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Environmental Impacts of Changes in Incentive Structures in Formerly Planned Economies

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ABSTRACT

While one of the main agricultural policy objectives of formerly planned economies is the maximization of agricultural output under a variety of domestic and international constraints, the current changes in incentive structures may be having a mitigating impact on environmental degradation. Using the case of Poland, we examine the state of current environmental policy and how it is affected by the process of transition to a market economy.

1. Introduction

The profound changes in formerly planned economies (FPE), including the former Soviet Union, Eastern Europe and some developing countries, are bringing about an economic transition of unprecedented proportions. In the past, these economies were planned in physical terms using normative models and a central decision maker (the state). Resources were centrally allocated and production decisions made by firms were based on an assortment of prescribed plans, within resource and administrative constraints. In the agricultural sector, the closed nature of these economies with the state ownership of the means of production generally gave rise to concentrated, often single-firm or state enterprise industries, and farms that could not compete internationally. The lack of accountability for environmental costs incurred in the production process and state-determined incentives on producing high levels of output meant that the firms seldom had to conform to standards for effluent and other byproduct discharges. Further, they make inefficient use of natural resources as measured by energy per unit value of output (Figure 1 and Roe 1992). In most of these countries, soil and water resources were severely affected by the location and intensity of industrial production and by the large-scale projects of drainage, land reclamation, irrigation, and deforestation.[1]

The transition to market economies creates many uncertainties and introduces important structural adjustments into the economy, particularly as prices are freed from the administrative controls and left to the forces of supply and demand (Csaki 1990). Western economists do not have a good understanding and certainly no simple recipes for designing efficient and equitable transition policies. The transition back from a socialist to a capitalist economy is less well understood than in the other direction. The distortions and inefficiencies created by a command and control economic organization have been the subject of extensive writing (e.g., Kornai 1980, Stuart 1984). The typical transition cases are from undeveloped, feudal, or rural farm economies to a free market economy, which is the subject of a lot of the development literature (e.g., Mexico).

The move from one stable form of economic system, based on administrative allocation of resources, to another one driven by market forces and government policy is by no means obvious: major discontinuities occur and adjustments by economic agents (firms and households) take different forms with varying results in the short and long runs. This is most clearly illustrated recently by firms reacting to the elimination of subsidies and the freeing of prices; most state-owned firms have increased prices while very few tried to cut production costs.

While in transition, the FPEs have an opportunity to design institutions and policies aimed at promoting a sustainable agriculture. The central question we address in this paper is whether the establishment of market-based incentives is a necessary and sufficient condition to realize important gains in environmental quality. First, we review the policy framework facing firms in transition. We then discuss incentive structures and firm and household behavior models in FPE. We use the example of Poland to evaluate the current and potential environmental impacts of the economic transformations taking place, and we conclude with some general observations on the role of environmental policy in the transition.

2. Issues in Environmental Policy in Transition

Pollution, or environmental degradation in general, is explained in western economic theory as "external effects" of production and consumption due to "market failure" or not well-defined "property rights" that impose external costs on society (Baumol and Oates 1988). In the FPEs the intensification of production for economic (meeting consumer demand) and political (inward-oriented development) reasons has exacerbated the environmental impact. Theoretically, in these countries we should expect property rights to be well-defined and clearly distributed because all means of production and environmental resources belong to the state. The equivalent of a market failure in this case could be termed "administration failure," since all market institutions are centrally administered.

In western economies, the theory has it that private decision makers have no incentive to adequately consider environmental social cost elements in their calculations, even if they are aware of them. In FPEs, it appears that the central planning authority, the state, had no incentive to take into account environmental inputs and/or outputs of economic processes, their wider social consequences, and their full translation into costs and benefits. An interesting question is why this "failure," which in a capitalist economy would be attributed to the nonexistence of markets, particularly since it can be argued that the socialist state had as its main objective society's welfare. This leads to an interesting symmetry in the two economic systems between the roles of public institutions and privatization in the generation and internalization of externalities.

An important feature of these economies, as is now becoming apparent, is that while environmental concerns were a societal goal, they were not reflected in the central planner's objective function, which was essentially to maximize physical output. The intensification of production turned out to be a major incentive for firms to use environmental resources freely, resulting in massive environmental degradation. The need to achieve high food production at any cost in Poland and the Ukraine resulted in massive land reclamation programs, drainage of wetlands, forest clearing and altering of river courses. The procurement price system in the former Soviet Union gave an incentive (through bonuses) to state and cooperative farms to farm marginal lands to increase production; this is the typical case of a pricing policy that distorted incentives and brought in land not suited for production and with it negative environmental impacts.

