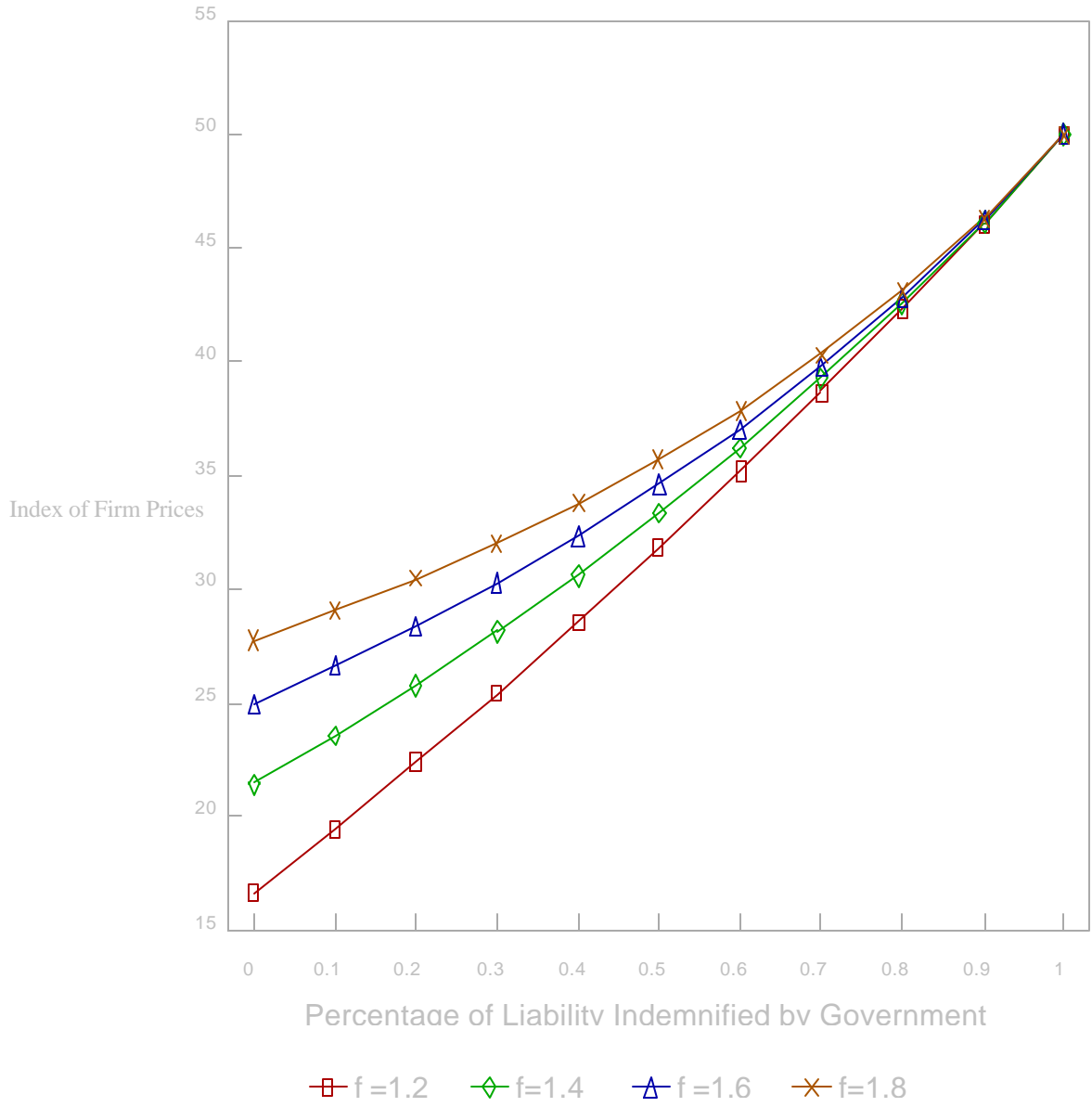
choice variable for the State. This recognition necessarily leads us into questions of risk assessment and valuation of environmental damages. Considering these issues will then probably imply an examination of zoning options.<sup>10</sup>

This paper has generated several testable hypotheses and points to the need for empirical research on environmental liability in CEE countries. Perhaps the most urgent need is for research to ground-truth some of the ideas being bandied about on the subject and to verify or refute some of the presumptions common in the region. It should also be possible to quantify some of the effects discussed in this paper. For example, it should be possible to place a marginal value on indemnification expenditures in terms of increased enterprise privatizations and treasury revenues. Such information would be useful to infer whether such expenditures are at or near optimum levels. Similarly, a return to environmental audits could be calculated to at least qualitatively infer whether the net revenues CEE governments receive from privatization could be increased by spending more on audits.

