

ENFORCEMENT, ECONOMIC INSTRUMENTS, AND WATER POLLUTION ABATEMENT INVESTMENT IN ROMANIA*

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Great attention has been placed, over the years, on the choice and design of economic instruments for a more efficient allocation of environmental goods and services and on stimulating environmental investment in such a way as to reduce the society-wide costs of attaining a desired level of environmental quality. Such policies, falling under the rubric of “getting the prices right,” presuppose that once set, the prices will be paid. However, in the transition economies of Eastern Europe, not even existing low prices for environmental goods and services are paid, let alone the presumably higher prices entailed by economic instruments set at allocatively efficient levels. Instead, compliance, such as it is, occurs through explicit and tacit negotiation and persuasion. Moreover, the region is undergoing massive privatization, the most powerful economic instrument of them all, whose effect in the name of profit is to reduce waste but also to take advantage of regulatory weakness. Taking as an example the water sector in Romania, the present article develops a simple theoretical model of enterprise compliance in the context of non-payment of environmental goods and services and an endogenous level of enforcement on the part of the water authority. The model is then econometrically applied at the level of the enterprise and the river basin to analyze the roles of enforcement and economic instruments in stimulating environmental investment in the presence of privatization. The water sector is particularly good to study given that it takes on aspects of both a “good” as well as a “service.” The article ends with policy recommendations and the prediction that privatization on net will improve environmental quality even in the short-run.

BACKGROUND¹

Romania is a country of 23 million people. Water resources include the Danube River and twelve tributary basins, as well as the 650,000-hectare Danube Delta — the largest wetland in Europe — and part of the Black Sea. In addition to having the largest old growth forest reserves in Europe and abundant deposits of ferrous and non-ferrous metals, the country has reserves of oil, natural gas, and coal. This resource abundance, however, has had its costs.² The country developed minerals, petrochemical, and metals processing industries that are highly polluting, leading to economic, health, and ecological impacts on an enormous scale. Such impacts have also stymied the development of activities with a potential future, such as tourism and fisheries.³ While these costs are clear, weak economic growth during the transition has led to understandable trepidation about pursuing too quick or rigorous a program of environmental protection, and economic instruments in particular.

Romania, like many other Eastern European countries, launched an ambitious privatization program in 1997 in an effort to generate strong economic growth. These and other reforms will place new stresses on the environmental regulatory authorities at a time when budgetary austerity imposed by the IMF-FESAL agreement will lead to a substantial reduction in personnel and equipment. While options are being considered on how to put regulatory finance onto a sustainable basis and though a comprehensive new set of environmental regulations has been drafted (Zinnes

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[1996]), enforcement in the near term is certain to get worse. It is important to consider whether the privatization program will generate enterprise investment in environmental protection or instead lead to further environmental degradation as has been found elsewhere (Reed [1995]).

At the same time, stimulated by (1) the new government's campaign commitment to set up an environmental fund, (2) anticipation of World Bank loan conditionalities, and (3) pressure to signal to the European Union Romania's sincerity to meet the environmental commitments of the legal approximation process of accession, there is a renewed interest in developing economic instruments. It is thus particularly germane to analyze in the context of Romania what the role should be of economic instruments and of command and control to elicit the necessary level of enterprise environmental investment in the future. In order to address these questions, we examine the effects that such policies have played so far in the privatization process on the water sector.

The water sector is regulated by the Water Department located in the Ministry of Water, Forests, and Environmental Protection (MAPPM). The Water Department supervises *Apele Române* (AR), a public utility with branches in each of the country's 12 river basins. AR is responsible for the management of 70,000 kilometers of rivers and 150 multi-purpose lakes and dikes. AR supplies 95 percent of the raw water to municipalities, industry, and agriculture. Local government is responsible for municipal water supply and wastewater treatment.