The opening of FPEs to market economics has resulted in the short run in massive unemployment, high inflation, and a fall in real output. In agriculture, the sharp rise in input prices (for energy, chemicals, seeds, and machinery), accompanied by a less rapid increase in commodity prices, has resulted in lower yields and planted areas, declining commodity outputs, worsening of the terms of trade, and a fall in real farm income. Input prices typically rose two to four times faster

than output prices (ERS 1992). In addition, high interest rates and depressed farm income have led to a fall in investment for farm production. Manufacturing plants of agricultural inputs are typically responding by increasing prices to maintain revenues rather than cutting production cost, a trend that should be reversed by privatization. Governments are trying to grapple with the new realities and respond with policies aimed at stabilizing farm income (e.g., intervention purchasing in Poland, price support in the Ukraine) while trying to address the major questions of privatization of state farms and agro-industrial complexes, land development, input and commodity markets, and the realities of international markets.

It is useful to distinguish two phases in the transition: "opening up" and "restructuring." The first phase corresponds with the liberalization of the economy, while the second phase corresponds with the privatization of state firms and the redistribution of property rights.

2.1. Opening Up Phase

The new incentive structures brought about by the opening phase include the freeing of prices, eliminating subsidies in input markets and credit, stabilizing prices (control of domestic output markets), and eliminating trade restrictions. Few of the changes explicitly address environmental uses. If the example of the western free market economies is used as a model for FPEs to emulate, then a number of observations can be made.

First, existing pricing structures are generally not sufficient to bring about a reduction in environmental degradation, particularly for water resources, to levels that could be characterized as "efficient" and "sustainable." Free market economies are grappling with major soil and water quality problems, and market failures are typically the source of the these externalities; Pigouvian taxes (Pigou 1960) and the establishment of appropriate property rights (Coase 1920) constitute the theoretical foundations for devising institutions to help internalize social costs. As a result of responding to the market failures, free market economies are ridden with policy-induced distortions

that affect environmental quality. Finally, for agriculture in the FPEs the short-term fall in input use may have a beneficial impact on water quality and soil conservation, but the impacts will not be lasting and may not even be noticeable, given the accumulated, sometimes irreversible, impacts of solid wastes, heavy metals, acid rain, and salinization.

2.2. Restructuring Phase

We argue that the definition of new property rights will go a long way toward securing important gains in environmental mitigation. When the economy was deregulated, state-owned farms responded to decreasing revenue by increasing prices; in some cases where farms were privately or cooperatively owned and were in better financial shape, revenue enhancement was achieved through savings in production cost and investment in new technologies.

Because of the massive costs necessary for cleanup,[2] environmental mitigation could be achieved through prevention. In agriculture, incentives that promote best management practices, including tillage, rotations, soil testing, conservation practices, contour plowing, terracing, integrated pest management, buffer/filter strips, livestock waste disposal practices, casing of drinking water wells, household waste disposal systems, and education and extension could go a long way to restricting future pollution. These incentives could be in the form of cost-shared voluntary adoption of any of these or other low-cost technologies (CARD 1992). The "Green Lungs of Poland" program is another example where entire areas previously not damaged by pollution are being protected and promoted for "ecological farming." The success of engaging in a program designed to facilitate restructuring with enhanced environmental quality depends on understanding the institutional transitions required for fostering appropriate outputs.

In industry, a combination of command and control approaches[3] with financial incentives like credit subsidies could, in the long run, bring pollution to levels similar to those in Western Europe and the United States. The cost of direct regulation could be balanced against the cost of subsidies to

find the optimal mix of instruments. But the basic idea is that technology standards may be more appropriate in cases where specific technologies are known to lead to substantial emission reductions, particularly in high risk areas. On the other hand, performance standards will give firms the choice to adopt least-cost abatement technologies and induce innovation; they may also help weed out a large number of inefficient firms. In either case, standards will have to be phased in over a long period of time, given the obsolete state of the production technologies in place, particularly in the industrial sector. It can be argued that society would suffer greater welfare losses if standards are required to go into effect in a short period of time. Financial incentives could be as taxes on inputs, outputs, or emissions and subsidies to promote less polluting technologies and resource conservation.

