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EXECUTIVE SUMMARY

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This project examines the impact of agricultural policies in Poland on the performance of private and socialized producers. These two groups exhibit different patterns of productivity growth: labor productivity growth is higher on private farms and land productivity growth is higher on socialized farms. In studying how agricultural policies influenced these two groups, this project has produced two main sets of conclusions. The first evaluates past and potential future agricultural policies in Poland and the second expresses the technical bases of policy analysis. The main implications of this study for policy evaluation are:

1. Investment policies have provided a smaller share of total investment resources to agriculture than that sector's contribution to national product over the entire postwar period. As agriculture's share in total output has fallen throughout these years, this gap has narrowed. Since the mid-1950's, private producers have received less favorable access to investment resources than have socialized producers.
2. Price policies have caused reductions in the agricultural efficiency of both socialized and private farmers. In the social sector, this resulted from the large subsidies necessitated by the political decision to maintain low consumer food prices. This subsidization established the dominance of bureaucratic forces in determining the allocation of inputs and output on socialized farms, which in turn has led to significant dynamic inefficiencies in the utilization of new technologies. For private producers, the principal institutional problem has been a lack of certainty about their future and the changing and often unpredictable effects of price and taxation policies.
3. A large outflow of labor from the private sector has occurred as part of the overall economic development of Poland. This has been accelerated by the relatively unfavorable price and investment policies for that sector, which also caused the outmigration to contain a disproportionate number of prime-age males. The subsequent aging and feminization of the private agricultural labor force poses significant problems for the long-term improvement of private agricultural production.
4. The primary technological constraints on Polish agriculture have been the inefficient use of available technology on socialized farms and the general lack of availability of new technology for private

farmers. Thus, policy changes which could remove technological limitations on improved agricultural performance differ between the two sectors. For the social sector, policies for rationalizing prices and introducing greater reliance on prices and profitability in making allocation decisions are required in order to utilize currently available technology more effectively. For the private sector, increased access to investment resources and a more stable and supportive policy environment are required.

5. Without changes in policy which promote the efficient use of resources in the social sector and assure a stable environment with positive incentives for private producers, Polish agriculture will remain a problem sector. If such policy changes are made, agricultural production and productivity could increase without significant increases in resources devoted to this sector; this would aid the Polish economy as a whole by contributing to Poland's hard currency earnings. While the potential benefits from such changes are great, it is unlikely that they will be pursued actively and effectively until the magnitude of the problem created by agriculture is recognized to be larger than it is currently thought to be.

The technical conclusions on which the above policy analysis is based, derived from estimated aggregate production functions for the private and social sectors, are:

1. Differentiated agricultural policies had an unintended negative impact on the rate of technological change in Polish agriculture (especially before 1975). Large negative rates of growth of technological change for socialized producers indicate that the new technologies and other resources which were being channelled into that sector were not being used effectively. The better performance of the private sector in this area, despite a general neglect of the needs of this group of producers, indicates that improved agricultural performance could be attained through policies designed to meet the needs of private farmers.
2. By several measures of relative efficiency, the private sector appears to show greater static efficiency and to have been more adept at adopting technology to produce dynamic efficiency (or at least to retard the effects of policies designed to hamper private production). Again, this implies that increased attention to private sector production is essential for the long-term health of Polish agriculture.
3. The social sector shows increasing returns to scale. These indicate that this sector has developed by means of techniques capable of generating large increases in growth through more effective use of large-scale technologies. If policies were adopted to promote this process (rather than to hamper it, as in the past), even greater gains in productivity could be obtained from socialized producers.

These findings were developed from an analysis of Polish agriculture which combines an evaluation of the qualitative factors involved in formulating and implementing agricultural policies with quantitative

estimation of sectoral aggregate production functions. This analysis begins with a description of agricultural price, investment and tax policies from 1956 to 1982. In 1956 widespread collectivization was abandoned in order to establish a two-sector agriculture with a significant number of private producers. From 1956 to 1960, agricultural policies which were more favorable to socialized producers were introduced; this established a bias which has been maintained to the present. The period from 1960 to 1982 (the years covered by the data of this study) can be divided into four subperiods based on agricultural policies: 1960 to 1969 - the 2nd and 3rd Five Year Plans (FYP), covering the Gomulka regime; 1970 to 1974 - the 4th FYP and the early years of the Gierek regime; 1975 to 1979 - the 5th FYP and the late Gierek regime; and 1980 to 1982 - the period of Solidarity and the beginning of martial law.

The first period (1960-1969) was characterized by policies designed to promote industry at the expense of agriculture. Within this generally negative environment, price, investment and tax policies were more favorable to socialized producers. In the second period (1970-1974), policy-makers recognized the need to improve conditions for agriculture as a whole and private farmers in particular and policies in line with these goals were implemented. In the third period (1975-1979) the decline in agricultural production put increasing pressure on the government to meet its goal of improving the quality of the Polish diet. In this period there was a return to the bias in favor of socialized producers and this exacerbated conditions for private producers. During the final period examined in this study (1980-1982), policy-makers recognized the need to promote private production (in response to the demands of Rural Solidarity) and initial, tentative steps were taken to improve conditions for private farmers.

