Transition to Markets and the Environment: Effects of the Change in the Composition of Manufacturing Output

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Contents

Tables

Abstract

The paper measures the changes in environmental quality that occurred in the early years of economic transition for 12 former centrally planned economies using information on 13 pollution effluents in the manufacturing sector and the energy intensity of the value added. For the manufacturing sector, the change in the pollution is separated into scale and composition effects. Pollution decreases substantially in most countries because of large decreases in aggregate manufacturing activity. The composition effect is more diverse depending on the effluent type and country. We examine the reduced form relationship between composition effects coupled with the energy intensity rate of change and the extent of policy reforms. The results indicate a strong relationship between environmental improvement and price liberalization, trade and foreign exchange reforms, enterprise restructuring, and privatization reforms. In addition, the amplification of the environmental regulatory regime causes a shift towards a less-polluting allocation of resources.

TRANSITION TO MARKETS AND THE ENVIRONMENT: EFFECTS OF THE CHANGE IN THE COMPOSITION OF MANUFACTURING OUTPUT

Executive Summary

This paper analyses environmental problems in 12 former centrally planned economies (CPEs) during their transition from plan to market. The empirical question addressed is whether the transition from a centrally planned to a market-driven economy exacerbates environmental degradation. Or, is it the case that environmental improvements complement economic transition?

Since no reliable statistics exist to monitor trends in pollution emissions in former CPEs, in constructing the data set for the purpose of inter-temporal and inter-country comparison, we had to rely on approximations. First, our goal is to quantify the changes in environmental quality that occurred in the early years of transition. We did this by measuring the changes in the composition of manufacturing output in the direction of cleaner or dirtier industries. Second, controlling for the overall decline in economic activity (which turned out to be a necessary byproduct of the transition process) we analyze whether changes in the composition of output towards dirtier or cleaner industries can be explained by the relevant institutional changes. For example, can these changes be explained by the degree of completeness of transition reforms and also by the impacts of environmental regulatory regimes?

Using relatively simple techniques we investigated the character of the change in the pollution emissions of 13 pollutants plus the energy intensity of value added in 12 former CPEs. We found that pollution emissions associated with aggregate manufacturing production have substantially decreased because of the near collapse of manufacturing in many of the former CPEs. However, it was more difficult to identify patterns of changes in emissions due to the new composition of manufacturing activities. A diversity of patterns emerge, with some cleaner composition for some

effluent types and some countries, but also with dirtier composition for other pollutants and countries.

Despite these heterogeneous patterns, we were able to identify two recognizable clusters of countries. The first group comprises Azerbaijan, Bulgaria, Kyrgyzstan, Latvia, Slovakia, and Ukraine. For these countries, the emphasis on chemicals, metallic industries, and plastics seems to have survived transition or even has increased. The second group, consisting of Armenia, Hungary, Macedonia, Poland, Russia, and to a lesser extent Slovenia, shows consistent environmental improvements in the composition of manufacturing output with respect to most pollution emission types except for biological oxygen demand and volatile organic compounds.

This analysis finds that price liberalization, trade, and foreign exchange system reforms, and enterprise restructuring and privatization resulted in a cleaner composition of manufacturing output and reduced energy consumption per dollar of value added. With available data capturing the degree of environmental policy reforms, we also find that the amplification of the environmental regulatory regime caused a shift towards less polluting allocation of resources.

Introduction

Early anecdotal reports on the status of the environment in the former centrally planned economies (CPEs), released immediately after the collapse of communism, portrayed an appalling picture of extensive environmental degradation. This was attributed to the absence of adequate environmental policies and a systematic neglect of environmental issues. Although this catastrophic portrayal appeared somewhat exaggerated (Pearce and Warford 1993), little systematic evidence on the status of the environment in the former CPEs and no international comparisons with the rest of the world, have been presented so far. In this context, an interesting question arises: What happened to the status of the environment in the CPEs in the early years of transition? An attempt to answer this question is presented in this paper. The empirical question addressed is whether the transition from a centrally planned to a market-driven economy exacerbates environmental degradation. Or, is it the case that environmental improvements complement economic transition?

The literature on explicit linkages between the environment and the socio-economic transition from central planning to markets tends to be "conjectural" or based on scarce and incomplete evidence (Pearce and Warford 1993; Scalan 1992; DeBardeleben 1991; OECD 1995; Buydos 1990; Zylicz 1997). In an attempt to try to predict the environmental consequences of a country's transition from a centrally planned to a market-driven economy, one can start with a standard categorization of pollution as an externality. This particular type of market failure can be mainly attributed to the absence of clearly specified property rights over different environmental media. Since centrally planned economies were characterized by a complete absence of markets, one can think about the transition from a centrally planned to a market economy as a movement from a domain of more (complete) market failure to a domain of less market failure. Therefore, in theory at least, the transition from more market failure to less market failure is consistent with an overall improvement in environmental quality.