Water resources in Romania are administered according to the principles of integrated water management which link water quality and water quantity. This linkage is important because excessive abstractions lower underground and surface water levels, thereby increasing contaminant concentrations and creating the same deleterious environmental effects as effluent discharges. The permitting process, the heart of the regulatory system, incorporates this duality by issuing permits and assessing charges and fines both for water consumption and for effluent discharges. The 12 river basin branch offices of *Apele Române* issue permits based on the national water management strategy specifying the amount of water used or consumed, as well as the quantity and quality of effluents. Water management standards include effluent standards that limit the amount or rate of discharges. Ambient water quality standards also exist. These standards provide some flexibility, because they allow facilities to choose which technologies should be used to meet requirements.

For enforcement, the Water Department of MAPPM and AR can take legal action against non-complying facilities and levy fines and other sanctions — including closure — against violators. Compliance is monitored in many ways. First, AR conducts routine plant sampling and inspections, including the review of the facility's records (enterprises are responsible for monitoring and reporting their discharges). While the number of inspections is planned, the timing of the visit is not known to the enterprise. Second, AR carries out unplanned plant visits, usually based on concerns raised from other inspections. Third, when an accident is reported, AR does an immediate inspection. Finally, through its ambient program, AR also conducts periodic sampling from a series of sampling checkpoints along water bodies, both selectively for pollution-prone water bodies and according to predefined annual programs. Local environmental protection agencies also carry out some limited water monitoring.

Water charges exist in Romania and are collected by AR. They consist of prices for raw water abstraction and tariffs for discharges into water bodies.⁴ Since abstractions can either be consumed or be discharged after use for cooling or for effluent removal, the charge system covers water as a "good" and as a "service." They were introduced at the start of 1991 and rates are indexed quarterly.

Considering raw water prices first, these are set nationally based on type of water body (surface, subterranean, Danube) and category of user, with industry paying more than agriculture, and agriculture paying more than households. With little relationship to location-specific or temporal characteristics, however, this system does not accurately signal differences in water scarcity to economic agents. As a result, water-intensive activities may be undertaken in (socially) high-cost zones, though in principle AR may reject a construction permit request for such an activity. For the most part, however, plant location decisions under communism were not based on economic considerations. Water prices are also very low: rates per thousand cubic meters in 1996 for industrial users were 23,755 lei (U.S.\$4) from rivers, 2,851 lei (U.S.\$0.47) from the Danube, and 29,240 (U.S.\$5) from underground sources. Penalties of two to six times normal rates can be levied for abstractions *above* permitted limits, with the multiplier depending on the amount of the infraction and whether it occurred during a period of restricted consumption.

There are also charges for effluent discharges into water bodies. This charge system comprises two components, a *tariff* for within-permitted discharge concentrations and

a *penalty* (over and above the tariff) for above-permitted discharge concentrations. In 1996, for example, tariffs were levied only on two contaminants: a 7,850 lei/ton charged for suspended solids and a 31,750 lei/ton (U.S.\$5.30) charge for BODs.

The penalty depends on both the volume of wastewater emitted and the *difference* between actual and permitted concentrations. For the i th pollutant, the formula used is $P_i = (C_i - C_i^*) V R_i$ where P_i is the total penalty assessed on the i th pollutant, C_i and C_i^* are respectively the actual and permitted concentrations of i th pollutant, V is the annual volume of waste-water discharged, and R_i is the rate for discharging the i th pollutant. In theory, for repeat offenders penalties are doubled each year until concentration standards are met.

Penalties are levied on twenty substances divided into two general categories. The first group (containing, e.g., nitrates, BODs, chlorine, cadmium,) is for those for which allowable levels are established to meet concentration standards. The second group (containing, e.g., mercury, persistent pesticides, radioactive residues, and carcinogens) is made up of substances for which no discharges are permitted and C_i^* is zero. Rates are lower for the first group of pollutants (BODs at U.S.\$4.90 per metric tonne in 1995) than for the second group (mercury at U.S.\$13,000 per metric tonne in 1995).