To evaluate the impact of these policies and other factors on the relative performance of private and socialized producers, aggregate sectoral production functions were estimated. These incorporate the effects of policies and regional environments through their impact on technological change and consider the direct effects of five inputs (labor, land, livestock, machinery and fertilizer) and their growth on performance. The data used in this study identified sectors (private and social), regions (17 political subdivisions from 1960 to 1974 and 49 from 1975 to 1982) and years for each of the inputs and output. This combination of regional, sectoral and temporal variation (producing 1,294 observations for each variable), permitted quantification of the effects of environment, policy and organization on performance.

This study leads to the conclusion that the agricultural policies pursued by the Polish government have had a significant, and in some respects negative, effect on agricultural performance. Private producers have been more efficient than socialized producers, despite unfavorable policy treatment. Socialized producers have been inefficient in their utilization of large-scale technologies, which could

have been used to increase production and productivity. This indicates that the Polish government must adopt policies to improve conditions for private producers and to impose effective discipline on the economic behavior of socialized producers if it desires to promote agricultural efficiency. In the past, the government has not shown the ability or desire to make such changes. Although developments in the last few years seemed to indicate that Polish policy-makers might be willing to attempt such changes, the Catholic Church's recent abandonment of its attempt to establish a fund to channel investment resources to private farmers suggests that the prospects for change and improvement are not bright.

I. Summary and Introduction

This study examines the effects of different policies and regional environments on private and socialized producers in Polish agriculture[1] in order to evaluate the causes of differential performance between these two groups and the range of policy options available to the Polish government in dealing with agriculture. The policy issues I address are: (i) what is the allocation of resources to and within agriculture and how does this affect performance? (ii) what institutional, technological and demographic factors constrain the ability of Polish agriculture to improve its performance? (iii) what are the principle strengths and weaknesses of the agricultural sector in Poland? and (iv) what are the implications of these factors for the long-term and short-term development of Polish agricultural policy and performance (including how current policies might be altered to improve performance) and for the development of the Polish economy as a whole?

The results of this study may be summarized as follows:

1. In general, agriculture received a smaller share of total investment resources than its share of total output, although investment shares rose significantly in the early 1970's. Between 1956 and 1982 more favorable access to investment resources was given to socialized producers.
2. The effect of price policies on socialized and private

farmers has been to reduce agricultural efficiency. In the social sector, this is due to the large subsidies entailed by the decision to maintain low consumer food prices for political reasons. This established the primacy of bureaucratic forces in determining the allocation of inputs and output on socialized farms, which in turn has led to significant dynamic inefficiencies in the utilization of new technology. For private producers, the principal institutional problem has been a lack of certainty surrounding their future and the changing (and often unpredictable) effects of price and taxation policies.

3. The large outflow of labor from the private sector (which is necessary for the overall development of the economy) was accelerated by the relatively unfavorable price and investment policies for that sector which also caused this outmigration to contain a disproportionate number of prime age males. The subsequent aging and feminization of the private agricultural labor force poses significant problems for the long-term improvement of private agricultural production.

4. The primary technological constraints on Polish agriculture have been the inefficient use of available technology on socialized farms and the general lack of availability of new technology for private farmers. Thus, the policy changes required to remove technological limitations on

improved agricultural performance differ between the two sectors. For the social sector, policies such as the rationalization of prices and a greater reliance on prices and profitability in making allocation decisions are required in order to utilize currently available technology more effectively. For the private sector, greater access to investment resources and a more stable and supportive policy environment are required.

5. Without changes in policy to promote more efficient use of resources in the social sector and to assure a stable environment with positive incentives for private producers, Polish agriculture will remain a problem sector. If such policy changes are made, agricultural production and productivity could increase without significant increases in resources used; this would aid the Polish economy as a whole by contributing to Poland's hard currency earnings. While the potential benefits of these changes are great, it is unlikely that they will be actively and effectively pursued until the magnitude of the problem created by agriculture is recognized to be greater than it is currently thought to be.

Before World War II, agriculture was the predominant economic activity of the Polish population.[2] Postwar economic development led to a relative rise of industrial and service production, but agriculture remains a key sector for determining the overall health of the Polish

economy. The declining relative importance of agriculture can be seen from census data which show a steady drop in the percentage of the population with its principal source of maintenance in agriculture: from 67% in 1950 to 58% in 1960, 30% in 1970 and 23% in 1978. The share of agricultural income in total national income has fallen from 52% in 1950 to 34% in 1960, 21% in 1970 and 13% in 1978 (Concise Statistical Yearbook of Poland, 1982, XX-XXI). Nevertheless, agriculture remains significant because of its connections to other domestic sectors (in both supply and demand) and because of its historic role as an earner of hard currency through food exports. Recent events in Poland have emphasized the connection between a healthy agriculture and a healthy economy. Major causes of the difficulties of the Polish economy in the late 1970's were policy-induced dislocations of agricultural resource allocation and production. This report examines agricultural policy in the 1960's, 1970's and early 1980's in order to understand the link between these policies and agricultural performance. Particular attention is paid to the differences in the policy treatment and performance of socialized and private farms.