3. Incentive Structures in an FPE

The environmental incentives facing state-owned firms under state planning are determined by two important factors, the production objectives and the system of standards and fines, both set by the central planner. Given an assortment of targets, constraints on input and resource availability, and the wage, management, and price systems, the maximization of physical output provides clear incentive for firms to achieve these objectives at any (external) cost. In addition, the combination of a system of "high standards" (higher than in the West in many cases) for water and air quality (Hughes 1992) and "low fines," typically planned and budgeted in advance by firms, created the incentive of "pollute first and then pay." In effect, the central planner exogenously priced resource very cheaply, with no relation to their true scarcity, and subsidized firms to cover the fines, thus exacerbating the degradation impacts. More important, this meant that at best firms equated marginal cost of abatement to the fine rate, and it is a failure of the central planner to properly reflect the marginal damage to society into the fine system.

It is no surprise that many studies of socialized agriculture by western economists (e.g., Hayami and Ruttan 1971; Koopman 1989) found no compelling evidence of static technical and allocative

inefficiency in production compared to the West. Technical (static) efficiency is independent of input and output prices and is a reflection of the internal organization and incentives for efficient operation of socialized farm units. In contrast, these studies conclude that it is the effects of agricultural policies and the administrative distribution of inputs that produce economic inefficiencies (many farms operated at a loss and did not equate prices and marginal cost and the value of marginal product). However, without accounting for the effects of intensity of resource use and pollution output, such measures of efficiency distort the measures of economic product. This, of course, is not explicitly accounted for in market economies either (see Bartelmus 1989; Cabe and Johnson 1990). Transition policies need to address these considerations explicitly.

4. Firm and Household Behavior in Transition

Under central planning, highly subsidized prices, low quality of goods, and shortages of certain foods combined with the opportunity cost of waiting in lines, gave the impression of constant food shortages. In fact, per capita caloric intake in Central Europe and the USSR was very similar to Western Europe (Von Witzke and Senauer 1992). With economic reforms, real household incomes have significantly declined, and food prices have risen sharply with the removal of consumer food subsidies. The slower increase in real incomes and changes in relative prices are likely to lead to reduced consumption of nonstaple foods, and reduced demand for goods and services whose prices are rising relatively faster and whose demand is more income elastic. The aggregate effects are likely to be complex. We suggest a few changes that will have greater effects on the environment.

For foods, there is likely to be a shift away from consumption of meats (Jensen 1992). Artificially low prices for livestock products have maintained relatively high levels of consumption of meat and dairy products. Changes in the composition of food demand, at least in the short run, are likely to reduce relative environmental impacts from livestock production.

The demand for other environmental goods (recreation, vacation-related amenities) is generally considered income elastic, and hence is likely to decrease with declines in real incomes. Lower incomes reduce consumers' ability to pay for many environmentally-related goods and services.

Slowly rising incomes are an impediment (or a disincentive) to individuals to at least partially compensate for the effects of environmental degradation that are directly linked to individual consumption (unhealthy residues, contaminated drinking water, disposal of household wastes, indoor air pollution, health care, etc.). Faced with the choice of paying higher costs for goods and services, consumers are unlikely to place pressure on local and federal governments to pursue policies that seek to mitigate the ill-health effects from the production and consumption of ozone depleting gases, sulfur dioxide, and particulate matter suspension, and the toxic effects of effluent discharges of industrial processes. This pressure on local and national governments may come, instead, only through international lending organizations, standards imposed by trading partners, and donors of assistance.

5. The Case of Poland

Poland is of particular interest because it opted for a "shock therapy" transition by moving into the opening up phase immediately (since 1989/90) and not gradually as many other FPEs are doing. Prices were completely freed, subsidies removed, and the Polish currency (Zloty) made totally convertible at market-determined exchange rates. It is therefore one of the few countries where some data are becoming available after three years of transition. In addition, the restructuring phase has also been initiated by putting in place a process of privatizing state enterprises.[4]

In 1990 (Central Statistics Office 1992), Poland had a population of 38.2 million (38 percent rural, 62 percent urban) distributed in 49 Vovoidships (provinces) and living on 323,000 km^2. Annual rainfall ranged between 500 mm and 1,000 mm with an average close to 600 mm. Total employment in the economy was 16.5 million with 26.8 percent in agriculture. Agriculture's share of

Total Net Material Product (GDP) was equal to 15.1 percent. Total planted land to agriculture was 14.2 million hectares and total forest area was 8.7 million hectares. Figure 2 clearly shows the decline in economic activity since the reforms started, and compares the Polish situation to other Central European countries. By 1990, Poland's Consumer Price Index was 35,748 and the Index of Average Monthly Nominal Wage was 42,198 suggesting that on average, wages may have kept up with the price increases.