The above conclusion would most likely hold in the very long run. However, in the short- and medium-run, the consequences of transition are far from obvious. This is especially true since even in the most developed and mature market systems, the environmental media are certainly the

last ones where property rights would be established and market failures alleviated. Based on the existing literature on growth, trade, and the environment, several more operational hypotheses pertaining to the transition and post-transition periods can be developed.

First, one can conjecture that the environment in the economies in transition would get cleaned up quickly because of rising energy prices, penalizing energy-intensive activities (Hughes 1991). Secondly, one can also argue that the abundance of skilled labor in these countries may result in a new allocation of resources towards cleaner specialization induced by international market discipline, as shown to be the case for Mexico (Beghin et al. 1995; Grossman and Krueger 1993). These optimistic views may be invalidated by the fact that many transition economies have lax environmental regulations and are "abundant" in environmental endowment (Rauscher 1995). If this is true, then one could potentially observe a worsening pollution due to an increased specialization in pollution-intensive industrial activities.

Some of these questions can be addressed by looking into a relationship between the pollution intensity of the economy and measures of openness. The literature on this question presents controversial evidence. Lucas et al. (1992) found that intensities for outward-oriented and fast-growing economies were decreasing rapidly in the 1980s and, further, that a negative relationship could be established between an index of openness and pollution intensity of value added. This finding suggests that outward orientation is environmentally less damaging than the inward orientation. However, Rock (1996) found little econometric evidence to support the relationship between outward orientation and environmental improvement.

The scope of this paper is largely determined by the availability of the empirical data. Since no reliable statistics exist to monitor trends in pollution emissions in former CPEs (Zylicz 1997), in constructing the data set for the purpose of inter-temporal and inter-country comparison, we had to rely on approximations. First, our goal is to quantify the changes in environmental quality that occurred in the early years of transition by measuring the changes in the composition of manufacturing output in the direction of cleaner or dirtier industries. Second, controlling for the overall decline in economic activity (which happens to be a necessary byproduct of the transition process) we want to see whether changes in the composition of output can be explained by the

relevant institutional changes. For example, can these changes be explained by the degree of the completeness of transition reforms and also by the impacts of environmental regulatory regimes? The paper investigates these issues for a representative subset of the Central and Eastern Europe countries (CEEC) and Newly Independent States (NIS).

We find that pollution sharply decreased in most CEEC/NIS because of a near collapse of output. The new manufacturing specialization varies a lot by country. No clear general pattern on transition and pollution can be easily identified. Further, we find that policy reforms affecting price liberalization, trade, and foreign exchange systems, as well as reforms in the area of enterprise restructuring and privatization had a beneficial effect on the composition of manufacturing output, steering it towards less polluting sectors, and on reducing the energy consumption per dollar of value added. With available data capturing the degree of environmental policy reforms, we find that the amplification of the environmental regulatory regime caused a shift towards a less- polluting allocation of resources.

Market and Environmental Policy Reforms in Former Centrally Planned Economies

The data for measuring the degree and completeness of the market reforms in the former CPEs used in this study comes from the European Bank for Reconstruction and Development (EBRD) (1995)[1], which summarizes the progress in transition in four major areas: enterprises, markets and trade, financial institutions, and the role of the state. As of October 1994, the countries that had made the most significant progress in establishing a market economy were Czech Republic, Slovak Republic, Hungary, Poland, Baltic States, Slovenia, and Croatia. Most of these countries had already liberalized foreign trade and domestic prices, privatized small-scale businesses, and had started to deal with banking reform, enterprise restructuring, and large-scale privatization. The intermediate group of countries consists of Romania, Bulgaria, and several NIS such as Kyrgyzstan and Russia. Russia, in particular, was already making rapid progress in privatization in all sectors, except in agriculture. The remainder of the former CPEs had made much less progress with market-oriented reform and were finding it difficult to liberalize trade,

embark upon enterprise restructuring and, even, in some cases, to achieve small-scale privatization.

The EBRD data is organized into three groups of transition indicators: *enterprises, markets and trade,* and *financial institutions,* with each group consisting of several elements. For each of the transition elements, each country is assigned a number between 1 and 4, indicating the degree of the completeness of the market reform in the respective category, with 4 being the highest degree of reform. There are no numerical scores given for the category *the role of the state*. Within the *enterprises* category, three aspects of market reform were analyzed: (a) *large-scale privatization,* (b) *small-scale privatization,* and (c) *enterprise restructuring*. In the category of *markets and trade,* two aspects of market reform were analyzed: (a) *price liberalization and competition,* and (b) *trade and foreign exchange system*. Finally, in the category of *financial institutions* the degree of market reform was assessed through the analysis of the *banking reform*. The transition indicators classification system is reproduced in Table 1.