The fundamental question of relative sectoral performance addressed by this study is: what factors have led to differences in relative sectoral rates of growth of labor and land productivity? Data on gross output and five inputs (labor, land, livestock, machinery and fertilizer)[3] were collected separately for private and socialized producers for each of the political subdivisions of the country from 1960 to 1982. Given two sectors, 17 regions from 1960 to 1974 and 49 regions from 1975 to 1982 (see Appendix C) and 23 years, each variable has 1,294

observations with significant regional and temporal variation. These data were then used to estimate sectoral aggregate production functions which control for temporal variation in agricultural policies and regional environmental effects as well as for the effects of different organizational structures. Section II describes the basis for identifying different policy subperiods. Section III presents the basic data on differences in sectoral productivities and productivity growth rates and discusses regional variation in these patterns. Section IV presents the production function estimation procedure and its results and section V discusses the implications of this study for evaluating past and potential future agricultural policies in Poland.

II. The Evolution of Institutions and Policy

Polish agricultural policy has a deep, pragmatically-based commitment to the continued existence of a large number of private producers. At the same time, the government has pursued policies which seek to promote the long-term socialization of agriculture. These two commitments, the pragmatic and the ideal, have often been in conflcit in the formulation of policy. However, the following conclusions can be stated:

1. During the First Five Year Plan (FYP) (1956-1960), the two-sector agricultural system was put in place with an initial bias in price, investment and tax policies in favor of socialized farms.

2. During the 1960's (the Second and Third FYPs), policy-makers recognized the need to improve the flow of resources to agriculture as a whole (to private as well as socialized producers), but policies continued to discriminate against the private sector.
3. During the early 1970's (the Fourth FYP), there was a shift in policy to promote private production. Although the changes in price and taxation policies in particular were somewhat successful, in the late 1970's (the Fifth FYP) there was a retreat to former biases in favor of socialized producers as production growth faltered.
4. At the end of the 1970's and in the early 1980's, agricultural policy-makers recognized the need to strengthen commitments to private production for the long-term health of both Polish agriculture and the Polish economy as a whole and they have begun to take tentative steps in that direction.

Development of a two-sector (private/social) agriculture in Poland began at the end of World War II. Government policies in the immediate postwar period (1945-1949) redistributed land and resettled peasants. The major areas of land confiscation and resettlement were the formerly German territories of the North and West.[4] These lands were resettled with internal migrants and were formed into large-scale farms. The remainder of Polish agricultural land remained in its former state of small holdings. From 1950 to 1956, there was a shift in policy to

promote the formation of agricultural cooperatives in order to exploit the possibilities of large-scale production. These years were marked by an attempt to pursue collectivization in the manner of the Stalinist model of "forced collectivization". However, as did most of Eastern Europe, Poland faced a different set of constraints than the Soviet Union, and the outcome was quite different. In particular, there was virtually no scope for extensive growth of agriculture (growth generated by increasing all inputs to agriculture). This entailed a need for intensive growth through increased mechanization and use of other technology, with a decrease in agricultural labor. Collectivization involved the formation (often involuntarily) of a large number of agricultural cooperatives in which technologically advanced inputs (but not land) were shared; the cooperatives were collectively responsible for meeting plan obligations and income was shared within them. This led to the formation of a large number of collectives, many having little real impact on agricultural organization, except to reduce incentives for producers. In areas of large-scale resettlement (primarily on the confiscated German lands of the North and West), the collectives were sufficiently large and their organizational structures such as to permit increased production through the introduction of large-scale farming methods. In most of the rest of the country, collectivization in this period did not alter the fundamental link between individual farmers and their land. Although they received targets and quotas from the collective, had to deliver much of their output to the collective and had their income largely determined by the collective, peasant farmers

continued to work what had traditionally been their lands.

The combination of decreased production incentives inherent in this type of collective organization, increased taxation of private producers remaining outside the collectives, inadequate supplies of technologically advanced inputs and two bad weather years (1951 and 1952) led to a marked decline in agricultural production, followed by a weak recovery in 1953 and 1954. The general economic dislocation caused by this poor performance led to a reevaluation of agricultural policy. In 1956, the government began to develop and implement policies which recognized the necessity for the continued existence of private farms because of their contribution to the health of Polish agriculture and the economy as a whole. While retaining the long-term goal of socializing agriculture through the spread of cooperatives, the government pragmatically recognized the need to permit private production as well.

1956 marked the beginning of a new agricultural policy which has lasted to the present. From December 1956 to December 1957, the number of cooperatives declined from 10,200 to 1,700 (Landau and Tomaszewski, 1985, p. 262). The dissolution of cooperatives was accompanied by some confusion, leading to the dismantling of even some well-run and profitable ones, but the overall effect was to produce a more efficiently organized agriculture by the late 1950's. While the number of collectives fell dramatically in this period, the share of land in collectives did not fall as much. This share declined from a high of 24% in 1956 to 16% in the late 1950's (Rocznik Statystyczny 1977, XXX, XXXVII-XXXIV). During 1960-1963, the social sector accounted for 5% of the

agricultural labor force and 12% of agricultural land and it produced 10% of gross output. Over time, these figures show a slow but steady rise, with the social sector labor share rising to 23% , the land share to 20% and the output share to 23% by the early 1980's. These figures describe the process of the relative increase in importance of the social sector since the early 1960's and they also sketch the outline of one of the basic questions addressed in this study: what factors have determined the differences in relative sectoral rates of growth of output per worker and per hectare of arable land?