5.1. The Structure of Polish Agriculture

Polish agriculture is characterized by two types of firms. One involves relatively small farms (3 to 25 hectares with an average of 6 hectares) with mixed enterprises, family owned and operated and comprising close to 80 percent of all agricultural land. The second involves state and collective farms with about 19 percent of the land (about 3.5 million hectares). Table 1 gives the general structure of agricultural production and the associated yields.

With the launching of the economic transformation program in January 1990, Polish farmers experienced a rapid transition from a heavily subsidized agriculture to one devoid of internal supports and offering little protection against international competition (U.S. Embassy-Warsaw 1992).

The first important economic impacts of the transition in Poland are clear in the worsening of the terms of trade since 1989 (Table 2).

Production of most agricultural commodities is projected to decline in 1992/93. Area planted is down and yields are projected to fall due to lower input use and to drought conditions. Beef and dairy output are also expected to decline. Processing industries (mostly state-owned) are in some financial difficulty and unable to reliably obtain agricultural input products. This is expected to result in higher imports of processed foods, except for the meat processing industry (ERS 1992).

The precipitous fall in real agricultural prices and the deterioration of the financial situation, particularly of the 2,000 state farms, have prompted the introduction of some measures to protect

domestic production (agricultural duties went from 8 percent to 18 percent) and to support farm income. To dampen the free fall of farm income, preferential credits have been provided by the government to purchase fertilizer, pesticides, seeds, breeding animals, land, investment in land, and food production using "ecological methods." In 1990, the Agency for Agricultural Market (ARR) was created to conduct intervention by purchasing (grain, milk, beef, and sugar) credit guarantees and minimum prices.

5.2. Agricultural Inputs

Removing price controls and reducing state subsidies has changed relative prices between inputs and outputs and has led to the fall in production levels and restructuring of agricultural production. Between 1988 and 1991, fertilizer prices increased 50 to 100 times but crop prices rose much more modestly (ERS 1992). Using the example of phosphate and selected agricultural commodities, Table 3 gives changes in relative prices that occurred between 1988 and 1991.

As a result of increased prices, the aggregate use of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) fertilizers went from 3.9 million tons to less than 2 million tons during the same period. The change is clearly reflected in application rates (average kilograms per hectare of N,P, K) as presented in Tables 4 and 5. And, as with fertilizers, pesticide use sharply decreased due to a 22-fold increase in prices in 1990; pesticide prices increased faster than crop prices. Table 6 summarizes the change in the price of the pesticide afalon relative to important commodities, and shows the decrease in application rates between 1989 and 1991; overall, active ingredient use declined 72 percent over the same period.

Other input prices have also increased. For example, machinery prices increased 3 to 5 times faster relative to livestock and crop prices; tractor prices increased by a factor of 20 to 40. The price of coal increased 160-fold; and the price of diesel fuel increased 67-fold between 1988 and 1992.

5.3. Resources and the Environment

Poland has accumulated very severe pollution problems due primarily to high coal use, old technology, and low energy prices. The average consumption of coal per person in Poland was almost 900 kilograms of coal-equivalent for 1989, compared with less than 50 kilograms of coal-equivalent for the European Community. In addition, energy prices (using an average index) were 60 percent lower in Poland than in the European Community (Hughes 1992).

The environmental damage in Poland stems in large part from the concentration of sources in some of the most populated regions. For example, 50 percent of airborne pollution originates from 15 percent of the total areas in south and southwest Poland; in these areas the maximum 24-hour ambient concentration of black smoke exceeds the European Community standard more than six-fold. The Katowice Province has 12 percent of the Polish population and is responsible for about one-fifth of all soot and dust and more than one-third of solid waste; just three mines producing 10 percent of coal output are responsible for 20 percent of the 30 million cubic meters of saline water and brine discharged daily as a byproduct from coal mining, rendering most of the main rivers, the Vistula and the Odra, too corrosive even for industrial consumption (World Bank 1992). Heavy concentration of industry and power plants in a few provinces (especially near the headwaters of the Vistula and Odra) and a number of major cities is responsible for further water pollution. River self-purification is low because of the flatness of the terrain and the slow flow stream (Hughes 1992).

Water Resources. Sources of water pollution include industrial enterprises and municipal sewage in urban areas, agricultural runoff and sewage in rural areas. More than a third of sewage in Poland continues to be discharged without any treatment and for another third, there is only primary (mechanical) treatment. It is estimated that 40 percent of rivers are polluted by physical-chemical elements and that 78 percent of rivers are polluted with biological elements (coliform count and sanitary conditions). Out of 39 major lakes, 23 are classified as over-polluted by Polish standards

(Central Statistics Office, Warsaw 1992). An estimated 33 percent of sewage flows into surface waters (rivers and lakes).