The aggregate scores for the three groups of transition indicators were obtained by summing the scores of individual elements. Since there are six individual transition elements (three in *enterprises*, two in *markets and trade*, and one in *financial institutions*), the maximal achievable score for each country is 24. The ranking of countries according to the total market transition score is presented in Table 2. The progress in transition is positively rank-correlated with per capita GNP calculated at purchasing power parity (PPP). There are two notable exemptions, Croatia and the Baltic States, where the progress in market reforms is well ahead of their wealth ranks, and Belarus and Ukraine, whose cumulative transition scores rank well below their per capita GNPs.

Aside from the changes in the political-economic environment brought about by the transition from central plan to market, the change in the environmental regulatory regime may have significantly influenced the changes in environmental quality. Unlike with the assessment of the overall degree of market reform in former CPEs, the comparable assessment of the degree of environmental policy reforms across former CPEs is not available.[2] To approximate changes in

environmental regulatory regimes, we use a measure of *revealed* regulatory effort exerted by policymakers to address environmental problems.

Environmental protection in the CEEC/NIS is mostly financed by the extra-budgetary "environmental funds" (Zylicz 1997). These funds have emerged as the major resource for environmental reform. Because the main sources of revenue for environmental funds are pollution fines, pollution emissions charges, waste disposal fees, and energy taxes, the size of the fund reflects the recent regulatory effort as well as the actual implementation, monitoring, and enforcement of environmental policies. Since environmental funds did not exist under central planning, their present size can be used as a gauge of the environmental policy reform paralleling the market transition processes. Looking at Table 2, we see that in 1993/94 the size of environmental funds range from $156 million (constant 1987 dollars), or 0.265 percent of the GDP in Poland, to only about $16 thousand, or 0.0001 percent of the GDP in Uzbekistan.

Measures of Environmental Quality

In order to carry out the empirical analysis, cross-country time-series data on pollution emissions are needed. As mentioned earlier, no reliable statistics to monitor trends in pollution emissions in former CPEs exist (Zylicz 1997). The only available environmental indicator that satisfies our criteria is the data on energy use.[3] To get a broader picture about the status of the environment in those countries, we had to rely on constructed measures. Notably, the changes in a country's environmental quality are approximated by the changes in the composition of manufacturing output. This is accomplished by using pollution intensities estimates[4] and the data on the composition of the manufacturing output for the sample of 12 countries. The intensities are expressed in pounds of pollutant per million dollars of output at 1987 prices. Thirteen types of pollutants are grouped into four subsets (total toxic chemicals released in air, water, and soil; bio-accumulative metals in air, water, and soil; air pollutants (nitrogen oxides, sulfur oxides, volatile organic compounds, suspended particulates, carbon monoxide); and water pollution (biological oxygen demand, and total suspended solids).

Countries included in the data set and the time period coverage are as follows: Armenia (1990-93), Azerbaijan (1991-94), Bulgaria (1990-94), Hungary (1990-93), Kyrgyzstan (1990-94), Latvia (1990-93), FYR Macedonia (1990-94), Poland (1990-93), Russia (1991-94), Slovakia (1991-93), Slovenia (1990-94), and Ukraine (1990-94). Countries were chosen according to the availability and continuity of disaggregated manufacturing data for the period 1990-94.[5] Data from other industries, such as mining and quarrying, and electricity, gas and steam, was too fragmented to be used.

The implemented analytical approach rests upon two assumptions. First, technologies are fixed across countries, meaning that former CPEs are all using the same technical/technological processes equal to what the U.S. industry was using in 1987. Second, technologies are also fixed in time, meaning that the analysis is not capable of capturing any environment-saving technological progress, that may have occurred during the analyzed period. During the central planning era and in the early years of economic transition, CEEC/NIS were probably using inferior technology compared to what the United States was using in 1987 and, hence, our early data (1990-1991) would tend to underestimate the pollution concentrations. However, as transition progressed, the influx of foreign capital brought about the installation of brand new technologies—most of them with superior pollution abatement specifications compared to the 1987 U.S. vintage. Hence our end-of-the-period data (1993-1994) would tend to overestimate pollution concentrations. As a result, for countries that moved towards a cleaner specialization in manufacturing, we underestimate the decrease in pollution, whereas for countries that moved towards dirtier specialization in manufacturing, we overestimate the increase in emissions by assuming a constant 1987 U.S. technology. Therefore, our approach has a systematic "pessimistic" bias.