As background for evaluating such differences, I now describe the development of agricultural institutions and the evolution of agricultural policies between 1956 and the early 1980's. The policies and changes in them were primary forces affecting the performance of Polish agriculture as a whole and the relative performance of its private and socialized producers. Once these factors are clearly understood, they can be taken into account in attempting to determine the sources of intersectoral performance differences and the implications of policies for potential improvement of Polish agricultural performance. Three broad types of policy (price policy, policies for providing investment funds and material and policies on the taxation of private producers) are evaluated. The period from 1956 to 1982 is divided into five distinct phases: 1956 to 1960 - the period of setting up the basic two-sector structure; 1961 to 1969 - roughly the period of the Second and Third FYPs, which were concurrent with the Gomulka regime; 1970 to 1974 - the Fourth FYP and the early years of the Gierek regime; 1975 to 1979 -

the Fifth FYP and the late years of the Gierek regime; and 1980 to 1982 - the period of the Solidarity events and the beginning of the martial law regime of Gen. Jaruzelski.[5]

The First FYP (1956 to 1960)[6] was marked by the retreat from "forced" collectivization and the establishment of the two-sector system. In the areas of price, investment and taxation policy, the fundamental premise of preferential treatment of the social sector (which has colored all official policy since that time) was established. Although the shift to a two-sector agriculture was premised on the necessity of promoting private production, the dominant goal of the long-term socialization of agriculture was not forgotten. In price policy, the government established prices for socialized enterprises and set minimum compulsory deliveries by private sector farmers at lower prices. These compulsory deliveries were designed to guarantee a sufficient supply of agricultural goods to urban areas and also operated as a tax on private producers. While free markets were permitted and private farmers did make use of them, their overall impact on incomes was minimal because of compulsory deliveries. With the shift away from "forced" collectivization came recognition of the need for increased investment in agriculture. In the period from 1956 to 1960, agricultural investment rose by 90% over earlier levels, mostly due to increased investment by private farmers (Feiwal, 1971, p. 295). Still, the overall distribution of investment resources to agriculture remained low, at about 10% of total investment. In 1959 the Agricultural Development Fund was established. This was financed by the government

contribution of the difference between the purchase prices of agricultural goods and the prices fixed for compulsory deliveries. These funds were made more readily available to the socialized farms. In addition to the implicit taxation of private farmers by the system of compulsory deliveries, these farmers were also assessed contributions to the Agricultural Development Fund and they had to pay income and land taxes. In all, these contributions created a relatively much higher level of taxation on private producers than on socialized producers. While this situation was fairly well entrenched, some efforts were made to improve conditions for private producers (notable among them was the reduction in the levels of compulsory deliveries in 1957).

The decade of the Second and Third FYPs saw little change in agricultural policy from the pattern set in the late 1950's. During the 1960's, the government moved away from the use of compulsory deliveries to assure basic levels of agricultural supply by continuing to lower the levels required and by promoting the instrument of supply contracts. These contracts were originally intended to foster longer-term and more complete connections between private producers and socialized farms and their marketing branches, with socialized producers supplying improved technology and inputs to private producers in return for payment in crops or livestock set by contract. The prices established in these supply contracts were higher than those for compulsory deliveries. In practice, the benefit of higher prices for private producers was realized, but continued shortages of agricultural inputs blocked realization of the broader goals. Instead of fostering deeper ties between private

and socialized farmers, these contracts created greater instability for private producers. This was because they were often not written or signed until the time of delivery and they represented merely a new mechanism for purchasing private production (Landau and Tomaszewski, 1985, pp. 265-268).

Investment policy in the 1960's recognized the need for increased resource flows to agriculture and even realized these to a certain extent. Investment funds to agriculture rose from around 10% of total investment resources in the late 1950's to about 16%. As agriculture's share in total output fell, these ratios came closer together, but agriculture still received relatively fewer investment resources than its contribution to total production. Most of the available investment funds continued to be directed to the expansion of production in the social sector, with more success in the Third FYP than in the Second. There were signs of a lack of effective use of investment resources and this, in combination with the lack of access by private producers to official sources of investments, caused the increased allocation of resources to agriculture to have a smaller impact on production and productivity than was desired. As compulsory deliveries declined in importance, the tax burden on private farmers was reduced, although income and land taxes remained in place. Overall, the impact of price policy in the 1960's was to make the two sectors somewhat more equal, although still maintaining favoritism toward the social sector (Wadekin, 1982, p. 189). The effect of investment and taxation policies was to retain more favorable treatment of socialized farms in order to maintain momentum toward

the long-term socialization of agriculture.

With the change of leadership in 1970 came a marked shift in agricultural policy. Private producers saw a notable improvement in their position. Beginning in 1971, purchase prices of livestock and grains were raised and taxes were rationalized and reduced. In 1972, compulsory deliveries were abolished and these farmers were granted access to the national health care system. Overall, these changes served to improve the profitability of private farming. In combination with good weather, these changes led to steady, substantial output growth in the early 1970's, consistent with the Gierek regime's commitment to increasing agricultural, and in particular livestock, production in order to improve the quality of the Polish diet.