In the village, the backbone of Polish agriculture, water quality is rated very low in 20 percent of household water supply systems, 48 percent of common wells, and 66 percent of home wells. This results in 50 percent of the village population being adversely affected by nitro-compounds and bacteria. In addition, it is estimated that between 1987 and 1989 only 29 percent of villages had active water supply networks, 5.3 percent had sewage systems, and 2 percent had water purification plants (Central Statistic Office, Warsaw 1992). It is also estimated that about 11 percent of the country area inhabited by about 35 percent of Polish population is in the ecological hazard category. Overall, an estimated 65 percent of Polish surface waters are considered to be unfit even for industrial use (Table 7); this highlights the need for immediate water conservation policies to reverse the current degradation trends. In the long run, the policy focus would then shift to best management practices, education, and institution building.

Soil Resources. Two important categories of soils can be found in Poland: podzodic, or brown earth, comprising 82 percent of total agricultural land, and clay and organic soil comprising 9 percent of total agricultural land. In addition, sandy soils are generally in areas with high water tables. Poland has adopted a classification of land by value class similar to the one used by the U.S. Soil Conservation Service (Table 8). A large amount of land is threatened by water erosion. Estimates of agricultural land threatened by erosion are summarized in Table 9 (Central Statistics Office, Warsaw 1992).

5.4. Environmental Policy

The government of Poland is moving aggressively on pollution. On November 19, 1990, the Economic Committee of the Polish Council of Ministers (U.S. Embassy Warsaw 1992) approved a National Environmental Policy. It is the first of its kind to be issued in the countries of Eastern

Europe now undergoing economic transformation. The short-term goals of the policy are: (1) closing or restricting the 80 worst enterprises in Poland and an additional 500 plants to be identified by the Vovoidships (provinces), (2) increasing the size of the coal washing program; (3) improving drinking water supplies for urban areas; (4) cleaning up the Baltic Sea shore; (5) preventing extreme air pollution in large urban areas through use of low sulfur fuels, and changing automobile traffic planning; (6) introducing more stringent motor vehicle standards; (7) improving environmental collaboration with neighboring states; (8) constructing regional centers to handle toxic and hazardous wastes; (9) establishing a food certification system and implementing food quality standards; and (10) implementing an intensive afforestation program (World Bank 1992).

Experts qualify the plan as ambitious and too costly to be successful. A recent World Bank report (1992) recommends that since cleanup of hazardous waste and other forms of liquid and solid waste is extremely expensive, only immediate risk to human health sites should be considered for cleaning and that attention should be given to mitigating ongoing pollution and preventing future pollution. Indeed, the cost of the proposed policy in Poland is estimated at U.S. $200 billion over the next 25 to 30 years. Pollution abatement will cost over U.S. $70 billion (excluding industrial and energy restructuring), 75 percent of which is earmarked for water protection and 15 percent for air quality management.

By 1991, about 1.25 percent of national income went to environmental expenditures, more than double any previous year. Out of the total capital investment, 48.3 percent was earmarked for water protection, 20.8 percent for soil protection, and 30.6 percent for air protection. However, such investment in environment-related expenditures is not likely to be sustained. And changes in allocation of resources toward practices with lower environmental costs are coming about through specific punitive regulatory measures. The total amount of fines and retribution for environmental contamination covered less than 7 percent of investment. Reduced industrial and agricultural

production since 1989 has been accompanied by reduced pollution emissions: air pollution emissions may have decreased 15 to 20 percent since 1989, and industrial emissions of water pollution may have fallen by about 30 percent (World Bank 1992).

Water pollution could be improved drastically by improved water allocation through pricing and institutional arrangements. The lack of effective regulations and lack of physical infrastructure to improve water quality (e.g., sewage and water treatment plants) suggest major changes and investment required to protect water quality. Institutional arrangements to guide appropriate decisions, such as assignments of property rights consistent with the established environmental goals, will be necessary.

In the short- and medium runs, taking the example of energy and water, the elimination of subsidies and establishment of free markets will not bring about equalization of "marginal benefits" (to firms) and "marginal damages" (to society). Given the obsolete technology in place, firms, particularly state-owned ones, will adjust by raising prices and passing the effect on to consumers and there will be only marginal impacts on the environment.