Following this approach, any measurable changes in environmental quality are the results of either the change in the country's aggregate output or the change in the sectoral composition of output, as shown in the following simple derivation. Let $E(t) = \sum_i e_i(t)$ denote the aggregate pollution in a given economy in period t expressed as the sum of pollution emissions of individual

sectors, and let $X(t) = \sum_i x_i(t)$ denote the aggregate output. Aggregate pollution is expressed as:

$$E(t) = \sum_i \left(\frac{e_i(t) x_i(t) X(t)}{x_i(t) X(t)} \right), \tag{1}$$

where, for the purposes of this exercise, the term (e_i/x_i) is assumed to be constant (therefore t has been dropped) representing the sector pollution intensities based on 1987 U.S. technology. Differentiating (1) with respect to time, one obtains:

$$\frac{dE}{dt} = \sum_i \frac{e_i}{x_i} \left(\frac{d\left(\frac{x_i(t)}{X(t)} \right)}{dt} X(t) + \frac{x_i(t)}{X(t)} \frac{dX(t)}{dt} \right). \tag{2}$$

Introducing $S_i(t) = \frac{x_i(t)}{X(t)}$ to denote the share of the i[th] sector's output in the aggregate output, and $\dot{S}_i = \frac{dS_i(t)}{dt}$ and $\dot{X} = \frac{dX(t)}{dt}$ to denote the respective time derivatives, expression (2) can be rewritten as:

$$\frac{dE}{dt} = \sum_i e_i \left(\frac{\dot{S}_i}{S_i} + \frac{\dot{X}}{X} \right). \tag{3}$$

After some straightforward manipulation of terms, (3) can be rewritten as follows:

$$\frac{\dot{E}}{E} = \sum_i \left(\frac{e_i}{E} \frac{\dot{S}_i}{S_i} \right) + \frac{\dot{X}}{X}, \tag{4}$$

where $\frac{\dot{E}}{E}$ denotes the rate of change in total pollution for the period under consideration, $\frac{e_i}{E}$ is the share of the i[th] sector pollution in total pollution, $\frac{\dot{S}_i}{S_i}$ is the rate of change in output share of sector i, and $\frac{\dot{X}}{X}$ is the rate of change in total output.

It follows from (4) that the rate of change in total pollution has two parts: the composition effect and the scale effect. The composition effect reflects the change in pollution resulting from

producing different goods (the product of the pollution share of sector i and the corresponding rate of change in output share, summed across all sectors). The scale effect represents the expansion or contraction of pollution directly proportional to aggregate manufacturing activity, holding composition constant (the rate of change in aggregate output). The composition effect also reflects the change in average pollution intensity of aggregate manufacturing output. Equation (4) forms the basis for the empirical analysis of the environmental quality changes in the remainder of this section.

All output data, originally reported in current values of local currencies, was first converted into constant 1987 U.S. dollars,[6] and then pollution intensities coefficients were used to convert sectoral outputs into pollution emissions. The results for the average annual rate of change in pollution composition and scale effects for 13 pollutants and 12 countries are presented in Table 3. Positive numbers indicate the environmental deterioration in the composition of manufacturing output (a movement towards more polluting industries), and negative numbers indicate the improvement in environmental quality (a shift towards cleaner sectors). Referring to the analytical formula in (4) indicates that adding up the composition effect and scale effect produces the rate of change in the aggregate pollution. However, the results show that independently computed rate of change in pollution differs from the sum of composition and scale effects. The differences are quite small and stem from the use of discrete time approximations of the continuous time derivatives.[7]

The last column in Table 3 represents the average annual rate of change of the GDP energy intensities, where the indicator was derived by dividing the total consumption of energy in metric tons of oil equivalent by the total GDP expressed in constant 1987 U.S. dollars. As of 1994, the CEEC/NIS exhibited far larger energy intensities per dollar of GDP than the OECD countries. The absolute numbers (not presented in this paper) show that for the group of countries analyzed, the energy intensity varies from as low as 387 grams of oil equivalent per 1987 dollar of GDP in Slovenia and as high as 4 kilograms of oil equivalent for Azerbaijan. From 1990 to 1994, the energy intensity of GDP decreases for nine countries in our sample, illustrating the rationalization brought about by higher energy prices in the transition period.

The obtained results seem to point towards several common tendencies emerging in transition economies. First, in most countries manufacturing output had collapsed or substantially decreased in early transition, and eventually leveled in later years, thereby reducing pollution levels by a corresponding massive scale effect. The scale effect virtually dominates composition effects in all countries for all pollutants. Second, various composition effect patterns, observed across pollutants and countries, suggest diverse patterns of specialization induced by the transition. In many countries, resources have been moved away from heavy manufacturing industries, such as iron and steel and towards lighter industries, such as food, beverage, and tobacco products. We find such instances in Armenia, Hungary, Kyrgystan, Latvia, and Poland. These compositional changes towards lighter industries have been accompanied by increases in biological oxygen demand (BOD) and volatile organic compounds (VOC) emissions, and by decreases in bio-accumulative emissions released in the soil and air. In addition, several countries have expanded their energy and petroleum-refining activities (for example, Bulgaria, Azerbaijan, Latvia, Hungary, and Kyrgystan), inducing more toxic pollution.