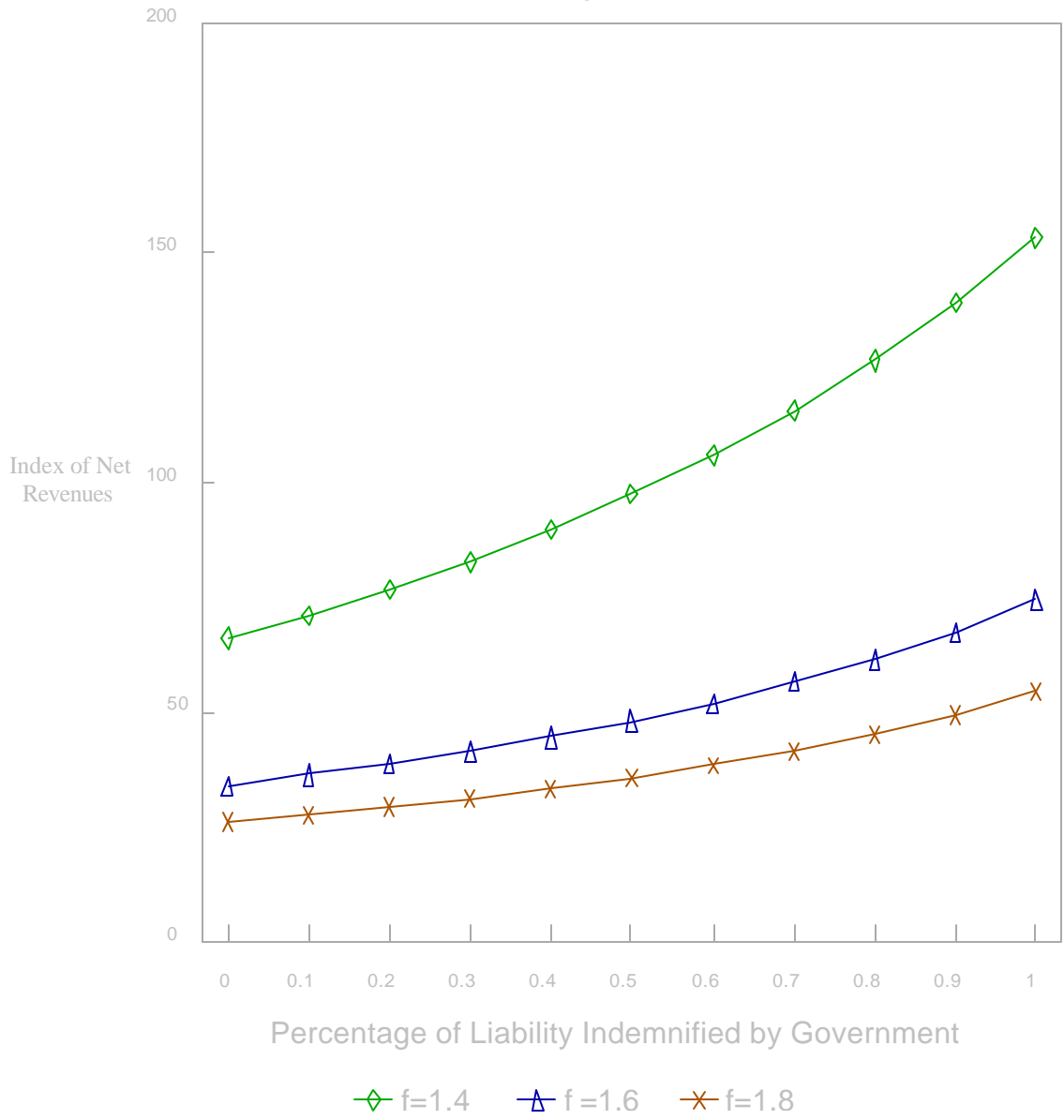
Privatizations as the Government Varies the Level of Indemnity