While these policies worked relatively well up to 1975, they were not without problems. For political reasons the government was not able to raise retail food prices sufficiently, so that there were some cases in which the new, higher purchase prices were above retail prices (Landau and Tomaszewski, 1985, p. 301). After 1975, output growth slowed. With the successes of the early 1970's, the government re-emphasized the long-term socialization of agriculture. This emphasis led to decreased investment incentives for private producers because they questioned the government's commitment to their long-term existence. In addition, overall investment remained at about the same levels at which it had been in the 1960's (between 11% and 16% of total investment), still below agriculture's contribution to total output. The supply of new technologies such as machinery, high-yielding varieties

of seeds, chemical fertilizers and irrigation was slower than planned. Finally, the weather was again unfavorable in the late 1970's. The slowed output growth was felt most acutely in the increasing shortages, notably of meat. The government's response to this situation was to give even more favorable treatment to the social sector in order to try to increase meat supplies through the construction of large-scale livestock operations. These policies increased Polish demand for Western technology and the inputs to use it.

Overall, the policies of the late 1970's reinforced the long-standing discrimination against private producers which the policies of the early 1970's had tried to counteract. Social-sector farms were given priority in access to land, machinery, fertilizer and other improved inputs and this further depressed private producer expectations. All of this slowed private output growth and increased the drain of resources, especially labor, from private farming. The government's response of promoting social sector growth via technology import served only to weaken the position of agriculture both in the domestic economy and in foreign trade.

It is clear that the impact of price and investment policies, in particular in the late 1970's, led to a slowing of output growth and that attempts to improve the situation only caused Poland's external debt situation to deteriorate while producing no tangible improvement in the internal use of the resources devoted to agriculture. To improve the situation, it will be necessary to tap the large potential of private production which was choked off by the policies of the late

1970's. The Rzeszow Agreement of February 1981 laid out the basic reforms required, in essence the rationalization of input and output prices and a more stable environment for private producers (Cook, 1986, pp. 471-2). In addition, adoption of more realistic, appropriate technologies should be pursued. If such policies are to work, it is critical that the Polish government make a commitment to the long-term existence of private producers and recognize the importance of both large- and small-scale production. In fact, the government has made limited moves in this direction. The new Constitution (of July 1983) does recognize the right to private ownership of land, although without the strong guarantees many had sought. Further, the government has remained committed in principle (if not with much enthusiasm in practice) to setting up a church-run fund to channel Western resources to private producers. The state has also permitted expansion of the scope for private market food sales. All of these moves, combined with the better weather of the early 1980's, brought about a remarkable turnaround in agricultural performance by 1985.

III. Growth and Levels of Output, Inputs and Productivity: 1960-1982

Table 1 describes production and input levels and growth from 1960 to 1982 for the private and social sectors.[7] These data show that output growth was much higher for the socialized sector than for private producers, slightly over 5% per annum for socialized producers and under

Table 1 — Sectoral Levels and Rates of Growth of Output and Inputs: 1960 - 1982

A. Output (x 1 b. zlotys)

	Private Sector	Social Sector	Percent Social	Growth Rates: Private Sector	Growth Rates: Social Sector
1960-1963	390.7	43.5	10	100	100
1964-1967	429.4	55.8	12	110	128
1968-1971	459.0	70.2	13	117	162
1972-1975	512.6	108.9	18	131	251
1976-1979	486.3	153.0	24	124	352
1980-1982	455.2	136.7	23	117	314
Average Annual Rate of Growth, 1960-1982 (%p.a.)				0.7	5.1

B. Labor (x 1,000 workers)

	Private Sector	Social Sector	Percent Social	Growth Rates: Private Sector	Growth Rates: Social Sector
1960-1963	6,944	348	5	100	100
1964-1967	6,489	426	6	93	122
1968-1971	6,044	492	8	87	141
1972-1975	5,075	641	11	73	184
1976-1979	3,558	911	20	51	262
1980-1982	3,198	944	23	46	271
Average Annual Rate of Growth, 1960-1982 (%p.a.)				-3.3	4.4

C. Land (x1,000 hectares)

	Private Sector	Social Sector	Percent Social	Growth Rates: Private Sector	Growth Rates: Social Sector
1960-1963	17,475	2,392	12	100	100
1964-1967	16,972	2,568	13	97	107
1968-1971	16,420	2,753	14	94	115
1972-1975	15,509	3,230	17	89	135
1976-1979	14,644	3,408	19	84	142
1980-1982	14,263	3,558	20	82	149
Average Annual Rate of Growth, 1960-1982 (%p.a.)				-0.9	1.7

Table 1 (continued)

D. Livestock	(x1,000 stock units)			Growth Rates	
	Private Sector	Social Sector	Percent Social	Private Sector	Social Sector
1960-1963	11,633	1,342	10	100	100
1964-1967	12,168	1,584	12	105	118
1968-1971	12,575	1,805	13	108	135
1972-1975	13,825	2,461	15	119	183
1 76-1979	13,257	3,136	19	114	234
1980-1982	12,056	2,977	20	104	222
	Average Annual Rate of Growth,1960-1982 (%p.a.)			0.2	3.5

E. Machinery	(x1,000 horsepower)			Growth Rates	
	Private Sector	Social Sector	Percent Social	Private Sector	Social Sector
1960-1963	389.3	1025.6	72	100	100
1964-1967	493.8	1521.3	75	127	148
1968-1971	1176.2	1895.3	62	302	185
1972-1975	4081.7	2195.4	35	1048	214
1976-1979	7707.8	2533.9	25	1979	247
1980-1982	13010.0	2695.6	17	3341	263
	Average Annual Rate of Growth,1960-1982 (%p.a.)			16.5	4.3