The composition effect results reveal two clusters of countries, with no country remaining at the status quo: those with dirtier and those with cleaner manufacturing composition. Those with dirtier composition are Azerbaijan, Bulgaria, Kyrgystan, Latvia, Slovakia, and Ukraine. For these countries, the compositional changes of manufacturing output were environmentally harmful with respect to at least ten pollutants, and sometimes for all pollutants (see composition effects in Table 3). The emphasis on chemicals, metallic industries, and plastics seems to have survived the transition, or even has increased. The countries with cleaner composition are Armenia, Hungary, Macedonia, Poland, Russia, and to a lesser extent Slovenia. They show consistent environmental improvements in the composition of manufacturing output with respect to most pollution emission types, except for VOC and BOD.

Composition Effect and Transition Reforms

Based on the results obtained in the previous section, we investigate whether changes in pollution that have occurred in the early 1990s can be explained by relevant institutional changes,

notably by the degree of completeness of transition reforms and the changes in environmental regulation. To isolate the impact of the overall decline in economic activity, which is a common characteristic of all countries in the region during that period, we select the composition effect, i.e., the rate of change in pollution attributable only to the change in the composition of manufacturing output (as a dependent variable in the regression model). For the same reason, we use the rate of change in energy intensity, i.e., the rate of change in energy consumption per dollar of GDP, as a dependent variable in the model. The data on 13 pollution intensities rates are stacked vertically together with the data on energy intensity rates to form a column vector of 14 pollution indicators for 12 countries.

The empirical method involves regressing the column vector of composition effects *cum* energy intensity rates on relevant transition and policy reform indicators. Defining $\mathbf{Z}_j$ to be the observable variables measuring the degree of the completeness of transition reforms and F_j to measure the changes in the environmental regulatory regime affecting the change in the pollution emissions of pollutant i in country j, the empirical model can be expressed as:

$$y_{ij} = y(\mathbf{Z}_j, F_j) + u_{ij,} \tag{5}$$

where y_{ij} is either the composition effect defined as $\sum_i \left(\frac{e_i}{E} \frac{S_i}{S_i} \right)$ from equation (4) or the energy intensity rate, and u_{ij} is the random error with zero mean representing measurement error as well as unmeasured and unmeasurable factors influencing the composition of output and energy intensity.

The strength of the transition reforms is measured by the scores for various transition elements from Table 2. The maximum theoretical score for enterprise restructuring and privatization is 12, whereas the highest observed score in our sample of 12 countries is actually 10. The highest possible score for price liberalization and trade and foreign exchange system reform is 8 whereas the highest observed score is 7. For banking reform, the maximum attainable

score is 4 and the highest observed score is 3. However, in regression analysis, rather than using cardinal scores, we use six categorical variables (dummies).

In the category of enterprise reform the first dummy variable Enterprise(7,8) has the value of 1 if the score equals 7 or 8, and zero elsewhere; and the second dummy variable Enterprise(9,10) has the value of 1 if the score equals 9 or 10, and zero in all other cases. The definitions of other dummy variables for markets and trade and banking reforms are recognizable from the self-explanatory variable labels in Table 4. The change in the environmental regulatory regime is approximated by the size of environmental funds expressed as a percentage of a country's GDP from Table 2. For those countries in our sample of 12 for which the OECD (1995) has not reported the existence of environmental funds (Armenia, Kyrgyzstan, Latvia, Macedonia, Slovenia), we assumed that they were zero.

Two specifications of the model are presented in Table 4: one with transition reform indicators only, and the other with transition reform and environmental policy regime indicators. The results look fairly similar, with the second specification providing a slightly better overall fit (adjusted R^2 of 26 percent compared to adjusted R^2 of 21 percent).[8] The results suggest the existence of a robust and negative link between enterprise and market reforms and pollution. In both specifications, pollution intensity decreases monotonically with the degree of completeness of the market reforms as indicated by the larger magnitude of the coefficient of Markets(7,8) than the coefficient of Markets(5,6). The composition component of pollution appears to respond negatively to price liberalization and trade and foreign exchange system reforms in a sense that advancing reform shifts resources towards less polluting manufacturing sectors. The same is true for energy intensity in a sense that more advanced reforms stimulate the reduction in the energy consumption per dollar of GDP.

The estimated link between enterprise reforms and pollution intensity is monotone and negative in the specification with no environmental reform variable in the model. As far as the first 13 pollutants is concerned, it suggests that the progress in enterprise restructuring and privatization shifts the resources towards less polluting manufacturing sectors. In the area of energy utilization, the result says that the degree of completeness of enterprise reforms reduces

the energy intensity per dollar of value added created. However, when we account for the change in environmental regimes, we observe an initial decrease in pollution intensity associated with enterprise reforms, but with no additional environmental improvement with further enterprise reforms. Hence, while the initial improvement appears well established, it is questionable if further completion of enterprise reforms brings any additional environmental improvement.