Technological rigidities (obsolete, inefficient) are such that firms cannot immediately adjust and will simply transfer the cost to society. In other words, the firms in FPEs cannot adjust marginally like a capitalist firm would, by continually improving technology and cutting cost, but will need to adjust structurally, by privatizing, reorganizing production, and investing in new technology, among other things, in order to reduce the social cost of environmental damage from agricultural and other economic production.

6. Conclusion

The transition process in FDEs is characterized by two qualitatively different phases, opening up and restructuring. Phase one is characterized by rapid changes as prices are liberated, price controls and subsidies are removed, markets are allowed to function and determine the levels of prices and

quantities, currencies are made convertible at exchange rates that are determined by market forces, and trade is liberalized with the removal of the state monopoly on international commerce, and the removal and/or adjustment of tariffs and barriers. The environmental impacts of this phase are mixed. On the firms' side, the combined effect of sharp increases in input prices, competitive international markets, and obsolete technologies results in most cases in lower production levels and consequently lower pollution levels (Figure 2). Reductions in industrial pollution occur as the result of the freeing (increasing) of energy prices. Another example is the drastic reduction of fertilizer and pesticides in agricultural production. A third example is the impact of freer trade on export goods required to conform to technical standards. This opening up phase is having the effect of a tax on output aimed at abating pollution by lowering output levels. However, these short-term reductions in pollution levels will not be sustained with future growth in production and will most likely have no impact on the cumulative damages already in place. Consumers also respond to the incentive structures associated with the opening up phase through a tighter budget constraint and reduce consumption of certain environmental goods considered to be luxuries.

Phase two is characterized by slower and more fundamental changes, as the large, inefficient state-owned enterprises are restructured and privatized, as property rights are distributed and related institutions (banking, legal, etc.) are created to support the proper functioning of free markets. The environmental impacts of this phase could be more lasting and should bring FPEs to levels comparable to the Western economies in the long run. This environmental adjustment period could be shortened considerably if lessons learned in the West and policy instruments found to perform successfully are utilized effectively and implemented in new environmental policies (e.g., in Poland and Hungary). According to a recent OECD study (French 1991), trends are manifesting themselves in the West and appear to mark successful environmental policies: (1) deregulations that move

toward reduced direct government intervention in society; (2) a trend toward policy intervention, both within the environmental policy field as well as between traditionally separated policy fields; and (3) gradual transition from curative to preventive environmental policies. However, even if successful, restructuring will not be sufficient for halting environmental degradation because free markets will still fail to price resources according to their true scarcity.

Externalities are the trademark of a capitalist economy. One challenge faced by FPEs, which could also be a blessing, is to create innovative approaches to resolve market failures from the outset by building institutions to establish, clarify, and completely assign property rights to privatizing state-owned firms.

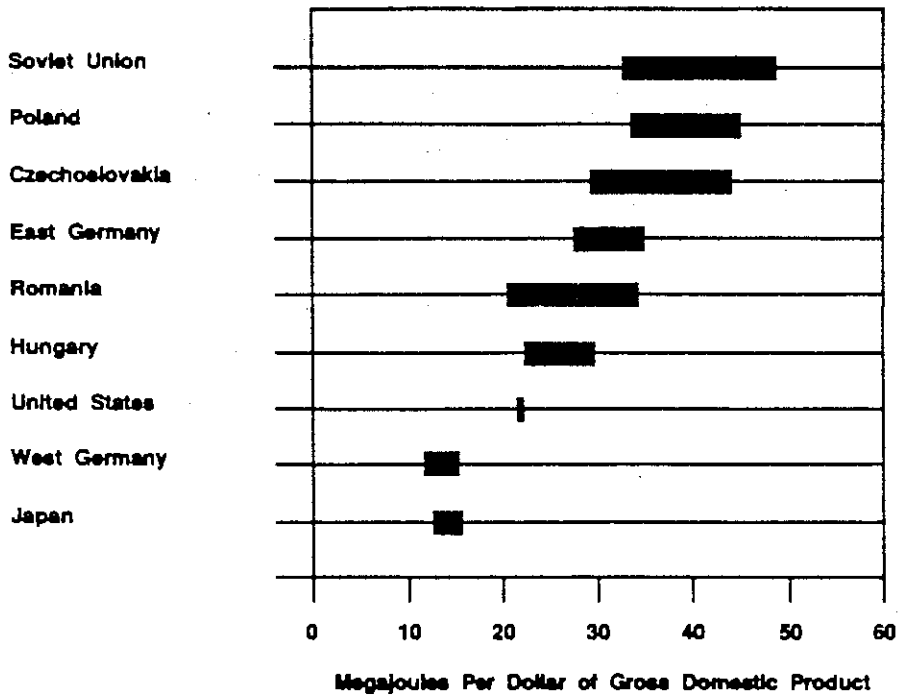

Figure 1. Estimated energy intensity in selected countries, 1985

SOURCE: French 1991.