F. Fertilizer	(x 1,000 tons)			Growth Rates	
	Private Sector	Social Sector	Percent Social	Private Sector	Social Sector
1960-1963	357.1	82.5	19	100	100
1964-1967	498.9	133.6	21	140	162
1968-1971	879.9	270.0	23	246	327
1972-1975	1960.6	814.7	29	549	988
1976-1979	2219.9	1124.2	34	622	1363
1980-1982	2102.6	1071.1	34	589	1299
	Average Annual Rate of Growth,1960-1982 (%p.a.)			8.0	11.8

Sources: Various offical publications of the Central Statistical Office (see footnote 3) and author construction.

1% per annum for the private sector. Sectoral differences in input growth rates identify the effects of policies on resource allocation to and within agriculture. The overall economic development of the Polish economy has led to a shift of resources out of agriculture and into industrial and service production. This is most clearly reflected in the data for the agricultural labor force. While labor employed on socialized farms increased substantially, with the 1980-1982 level being roughly 2.7 times the 1960-1963 level, this increase was overshadowed by the dramatic outflow of labor from the private sector. Over the entire period, roughly 3.7 million workers left private-sector agriculture,[8] so that by the early 1980's the private agricultural labor force was less than one-half of its 1960-1963 level. The outflow was steady, but did show a marked increase in the 1970's. The goal of increasing the relative importance of socialized production in agriculture was reinforced by this transfer of private-sector labor, which was used to fuel growth in industry and services. Part of the increased outmigration in the early 1970's, as measured by the data presented, is due to the "quality-adjusted" nature of these data, which reflect the fact that the workers drawn off into other sectors were primarily prime-age males.

The data on land show a similar pattern of relative sectoral growth and decline, reflecting the overall emphasis on promoting socialized agriculture. For Poland as a whole, arable agricultural land declined by approximately 2 million hectares from 1960 to 1982, a drop of about 10% from 1960-1963 average levels. Again, the aggregate decline masks different patterns between the socialized and private farms. Social-

sector producers increased arable landholdings by about 50% from 1960 to 1982, while private producers decreased their holdings by roughly 18%. Taken together, the data on the labor force and land show that the policies designed to promote socialized agricultural enterprises at the expense of private producers had the desired effect on the distribution of resources within agriculture. The share of socialized production in total production rose from about 10% in 1960-1963 to nearly 25% by the late 1970's and this was brought about in large part by the changes in the relative sectoral distribution of labor and land.

Although these primary factors are extremely important, they are by no means the only inputs to agricultural production. The earlier discussion of agricultural policies emphasized the role of investment and the allocation of investment resources. To see how investment policies have affected the two sectors, three additional inputs which capture different aspects of agricultural investment are included: livestock, machinery and fertilizer. Livestock is measured as an aggregate of the cattle, swine, sheep and poultry in a given sector at the beginning of the year. Overall, the level of livestock input increased by approximately 16% from 1960-1963 to 1980-1982. For the private sector, the increase over these years was much smaller (only about 4%) and was marked by an increase throughout the 1960's and into the early 1970's, followed by decline in the late 1970's and early 1980's. In the 1960's, socialized farms showed a higher rate of growth of livestock input than did private producers and this rate increased in the 1970's as the government promoted socialized stock production in order to improve the quality of the

Polish diet. As I noted earlier, although these policies did increase production through the early 1970's, they failed to yield the desired results in the late 1970's, despite the fact that the government continued to allocate resources to this end. The data for social-sector livestock input growth show continued growth in the late 1970's and a marked decline in the early 1980's which was necessitated by more stringent policies.

Machinery and fertilizer inputs (machinery is tractor horsepower available and fertilizer is chemical fertilizer consumed) capture aspects of two agricultural technologies: mechanical and chemical/biological. Thus, rather than being measures of mechanical or fertilizer inputs per se, they are proxies for the expansion of these two types of advanced agricultural technology. For Poland as a whole, tractor horsepower input increased by over 10 times from 1960 to 1982. In the private sector this increase was even larger (more than 30 times), while the social sector increase was about 2.5 times. In the 1960's, socialized farms had 60-75% of all tractor horsepower in agriculture, compared with 12% of output, 7% of labor and 13% of land. It is clear that the early focus of agricultural policy was to supply scarce mechanical technology to the socialized producers, and only later was it made widely available to private producers. The explosive growth of private farm mechanization did not begin until the early 1970's, when the Gierek regime attempted to improve conditions for private producers. For Poland as a whole the use of chemical fertilizers rose by 2.7 million tons from 1960-1963 to 1980-1982. In the 1960's, growth rates of chemical

fertilizer consumed were higher in the social sector: consumption increased from 19% to 23% from 1960 to 1970. In the 1970's and early 1980's, as private sector fertilizer use grew slowly and then declined, socialized farm use continued to increase rapidly. From 1960 to 1982, private producer chemical fertilizer use increased 6 times, while socialized producer use rose 13 times. In the 1970's there was a shift to policies which promoted social sector over private sector input growth as attempts were made to intensify agricultural production and raise productivity.