The response of pollution intensity to the environmental funds variable is robust and negative in both specifications, strongly suggesting that a shift away from pollution-intensive activities is induced by environmental reforms. Hence, we found evidence supporting the conjecture that environmental "abundance" (lax environmental regimes) is associated with specialization in pollution-intensive industries.

A surprising result is a positive and robust relationship found between the banking reform variable and pollution intensities. We could not find any obvious rationalization for this result. Several countries that have lowered the pollution intensity of manufacturing also have been lagging on the banking reform front; such is the case of Armenia, and Macedonia. The converse is, however, also true. For instance, Slovakia and Latvia have extensively reformed their banking institutions as of 1994, while also specializing in more pollution-intensive manufacturing. The heterogeneous sequencing of reforms in the countries included in our sample may explain this finding and certainly warrants further investigation when data on other countries become available. We have also estimated several alternative specifications with only two banking reform levels (one dummy variable) and also without banking reform variables. In both instances, the explanatory power of the model decreases, but qualitative results remain unchanged.

Finally, we investigated the sensitivity of our results to the inclusion or exclusion of the energy intensities in the data. Regression results are invariant to the inclusion or exclusion of the energy intensities as a fourteenth pollution indicator.

Conclusions

Using relatively simple techniques we investigated the character of the change in the pollution emissions of 13 pollutants plus energy intensity of value added in 12 CEEC/NIS embarked on the path of economic transition from the centrally planned towards market-driven economic systems. We found that pollution emissions associated with aggregate manufacturing production have substantially decreased because of the near collapse of manufacturing in many of the former CPEs. However, it was more difficult to identify patterns of changes in emissions due to the new composition of manufacturing activities. A diversity of patterns emerge, with some cleaner composition for some effluent types and some countries, but also with dirtier composition for other pollutants and countries. Despite these heterogeneous patterns, we were able to identify two recognizable clusters of countries, one expressing the tendency towards cleaner manufacturing, and the other moving towards dirtier sectors based on heavy manufacturing.

From our econometric exercise we found strong evidence that the majority of the transition reforms, such as increased openness and enterprise restructuring and privatization, has influenced the allocation of resources towards cleaner manufacturing sectors. The same can be said about the changes in energy intensity per dollar of value added. Most of the former CPEs experienced a major change in the price of energy caused by realignment of domestic prices to world prices, as evidenced by decreasing energy intensity of aggregate income. Because of tighter budget constraint at the enterprise level, enterprise restructuring and privatization reforms reinforce the response to price signals and induce greater allocative efficiency, with an indirect environmental improvement. Both of these results provide support to the early conjecture of Hughes (1991) on rapid environmental improvement in CPEs following the collapse of the communist system.

In summary, our findings can be interpreted as being consistent with Lucas et al. (1992). In the case of the former CPEs, the partial effect of outward orientation achieved with reforms affecting market incentives and border measures is beneficial to the environment. We also find empirical support for the conjecture that more stringent environmental regimes produce further shifts away from pollution-intensive activities, suggesting increased environmental benefits from the coordination of environmental protection and market reforms.

Table 1. Classification System for Transition Indicators

Transition Indicator	Score	Description of the Category
ENTERPRISES		
Large-scale privatization	4	More than 50 percent of the state-owned enterprise assets are privatized in a scheme that reflects support for corporate governance.
	3	More than 25 percent of large-scale state owned enterprise assets are privatized or in the process of being sold but with major unresolved issues regarding corporate governance.
	2	Advanced comprehensive scheme is almost ready to be implemented and some sales have already been completed.
	1	Little done.
Small-scale privatization	4	Comprehensive and well designed program implemented.
	3	Nearly comprehensive program implemented, but design or lack of central supervision leaves important issues unresolved.
	2	Substantial share privatized.
	1	Little done.
Enterprise restructuring	4	Restructuring program which substantially improves corporate governance in operation, strong financial discipline at the enterprise level, large-scale conglomerates broken up.
	3	Structures created (e.g., through privatization combined with tight credit and subsidy policies and/or enforcement of bankruptcy legislation) to promote corporate governance, or strong action taken to break up conglomerates.
	2	Moderately tight credit and subsidy policy, weak enforcement of bankruptcy legislation and little action to break up large conglomerates.
	1	Lax credit and subsidy policies weakening financial discipline at the enterprise level and few other reforms to promote corporate governance.
MARKETS AND TRADE		
Price liberalization and competition	4	Comprehensive price liberalization and price competition and anti-trust legislation in place.
	3	Comprehensive price liberalization and price competition.
	2	Price controls remain for several important product categories.
	1	Most prices remain formally controlled by the government.
Trade and foreign exchange system	4	Few import or export quotas, insignificant direct involvement in exports and imports by ministries and state-owned former trading monopolies, almost full current account convertibility at unified exchange rate, no major non-uniformity of customs duties.
	3	Few import quotas, almost full current account convertibility at unified exchange rate.
	2	Few import quotas, almost full current account convertibility in principle but with a foreign exchange regime which is not fully transparent (possibly with multiple exchange rates).