THE STYLIZED FACTS

In spite of their low levels, revenue collection from water prices and discharge tariffs is a serious problem. Penalties assessed for effluent discharges and raw water abstractions *above* permitted limits in 1996 were 2.96 billion lei (U.S.\$1.5 million), yielding collections of 482 million lei. Worse, while revenues assessed in real terms in 1996 were 240 percent of those assessed in 1993, the collection rate had fallen from 24 percent in 1993 to 16 percent in 1996. Regarding water prices, while in 1996 AR regulated 5,000 industrial permit holders, it also was owed arrears from 3,000 of them.⁵ However, only three enterprises were closed between 1991 and 1997 due to water infractions.⁶

This relatively lax enforcement is perhaps not surprising. At least until recently, past governments regardless of the ministry have had an implicit soft approach on enterprises, many of which were prohibited from borrowing and subject to other uneconomic restrictions. This has led to the authorities' inability to impose penalties or set prices for environmental goods and services at economic levels to achieve acceptable

emissions, and to enterprises' indifference to operating with a valid permit. Therefore, two complementary approaches have been taken, investment co-financing and compliance schedules.

The favored instrument of the government has been to augment the permit system with environmental abatement investment co-financing to stimulate enterprises to fulfill permit requirements. In 1994, for example, the national treasury provided the majority of environmental financing. In the country's 1996 National Environmental Action Plan, the budget's share of investment fell to 45 percent of all investments compared to 58 percent in 1994 (see MAPP 1995). Under the 1997 FESAL agreement with the IMF, this mechanism is not likely to continue, with the burden being shifted onto economic agents themselves as the enterprises are privatized.

While the concept of compliance schedules was developed to create feasible plans for polluters to reach compliance, in practice they have been used in the water sector to work with the enterprises to simply improve their performance. As such, it is an open question for analysis as to whether their use has actually slowed down full compliance.

With the hope of increasing its collections of water charges, MAPP implemented a phase-in program for payments of assessed penalties. It was announced that for 1991, 25 percent of the assessed penalty must be paid, 50 percent of what was assessed in 1992 should be paid, 75 percent in 1993, and 100 percent from 1994 onwards. Starting in 1996, fines owed must double each year until individual standards are met. Unfortunately, the schedule was not indexed for changes in prices and inflation averaged 175 percent per year during the period 1991 to 1996. Debts from early in the phase-in period were therefore highly discounted. In real terms the pressure on enterprises actually fell over time up until 1995 and only after the period of forgiveness ended did real penalty rates increase.

These broad impressions can be deepened by looking at two datasets. The first is a firm-level survey for 1996 administered as part of the present research effort. It comprises a random sample of 81 above-average⁷ industrial water users possessing or in the process of receiving a water permit from AR.⁸ The second contains data for the years 1993–1996 on the fees and fines assessed and collected from all of AR's 5000 clients aggregated at the river basin level. Bivariate correlations from these two data tell a consistent, if surprising story leading to a set of stylized facts.⁹

Physically, water pollution and abstraction were unrelated to whether the enterprise was located in a big or small town (though smaller-town enterprises used older technologies). The greater the share of state ownership in an enterprise, the more likely it had a water purification station. While bigger enterprises abstracted and discharged more, concentrations of discharges were unrelated to enterprise size.

The penalty picture for abstraction was unexpected: no penalties were issued for excess abstraction for any enterprise in the sample. There simply was no above-permitted abstraction; in spite of the regulators' claims, the abundance of raw water was such that water allocations were not binding constraints for enterprises. This view is reinforced below when enterprise investment patterns are discussed.