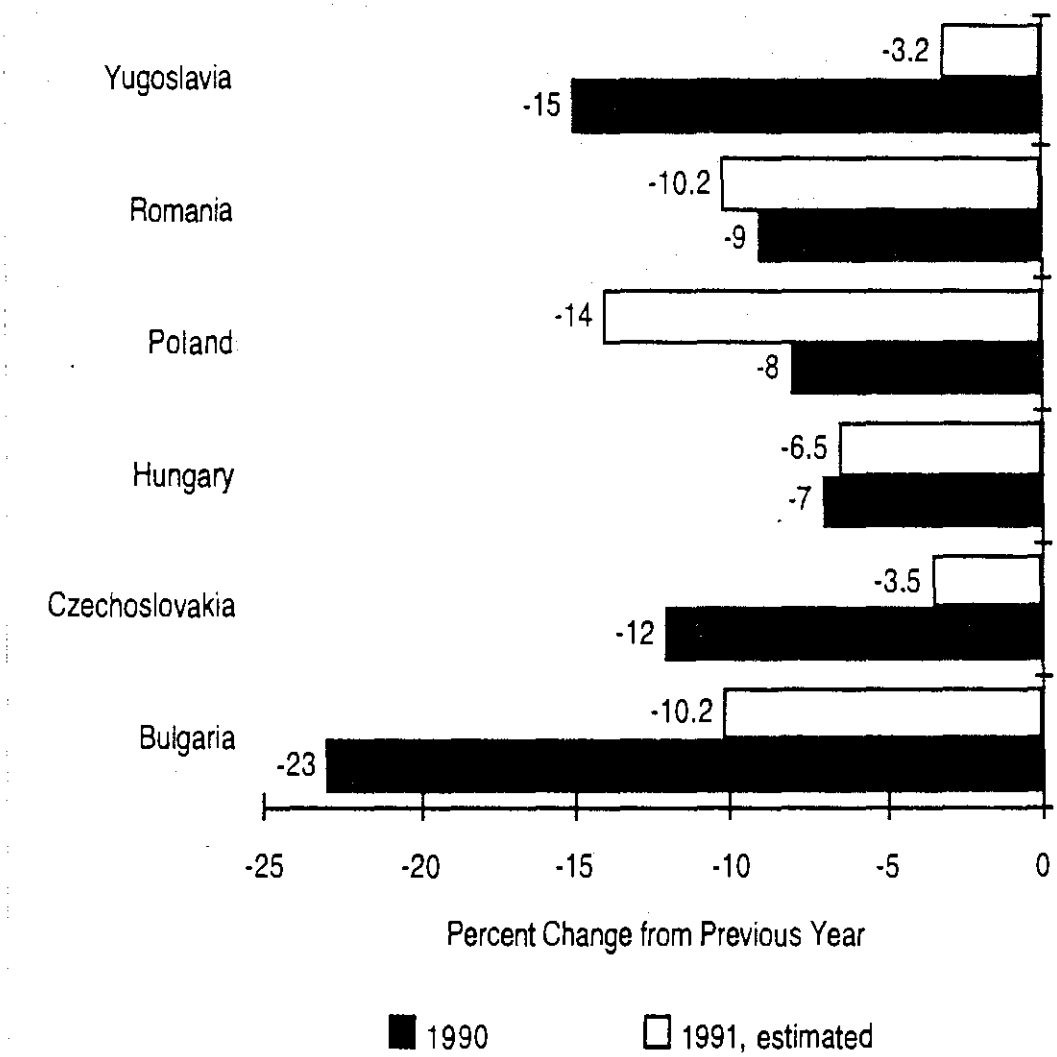

Figure 2. Change in GDP growth in Central Europe

SOURCE: Roe 1992.

Table 1. Structure of agricultural production in Poland (1990)

	Production	Yield
	(million tons)	(mt/ha)
Basic cereals[a]	24.1	3.32
Wheat	9.0	3.96
Rye	6.1	2.62
Potatoes	36.3	19.8
Sugar beets	16.7	38.0

[a]Include wheat, rye, barley, oats, triticale.