	1	Widespread import controls or very limited legitimate access to foreign exchange.

Table 1. Classification System for Transition Indicators (continued)

FINANCIAL INSTITUTIONS		
Banking Reform	4	Well functioning banking competition and prudential supervision.
	3	Substantial progress on bank recapitalization, bank auditing, and establishment of a functioning prudential supervisory system, significant presence of private banks, full interest rate liberalization with little preferential access to cheap refinancing.
	2	Interest rates significantly influencing the allocation of credit.
	1	Little progress beyond establishment of a two-tier system has been done.

SOURCE: Transition Report Update, European Bank for Reconstruction and Development, April 1995 (pp. 69-70).

Table 2. Progress in Transition and Environmental Reform in CEEC/NIS

	PCGNP (ppp US $) 1994*	Transition Scores** Enterprises	Markets and Trade	Banking	TOTAL	Environmental Funds 1993*** mil. 1987 US$	% of GDP
Czech Rep.	7910	11	7	3	21	84.119	0.2773
Slovak Rep.	6660	10	7	3	20	27.516	0.1885
Hungary	6310	10	7	3	20	21.777	0.0953
Poland	5380	10	7	3	20	156.053	0.2650
Estonia	3785	10	7	3	20		
Slovenia	9234	9	7	3	19		
Croatia	3828	9	7	3	19		
Lithuania	3240	9	7	2	18		
Latvia	5170	7	7	3	17		
Kyrgyzstan	1710	9	6	2	17		
Macedonia		8	7	2	17		
Russia	5260	8	6	2	16	55.031	0.0157
Romania	2920	7	7	2	16	0	0.0000
Bulgaria	4230	6	7	2	15	1.808	0.0084
Albania		6	7	2	15		
Moldova	2215	6	5	2	13	0.0126	0.0003
Uzbekistan	2390	6	5	1	12	0.016	0.0001
Armenia	2170	5	5	1	11		
Belarus	5010	6	3	1	10	0.46	0.0023
Kazakhstan	2830	5	4	1	10	2.913	0.0166
Tajikistan	1160	5	4	1	10		
Ukraine	3330	4	3	1	8	0.786	0.0010
Azerbaijan	1720	3	4	1	8	0.057	0.0019
Georgia	1160	4	3	1	8		
Turkmenistan		3	3	1	7		

SOURCES:

*Transition Report 1996, EBRD, p.122. The numbers for Croatia, Estonia, Moldova, and Slovenia are for 1993.

** Transition Report Update, EBRD, April 1995, p.69

*** Zylicz, 1997; and OECD, 1995. The numbers for Azerbaijan, Kazakhstan, Romania, and Belarus are for 1994.

Table 3. Pollution Indicators: Average Annual Rates of Change

	SCALE		COMPOSITION EFFECTS*												Energy**
	EFFECT*	BOD	TSS	Toxic Air	Toxic Solid	Toxic Water	SO_2	N_2O	CO	VOC	Particul.	Bio Air	Bio Land	Bio Water	Intensity
Armenia (1990-93)	-0.4555	-0.0125	0.1401	0.0082	-0.0264	-0.0101	-0.0993	-0.0299	-0.0674	0.0039	-0.0499	-0.1242	-0.1586	-0.0138	-0.0446
Azerbaijan (1991-94)	-0.4420	-0.0069	-0.1158	0.0219	0.0968	0.0312	0.1315	0.2011	0.0938	0.2280	0.0908	-0.0816	-0.0983	0.0418	0.1550
Bulgaria (1990-94)	-0.2668	0.0682	0.1992	0.1205	0.1729	0.1837	0.1985	0.1805	0.1916	0.1377	0.1578	0.1971	0.2035	0.1958	-0.0039
Hungary (1990-93)	-0.0802	-0.0296	-0.1602	-0.0371	-0.0831	-0.1113	-0.0553	-0.0105	-0.0269	0.0333	-0.0290	-0.1704	-0.1903	-0.1154	-0.0182
Kyrgyzstan (1990-94)	-0.3209	0.1519	0.3197	0.1288	0.2275	0.1109	0.2372	0.1221	0.2581	0.0706	0.1337	0.3031	0.3086	0.1990	-0.0929
Latvia (1990-93)	-0.3573	0.0943	0.4593	0.0642	0.1423	0.1183	0.1259	0.1052	0.1714	0.1458	0.0838	0.3397	0.3286	0.2571	-0.0446
Macedonia (1990-94)	-0.1342	0.1055	-0.1953	-0.0215	-0.0659	-0.0357	-0.1067	-0.0712	-0.1453	-0.0446	-0.0757	-0.1708	-0.1550	-0.1339	-0.0141
Poland (1990-93)	-0.0127	0.0037	-0.1108	-0.0247	-0.0426	-0.0608	-0.0176	0.0135	-0.0373	0.0563	-0.0215	-0.1022	-0.1062	-0.0780	-0.0138
Russia (1991-94)	-0.2449	-0.1419	0.1100	-0.1712	-0.1404	-0.2068	-0.0068	-0.0624	0.0316	-0.0867	0.0003	0.0247	-0.0013	-0.0808	0.0383
Slovakia (1991-93)	-0.1463	-0.0003	0.1069	0.0200	0.0332	0.0165	0.0365	0.0277	0.0656	0.0279	0.0277	0.0842	0.0747	0.0837	-0.0755
Slovenia (1990-94)	-0.0580	0.0704	-0.0058	0.0323	0.0418	0.1431	-0.0355	0.0639	-0.0163	0.0474	-0.0018	-0.0869	-0.1011	0.0625	-0.0560
Ukraine (1990-94)	-0.1521	0.0203	0.1770	0.0764	0.1209	0.1111	0.1266	0.1222	0.1523	0.0969	0.1173	0.1568	0.1497	0.1602	0.0490