Regarding penalty collection rates, the greater the number (as well as average and total value) of penalties assessed, the lower was the enterprise's penalty payment rate.¹⁰ Examining their ability to pay, enterprises with higher (gross) profits had fewer penalties (in number) but a higher total value of penalties assessed. The number and average size of penalties were unrelated, however, to the profit *rate*. Looking at the relationship between penalties to inspections, the number of penalties was positively related to the number of unannounced inspections but not related to routine or accidental inspections. Total penalties assessed were related positively to both routine and unannounced inspections, but not to accidental inspections. Penalties paid, however, were positively correlated to accidental inspections while *not* related to routine and unannounced inspections. Thus, while most penalties were issued as a result of unannounced inspections, payment of these were generally ignored. Only inspections as a result of accidents resulted in a fine actually being paid. In fact, the greater the number of unannounced inspections, the lower was the enterprise's penalty payment rate.¹¹ Regarding regulatory control strategies, the probability of being inspected was not related to the enterprise's location (perhaps not surprising since, as mentioned earlier, neither was pollution or abstraction). The number of total inspections had no relation to the economic size (e.g., number of employees, revenues, equity) of the enterprise or its amount of abstraction. Finally, the greater the degree of state ownership (versus domestic private, or foreign), the greater the probability of routine and unannounced inspection and the higher the value of total and average penalties; the opposite was true the more ownership was domestic private.

Before continuing, we may draw two important conclusions regarding penalties, inspections, and

collections. First, there is a basic simultaneity between compliance and enforcement which needs to be disentangled to properly understand agency incentives. Second, the only way to understand the regulator's inspection program is to see that only unplanned inspections and "accidental" inspections directly reflect non-compliance at the enterprise, while routine inspections, established by bureaucratic inertia based on the number in the previous year (and thus only weakly related to current year compliance), represent the enforcement stance of AR toward the enterprise. Regarding the investment and finance picture, the level of investment in water abatement was unrelated to the size of enterprise profits, equity, or turnover. State budget subsidies for water abatement investment were negatively related to enterprise profits, to whether it exported and had regular foreign contacts, and to whether the enterprise engaged in water pre-treatment. Higher capacity utilization was related to higher concentrations in discharges and, therefore not surprisingly, related to higher levels of water investment, particularly investment for improving water quality. Curiously, higher capacity utilization was also associated with higher levels of investment subsidies and less interaction with the foreign sector.

Regarding public participation, a quarter of the enterprises in the sample experienced some public pressure. Most was related to pollution, not to excess abstraction — perhaps not surprising given that in truth raw water was not scarce.¹² The greater the share of domestic private ownership, the more likely a chance of pressure being exerted on an enterprise (the opposite is true with state-owned enterprises). This is odd considering that the sample indicated that the higher the state ownership share, the higher were the pollution penalties.

Those firms with compliance schedules in force were much more likely to invest in abatement (though only financed through their own funds) but such investment was related to water quality only (the compliance schedule being uncorrelated to water quantity investment). While the existence of a compliance schedule was independent of the penalty collection rate for a firm (the latter, perhaps, being a measure of the desire to comply), it was more likely for firms which experienced incidents leading to accidental inspections to have compliance schedules. Interestingly, while compliance schedules were also to be found more readily the higher the amount of penalties actually paid, they were *less* likely to be found the higher were the *assessed* penalties. This suggests that regulators have succeeded in negotiating compliance schedules as a *quid pro quo* for leniency on penalty collection. Finally, compliance

schedules were more likely to be found at firms with lower average penalties and a higher foreign share of ownership; this probably reflects the fact that minor problems (as suggested by the smaller penalty) are cheaper to fix, thereby facilitating the acceptance of a compliance schedule and that foreign investors have more money and are more interested in quickly improving their environmental image.

Looking across the eleven river basins in aggregate from 1993–96, a similar picture emerges regarding penalty and collection rates and enforcement. First, average penalties and collection rates over the period were negatively correlated (-0.22). This suggests that because returns to evasion are increasing in the value of penalties, higher penalties tend to reduce collections; smaller penalties therefore appear to be easier to collect.

In general, greater abundance of water resources was highly correlated to the number of penalties issued (0.68) and to the value of penalties paid (0.49) but, curiously, less so for the value of penalties assessed (0.28). The number of inspections was unrelated to the value of penalties assessed but correlated (0.27) to the value of penalties paid. The average penalty assessed by basin increased the *fewer* the number of users and amount of water resources per inspector, suggesting that increasing AR's financial and human resources would improve enforcement. While the number of users and the amount of water resources had no effect on collection rates, the latter did increase the fewer were the resources per user. This complements the related finding on average penalties and suggests that as water scarcity increases, the user community does accept and take regulatory enforcement more seriously.