The relative levels of growth of inputs illustrated in table 1 are consistent with the conclusions of a qualitative examination of agricultural policies and show some of the explicit mechanisms which influenced relative sectoral performance. Table 2 presents the basic data on labor and land productivities for private and socialized producers from 1960 to 1982. In 1960-1963 the level of output per worker of socialized producers was over twice that of private producers, but labor productivity growth was much higher in the private sector. By 1980-1982 the two sectors had approximately equal levels of labor productivity. In 1960-1963, output per hectare of private producers was 20% above that of socialized producers, but the rate of growth of land productivity was higher in the social sector. By 1980-1982, the situation was reversed and socialized producer levels of land productivity were 20% above those of private producers.

It is clear that differences in the process of capital accumulation in the two sectors were important in generating the observed differences

Table 2 Sectoral Labor and Land Productivities and Productivity Growth Rates: Poland, 1960-1982

A. Productivity (x 1,000 zlotys)

	Output per Worker		Output per Hectare	
	Private Sector	Social Sector	Private Sector	Social Sector
1960-1963	56.3	124.9	22.4	18.2
1964-1967	66.2	131.1	25.3	21.7
1968-1971	75.9	142.8	28.0	25.5
1972-1975	101.0	170.0	33.1	33.7
1976-1979	136.7	167.9	33.2	44.9
1980-1982	142.4	144.7	31.9	38.4

B. Productivity Growth Rates

	Output per Worker			Output per Hectare		
	Private Sector	Social Sector	Social / Private	Private Sector	Social Sector	Social / Private
1960-1963	100	100	2.2	100	100	0.8
1964-1967	118	105	2.0	113	120	0.9
1968-1971	135	114	1.9	125	140	0.9
1972-1975	180	136	1.7	148	186	1.0
1976-1979	243	135	1.2	149	247	1.4
1980-1982	253	116	1.0	143	211	1.2

Source: Table 1.

in levels and growth rates of labor and land productivities. The lack of reliable and comparable data on sectoral capital stocks makes it impossible to obtain further information on the factors which generate these differences from the partial productivity approach. Because each group of producers shows a higher rate of growth of one of the productivities, it is also clear that it is not simply the case that one sector obtained more or better capital. A different type of analysis involving more complete evaluation of the factors affecting productivity is required for a deeper understanding of the causes and implications of different patterns of sectoral productivity.

IV. The Aggregate Production Function Approach and its Results

The implications of the production function estimates for policy analysis are:

1. Differentiated agricultural policies had a clear impact on the rate of technological change in Polish agriculture, but generated larger negative growth rates for socialized producers, especially before 1975. This was not the intention of agricultural policy-makers.
2. Large negative rates of growth of technological change for socialized producers in Poland indicate that the new technologies and other resources being channelled into that sector were not being used effectively. The better

performance of the private sector in this area, despite a general neglect of the real needs of this group of producers, indicates that improved agricultural performance could be obtained through policies designed to meet private needs.

3. By several measures of relative efficiency, the private sector appears to show greater static efficiency and to have been more adept at adopting technology to produce dynamic efficiency (or at least to retard the effects of policies designed to hamper private production). Again, this implies that increased attention to private sector production is essential for the long-term health of Polish agriculture.
4. The social sector clearly shows increasing returns to scale which indicate that it has developed by means of techniques capable of generating large increases in growth through more effective use of large-scale technologies. If policies were adopted to promote this process (rather than to hamper it, as in the past), even greater gains in production and productivity could be obtained from socialized producers.

The total factor productivity approach is a standard method used to address questions of productivity and productivity growth. This type of analysis involves estimating a production function, a well-specified relation between output and the factors or inputs used to produce it. Appendix A presents a formal description of the particular functional

form and estimation framework used.

The production function is specified as a relation which shows how five inputs (labor, land, livestock, machinery and fertilizer) are combined to produce output. Each of these variables has been described in table 1. Table B1 (in Appendix B) provides summary statistics for the variables used in production function estimation. Observations on each of these variables cover each year from 1960 to 1982 (23 years) separately for each sector (private and social). In addition, these data are broken down for each political subdivision of Poland; from 1960 to 1974 there were 17 such regions and from 1975 to 1982 there were 49 (table C1 in Appendix C lists these regions). Given this combination of regions, sectors and years, there are 1,294 observations for each variable. Because these data have regional and temporal variation (as well as variation between private and socialized producers), the production function can be used to separate certain regional environmental factors and temporal policy effects in order to consider these as distinct from the effects of different modes of organization.

Based on the description in section II of agricultural policies and their evolution, the period 1960-1982 can be divided into four subperiods: 1960-1969 - roughly the Gomulka regime and the Second and Third FYPs; 1970-1974 - the Fourth FYP and the initial years of the "Gierek reforms"; 1975-1979 - the Fifth FYP and late years of the Gierek regime, during which problems with the reforms became apparent; and 1980-1982 - the beginning of the Sixth FYP, overshadowed by the era of Solidarity and the inception of martial law. In the production function estimation,

dummy variable techniques are used which permit identification of the effects of agricultural policy in each of these periods on the rate of growth of technological change. Based on evaluation of climatic, pedological and production information,[9] four regional subdivisions of the country were defined. These are shown on map C1 (in Appendix C) and the composition of these regions based on the pre- and post-1975 political regions is given in table C2. Appendix table B2 presents labor and land productivities and growth rates for each of these four regions comparable to the data for Poland as a whole which are shown in table 2. These data reflect the general pattern of relative sectoral productivities in the country as a whole, but with sufficient variation to warrant consideration of potential regional differences in factors affecting productivity. As with the policy periods, dummy variables are used to introduce regions directly into the production function to account for their potential influence on performance.