Table 2. Terms of trade

Economic variable	1990	1991	1992
Input prices	+900%	+78%	
Output prices	+400%	+30%	
Real farm income	-50%	-8%	
Real wages of the general population	-24%	+1.5%	
Outlays for farm production	-30%	-17%	
Average land prices (million zlts/ha)	4.4	7.7	
Ratio of farm debt to final production			17% overall 62% state farms 7% private farms
Interest rates			46-55%

Table 3. Changes in relative agricultural prices in Poland

	Change in ratio from 1988 to 1991
Phosphate/wheat	1.0 to 5.0
Phosphate/rye	1.4 to 8.3
Phosphate/potatoes	2.8 to 12.1

Table 4. Changes in fertilizer application rates in Poland

	77-79	87-89	1988	1991	1992 (forecast)
			(kg/ha)		
N+P+K	244	224	176.4	95.1	60-70
Calcium[a]			202	139	

[a]Calcium is used to treat acidic soils.

Table 5. Polish fertilizer consumption in nutrient value

	Farms			
Year	State	Cooperative	Private	Total
		Pure ingredient per kilograms per hectare		
1987/88	274	261	155	182
1988/89	291	280	168	196
1989/90	258	257	136	164

Table 6. Relative prices and use of pesticides

	1989	1991
Afalon[a]/wheat	0.3	1.3
Afalon/rye	0.4	2.2
Afalon/potatoes	0.4	3.2
Price of afalon (zlts per kg)	3,675 ($ .30)	126,000 ($ 9.30)
Active ingredient use (kg/ha)	1.62	0.44

[a]Afalon is a herbicide used in field crops and vegetables.

Table 7. Water purity in Polish rivers

	1967	1977	1983	1987	1991
	Percent of total length monitored				
Class I[a]	31	10	7	5	--
Class II[b]	26	30	28	27	--
Class III[c]	14	27	29	26	--
Beyond classes[d]	29	33	36	42	65

[a]Suitable for use in municipal water supply.
[b]For animal consumption, agriculture, and recreational uses.
[c]Industrial use.
[d]Unfit for industrial use.
Approximately 15,000 km monitored.
980 km of Vistula's 1,047 km have no I and II.

SOURCE: Compiled from USEPA 1990 and French 1991.

Table 8. Agricultural land classification

		Classes					
	Total	I	II	III	IV	V	VI
	(million hectares)	percent					
Arable land and orchards	14.7	.4	3.3	24.9	39.1	20.3	12.0
Permanent grassland	4.1	0	1.5	13.5	42.5	31.3	11.3
Total	18.8	.4	2.9	22.3	39.8	27.7	11.9

Note: Class I is highest agricultural value.

Table 9. Agricultural and forestland threatened by erosion

			Erosion intensity risk as percentage of total threatened area		
	Million hectares	Percentage of total	Low	Moderate	High
Wind	8.8	28.2	61.6	34.8	3.6
Water erosion					
Sheet	8.7	27.9	48.7	38.7	12.6
Gully	5.7	18.2	2.4	82.3	15.3

ENDNOTES

1. Some accounts estimate that, in the former Soviet Union, 150 million hectares (about two-thirds of arable land) has lost fertility because of wind and water erosion. About 12 percent of irrigated farmland is contaminated with salt compounds due to poor drainage systems. Production losses attributable to soil erosion in the former Soviet Union were estimated to be about $30 billion annually. Also, in the former Soviet Union, the largest body of fresh water in the world, Lake Baikal (which contains 80 percent of the country's fresh water supplies), and the Aral Sea, one of the largest inland body of waters in the world, have been severely degraded by industrial and agricultural practices (French 1991). In Romania, the livestock production complexes (some of which contain as many as 300,000 pigs, 20,000 cattle, and more than one million chickens) discharge an estimated 125 million cubic meters of wastewater per year, about equivalent to the volume of domestic wastewater expected to be discharged from a U.S. city with a population of one million. It is estimated that less than 5 percent of these complexes meet effluent standards for BOD and two out of five wells in Romania have a concentration of nitrates exceeding the allowable standards (Wolf 1992).

2. For example, in the former Soviet Union, it is estimated that 20 to 30 percent of Gross Domestic Product will need to be committed for the next 20 to 30 years to cleanup the environment (French 1991, World Bank 1992).

3. For example, technology standards require implementation of specific abatement practices and performance standards are aimed at reducing emissions to specified levels.

4. This is being done in two ways (ERS 1992): the liquidation and sale of assets; or the transformation into a one-person company of the state treasury, followed by sale of shares to interested domestic or foreign buyers.

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