These river basin-level correlations aggregated over a tumultuous four-year period, however, hide some important temporal changes. First, while over the period 1993–95 the annual correlation between the collection rate and average penalty size fluctuated between -0.37 and -0.50, it fell to zero in 1996. Second, the correlations between the number of inspections, on the one hand, and the scarcity of water resources and the number of penalties, on the other, fall continuously and drastically from a high of 0.67 and 0.69 in 1993, respectively, down to a low of 0.18 and 0.17 in 1996. Furthermore, the correlation between users per inspector and the average penalty assessed fell from 0.67 to 0.36 over this period. Worse, regression analysis yielded a *negative* growth rate of inspection efficiency (number of penalties per inspection) of -33 percent over this period. Since the number of inspections increased 50 percent over this period but staffing remained relatively constant, this is clear evidence for inspection quality being sacrificed for

quantity as enforcement resources are squeezed during the transition period.

This plethora of stylized correlations, while intriguing, is far from definitive, primarily due to the extensive simultaneity and endogeneity of the various characteristics examined. We therefore developed a theoretical behavioral model¹³ of the enforcement game between the enterprise and AR. This model was then used to econometrically disentangle the relationship between an enterprise's level of compliance and AR's level of control and enforcement. Below we present the findings of the model to examine the role of economic instruments and command and control to influence the enterprise's investment response to the regulatory regime.

NON-COMPLIANCE AND INVESTMENT

Our estimated model suggests that the effect of expected non-compliance leads to greater investment in water quality. The amount of this investment was found to be greater, the greater was past investment. The level of an enterprise's profitability indicates an ability to pay and was found to have a positive effect on the firm's level of water investment. A negative relationship was found between the firm's level of water investment and its amount of water discharges. This supports the hypothesis discussed below that more polluting enterprises dilute their waste streams, thereby lowering their average concentrations and subsequent requirements in water quality investment. Water consumption by the enterprise, on the other hand, is costly and is found to trigger a positive response in its water abatement investment.

We also examined the effects of the size of government subsidies to the enterprise. The above results still hold; the subsidies had no stimulative effect in generating additional investment once the effects of other factors are eliminated.

PRIVATIZATION

Romania, like most other countries in Eastern Europe, is undergoing a massive privatization of its industrial enterprises. This raises the question about whether the ownership of an enterprise has been a missing factor in the above analysis. As argued at the outset of this paper, privatization should have at least two effects in theory. First, the imposition of a "hard" budget constraint should cause management to have a more pronounced response to the price incentives of economic instruments. Second, the new owners of privatized enterprises often have made additional investment commitments and have brought additional sources of capital (as well as the ability to borrow it). While this may increase their ability to pay

economic instruments on the one hand, it may also make them targets for the regulatory agencies whose compliance demands have historically been tailored to their perceptions of an enterprise's financial resources. The profit motive brings with it pluses and minuses. On the plus side, it causes enterprises to reduce all forms of waste, including waste in the form of pollutants in water discharges (which may even be potentially valuable if recovered). On the minus side, however, it leads enterprises to use relatively intensively those inputs whose relative prices are lowest. Since weak enforcement serves to reduce the perceived "price" of the environment's waste assimilation services, the profit motive could encourage privatized enterprise to take advantage of weak enforcement, thereby stretching (or even ignoring) regulatory limits.

What is different about the privatized firm? Here we looked at the firm characteristics *after* accounting for the likely fact that the state's share of ownership is probably sector-specific. We found that enterprises with older vintage equipment and lower capacity utilization tend to have greater state ownership. These variables are indicators of efficiency (as well as pollution generation). However, surprisingly, greater numbers of employees or lower profitability were *not* the mark of greater state ownership in this sample.