* The scale and composition effects for 13 pollutants are calculated for the time period indicated following the country name.

** The average rate of change in energy intensity reflects the period 1990-1994 for Bulgaria, Hungary, and Poland, and 1992-1994 for all other countries.

Table 4. Pollution and Institutional Reform Model Estimation Results

Variable	Estimate	Standard Error	t-Statistics
Model 1: Specification with transition reform indicators			
N	168		
Adjusted R^2	0.2073		
Constant	0.08664	0.02055	4.216
Enterprise(7,8)	-0.23809	0.04110	-5.793
Enterprise(9,10)	-0.26551	0.04836	-5.490
Markets(5,6)	-0.12124	0.03559	-3.407
Markets(7,8)	-0.27942	0.05192	-5.382
Bank(2)	0.35015	0.05584	6.270
Bank(3)	0.47469	0.08220	5.775
Model 2: Specification with transition reform and environmental policy regime indicators			
N	168		
Adjusted R^2	0.2576		
Constant	0.08729	0.01989	4.389
Enterprise(7,8)	-0.24187	0.03979	-6.079
Enterprise(9,10)	-0.23409	0.04768	-4.910
Markets(5,6)	-0.12189	0.03444	-3.539
Markets(7,8)	-0.26599	0.05040	-5.278
Bank(2)	0.33985	0.05412	6.279
Bank(3)	0.48552	0.07960	6.099
Funds	-0.44904	0.1301	-3.452

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Endnotes

1. Alternative set of transition progress scores are available from The World Bank (1996).

2. For the individual countries' experiences with environmental reform and recovery problems see for example Bluffstone and Larson (1997) and Kaderjak and Powell (1997).

3. Data used in this study represents the total consumption of energy in metric tons of oil equivalent and comes from United Nations (1995, 1997).

4. The estimates of pollution intensities of aggregate gross output and by sectoral activities come from a database called the *Industrial Pollution Projection System* (Hettige et al. 1995). The database provides estimates of sectoral pollution intensities for industrial activity at the 3 digit ISIC disaggregation level for 13 effluent types.

5. The data on the composition of manufacturing output is 3-digit ISIC sectoral data collected from United Nations Industrial Development Organization (UNIDO) (1996, 1997). As of 1997, UNIDO has switched its data base to ISIC - Revision 3 for some countries whereas retained the older ISIC - Revision 2 for the remaining countries rendering the construction of longer time series virtually impossible.

6. For all countries in the data set, nominal exchange rates were obtained by dividing the respective GDP in current US$ by the GDP in current local currency. The real exchange rates were obtained by dividing the yearly nominal exchange rates by the corresponding U.S. consumer price index based on 1987=100. The GDPs and the U.S. CPI data were obtained from the World Bank (1997).

7. The scale and composition effects from equation (4) are approximated by the geometric rate of change: $\frac{\Delta X}{X} = \sqrt[s]{\frac{X_{t+s}}{X_t}} - 1 = \exp\frac{1}{s}(\log X_{t+s} - \log X_t) - 1$ where t denotes the first year and t+s the final year of the period under consideration. For details on how to construct and decompose indices see Boyd, Hanson, and Sterner (1988).

8. We tested both models for the presence of heteroskedasticity by performing a battery of Goldfeld-Quandt tests for all possible splits of the data set. Only 11 of the 153 computed Goldfeld-Quant test values were larger than the corresponding critical F-value in the first model, and only 12 out of 151 in the second model, indicating that heteroskedasticity is not a serious problem.