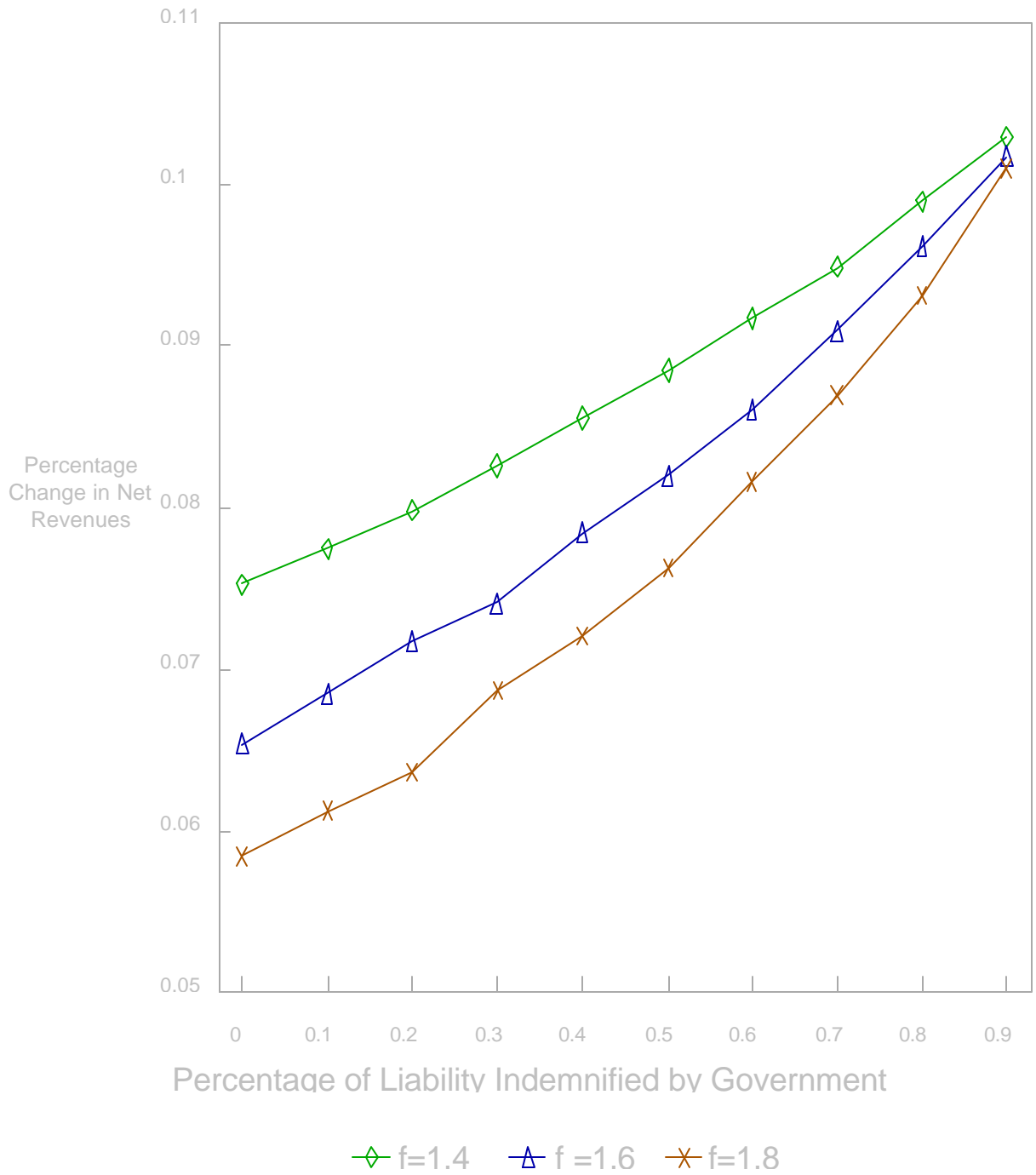
Firm Prices as the Government Varies the Level of Indemnity



Treasury Revenues Net of Environmental Costs as Indemnity Level Varies



Percentage Change in Treasury Revenues Net of Environmental Costs as Indemnity Level Varies



<sup>1</sup> For example, in the case of the San Gabriel Valley Superfund site, over 100 potentially responsible persons, all of whom were considered potentially liable, were identified.

<sup>2</sup> It should also be noted that government agencies may have incomplete and asymmetric information with respect to enterprise management.

<sup>3</sup> Though this objective function maximizes social welfare in the partial equilibrium setting, as noted above privatization is an important instrument of economic reform. In a general equilibrium model the level of privatizations would likely itself be an element.

<sup>4</sup> This objective function appears to have been pursued in the Czech Republic, where over 3500 enterprises were offered for sale in 1992 and 1993. During the two years, enterprise prices were successively adjusted until excess demand and excess supply were zero, and then firms were sold.

<sup>5</sup> Ministries of privatization are typically responsible for sales, while ministries of environment generally handle the technical issues of environmental impact assessment.

<sup>6</sup> Because this expression is easily derived, we have not presented it here.

<sup>7</sup> Mathematically, this is analogous to an upward shift in any marginal cost function.

<sup>8</sup> If this condition does not hold, it is also possible for the State to lose money by providing insurance in a market where the gains from insurance are low and declining in privatization sales; in that case, the market is then not worth indemnifying.

<sup>9</sup> It is assumed for simplicity that environmental audits are costless. In reality this is, of course, untrue and the State must optimize expenditures on costly environmental audits as it does expenditures on indemnifications.

<sup>10</sup> We thank Jerome Rothenberg for this insight presented at the 1994 Eastern Economic Association annual