We then examined the effect of accounting for the share of state ownership on enterprise compliance and environmental performance. We examined how the compliance-enforcement relationship is affected by the level state ownership. Controlling for other relevant factors, we find that non-compliance is higher the greater the level of state ownership. This finding is strengthened when we look at how the performance of enterprises with greater state ownership influences the assessed penalty component of the pollution charge. Accounting for the possibility of state pre-selection into more polluting sectors, we find that higher levels of state ownership tend to lead to higher average penalties, *ceteris paribus*.

PERVERSE RESPONSES: DILUTION EFFECTS

As is always the case with government intervention, even of the economic instruments type, it can lead to perverse incentives and unwanted side-effect behavior if improperly designed. Consider the case of charging for pollutants based on the discharge concentration. By diluting the effluent stream, the polluter can reduce the total tariff charges (or the threat of command and control oversight). In Romania, though pollutant concentrations are monitored together with the total volume of water discharged, the actual computation procedure may still

distort behavior. This is because the total payment is based on the number of hours of factory operation times a technical coefficient of discharge per hour of operation times the monitored concentration. Thus, by exceeding the technical discharge rate, the enterprise can reduce the level of the monitored concentration. The only additional cost for this sort of defensive action is to increase the enterprise's abstraction costs. Thus, if the discharge tariff is sufficiently high relative to the abstraction charge, behavior may become distorted.

This was confirmed by the model analysis. We find that once (exogenous) water consumption is accounted for, an enterprise's abstraction is influenced by the degree of pollutants it discharges, the more so the higher the (firm-specific) tariff rate. As predicted by the model, since higher charges lead to greater abstraction as firms dilute pollution discharges, the pollution charges have created a perverse incentive to abstract water in excess of what is needed to meet permit concentration requirements.

COLLECTION RATES AND INSPECTIONS

Clearly, in order for economic instruments to have an incentive effect, not only do they need to be raised to economic levels, but the sums assessed must also be collected. As presented in section 3, however, collection rates are very poor. This calls into question the efficacy of further raising pollution rates. In this section, we look at a number of contributing factors at both the basin- and the enterprise-level. These include ability-to-pay issues, ownership, and the strength of regulatory enforcement.

At the basin level, we examine whether the average size of the assessed pollution charge influences the collection rate of the AR branch, once other factors are accounted for. Two key factors include the state of the economy to capture the general ability to pay of enterprises in the basin, and the regulatory load of AR in the basin to capture the strength of regulatory enforcement. We would expect that basins with higher average charges would lead to lower rates of repayment.

The results indicate that increases in the average charge are associated with lower collection rates *ceteris paribus*. Moreover, results show that collection rates would improve if additional resources were allocated to enforcement and if the state of the economy were to improve.

Turning to the enterprise level and accounting for regulatory load, we examined the effect of higher pollution assessments on enterprise collection rates, taking into account ownership structure and the second profitability.¹⁴

These more micro-level relationships reinforce the basin-level insights above. First, the larger is the pollution charge bill, the lower is the tendency to pay in full. Second, the state of the economy effect on repayment in the basin-level regression probably reflects the enterprise's lack of ability to pay, as proxied here by profitability. Finally, we find that privatization will improve enterprise payments of pollution charges — regardless of profitability. While this is helpful in its own right, it portends another more important development. Since privatized enterprises will try to minimize input costs, the fact that they tend to pay more of the charges they are assessed indicates that they will be more responsive to the existing (low) pollution charge rates; thus, privatization should lead to reduced pollutant flows.

POLICY IMPLICATIONS

Based on the analysis above, a number of policy conclusions may be drawn. First, although pollution fees are extremely low and rarely assessed, they do have some value in signaling to enterprises when the authorities are fed up with the enterprise's low compliance. As such and probably only indirectly as a result, higher fee rates do seem to generate an improvement in compliance. On the other hand, as enterprise's acceptance to pay these fees falls, the higher is the overall fee bill. Still, it is possible to discern an effect of these fees on enterprise investment behavior, even after controlling for the level of water authority enforcement efforts.¹⁵ Subsidies, on the other hand, were found to have no influence on water sector investment.

As suspected, privatization so far has had an influence on the use of water assimilation services and consumption. Since enterprises with a lower private ownership share are assessed higher penalties, display lower compliance, and are less likely to pay the pollution fees assessed, privatization is likely to improve enterprise compliance in spite of the many forces mentioned in this paper which might encourage profit-maximizing firms to operate to the contrary.

As is true with any government interference in the market, pollution charges can generate perverse incentives if improperly implemented. In Romania we show that this is the case in the water sector. Enterprises apparently have an incentive to dilute their effluents in order to reduce pollution tariffs and additional regulatory oversight measures. However, at least in this case, a modified procedure involving the monitoring of discharge amounts (instead of using preset technical parameters) would correct the problem.

We ended our analysis by recognizing that it is the *expected* pollution charge which economic agents use to base their compliance decision, and that the expectation was related to the rate of collection of the pollution charges assessed. We therefore examined the collection problem. We show that nonpayment of pollution charges is inversely related to the level of the assessment and that enterprise nonpayment is exacerbated, the more overstretched is the enforcement agency and the weaker is the economy while it is ameliorated the more profitable are enterprises. Finally, regardless of profitability, greater state ownership increases nonpayment. As such, the lower the enterprise's ability to pay and the higher is its assessed bill, the lower will be its rate of payment of charges that do get assessed. These results, however, point to solutions: enterprise privatization and greater financial resources to the regulatory authorities. Moreover, since privatized firms also seek to minimize input costs, the fact that they are more likely to pay their assessments corroborates our earlier result that they will also improve their environmental compliance.

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ENDNOTES

¹ This section draws on, updates, and extends Zinnes (1997).

² This is not unusual internationally. Sachs et al. (1995) show that countries with a greater abundance of natural resources have experienced *lower* long-run growth.

³ A summary of the worst of these impacts by key economic sector and by health, ecological and economic effect is provided in Manea and Zinnes (1994).

⁴ Discharges into sewage systems are contracted directly with the municipality owning the sewage works. Such services are not generally used by large enterprises.

⁵ The comparability of these two figures is in doubt since it is not clear whether the latter includes users without valid permits while the former comprises only permit holders. Information from personal discussions with AR officials.

- ⁶ Information from personal discussions with AR officials.
- ⁷ Average consumption nationally for permitted industrial users was 25 m³/hr. The rationale to restrict the sample to such firms was that, being the most polluting, they are the focus of regulatory enforcement such as it is.
- ⁸ This dataset contains (1) general information related to location, ownership status, and type of activity, (2) size and financial data, (3) capacity utilization and technology vintage, (4) detailed water consumption and discharge data, (5) source and destination information on water abatement investment, including the loan and/or subsidy terms, (6) a description of existing abatement investment and the regulatory compliance situation, including measures of public pressure and (7) information regarding the enterprise's foreign contacts.
- ⁹ We use the arbitrary cut-off of less than 0.20 as the absolute value of the correlation coefficient to describe two variables as related or not.
- ¹⁰ Keep in mind that the "penalty" is really just the second component of the pollution charge representing the price for above-permitted discharges.
- ¹¹ The data itself generally indicate that if an enterprise paid any amount of the assessed penalty, it paid the full amount; unfortunately, about half the fined enterprises chose to pay zero.
- ¹² This is not as obvious as it may seem considering that most households in Romania do not have water 24 hours a day. The paradox is resolved by noting that municipal systems have 60-percent loss rates and pumps are turned off to reduce energy bills.
- ¹³ See Zinnes et al., (forthcoming, 1999) for complete description of the model and related econometric analysis.
- ¹⁴ Recall that for the current sample, profitability and state ownership share capture very different characteristics, with no correlation between the two.
- ¹⁵ While not developed in this paper, the data have helped resolve a long-standing dispute regarding water scarcity in Romania: no abstraction penalties were assessed, let alone collected. The reason? In spite of all the hype, water is so abundant that abstraction permit levels may be set so high so that no enterprise need exceed — never mind have to pay for — "excessive" (above-permitted) abstraction.