I estimated aggregate production functions for each sector and then examined the extent to which these sectoral functions were similar. This process (described technically in Appendix table B3) produced the final version presented in table 3. The following points concerning these estimated coefficients may be noted:

1. There is a fixed difference (irrespective of region) between the social and private sectors. The private sector intercept (a measure of initial differences in production, given equal, low levels of inputs) is larger by 2.74 than that for the social sector. The intercept is a basic

Table 3 Aggregate Agricultural Production Functions: Private and Social Sectors

	Social Sector	Private Sector
Regional Intercepts		
Southeast	9.32 (119.37)	12.06 (137.61)
Northeast	9.32 (238.23)	12.06 (205.91)
Southwest	9.41 (240.73)	12.15 (206.82)
Northwest	9.41 (239.03)	12.15 (204.75)
Time Trends		
1960-1969	-.032 (12.89)	-.004 (3.44)
1970-1974	-.023 (13.22)	-.006 (9.23)
1975-1979	-.004 (2.13)	-.009 (17.42)
1980-1982	-.010 (5.10)	-.008 (17.41)
Inputs		
Labor	0.82 (64.02)	0.16 (11.00)
Land	0.10 (8.37)	0.44 (42.94)
Livestock	0.11 (8.80)	
Machinery	0.02 (2.75)	
Fertilizer	0.20 (21.58)	
Sum of Input Coefficients	1.24 (31.95)*	0.93 (28.94)*
SSR = 5.27	N = 1,161	SER = .068

Notes to Table 3

1. All figures in parentheses are t-statistics for the test of the difference of estimated coefficients from zero, except those marked by a * which are for the test of the difference of the coefficient from one.
2. The method of estimation used was instrumental variables, where the instruments were the one-year lagged values of the independent variables plus all regional, temporal and sectoral dummy variables.
3. Composition of the regions is described in Appendix C, table C2. The method used to arrive at the specific combination of varying and constrained input coefficients reported here is described in Appendix B, table B3.

(although crude) measure of relative sectoral "efficiency" which appears to show that private producers are significantly more efficient than are socialized producers.

2. There is relatively little difference among regional intercepts, with the Western regions showing higher intercepts for both sectors than did the Eastern regions.
3. The estimated time trends, which measure the rate of growth of technological change which is not captured in any of the measured inputs, show significant sectoral differences. In the 1960's, both sectors exhibited negative rates of growth of technological change, -3.2% per annum for the social sector and -0.4% per annum for the private sector. In the early 1970's, the social sector rate of growth of technological change rose to only -2.3% per annum, while the private sector rate remained almost the same, dropping to -0.6% per annum. In the late 1970's and early 1980's, these sectoral rates of growth became more similar and approximated the higher private sector levels (all lying between -0.4% and -1.0% per annum), although they remained negative. These figures imply that if input levels had remained constant, output would have fallen in both sectors from 1960 to 1982. This tendency was more pronounced in the social sector than in the private and was strongest in the years prior to 1975. Given the differentially favorable policy treatment of socialized producers

throughout the period under examination, the large negative rates of growth of technological change for this sector suggest that the benefits of these policies were not fully captured.

4. The input coefficients measure the percent change in output that would be obtained for a given percent change in the level of any particular input, with all other factors being fixed. These coefficients vary between the sectors for labor and land and are the same for livestock, machinery and fertilizer. The labor coefficient indicates a larger impact of changes in labor input on output for socialized producers than for private producers, while the land coefficient indicates a larger impact of changes in the level of this input in the private sector. These figures may appear to contradict the data in table 2, which showed higher rates of growth of labor productivity for the private sector and of land productivity for the social sector. However, the data for output per worker and per hectare do not hold all other inputs fixed and thus are not directly comparable to these coefficients. The relatively larger input coefficients found here are consistent with the fact that the social sector tended to have higher levels of output per worker throughout the period 1960-1982, while the private sector tended to have higher levels of output per hectare. The other coefficients show the significant

but modest impact of livestock on output, a very small impact of machinery input on production and a large and significant effect of fertilizer. The sum of the input coefficients measures returns to scale. For the social sector, this is greater than one, indicating increasing returns to scale. This means that if all inputs were changed by the same percentage (e.g., doubled), output would change by more than that percentage (e.g., by more than two times). The private sector exhibits decreasing returns to scale, with the sum of the input coefficients being less than one. Here, if all inputs are changed by the same percentage, output changes by less than that percentage (for example, an increase of all inputs by 50% would increase output by less than 50%).

These production function estimates can be used to examine several additional questions relating to production and productivity growth in the two sectors. Table 4 describes the sources of growth of production, labor productivity and land productivity for each sector. In each portion of the table the first line shows the average annual rate of growth from 1960 to 1982, line 2 shows the portion of that growth explained by the growth of inputs, line 3 shows the residual or unexplained growth and line 4 gives the share of residual growth in total growth. For the social sector, in each case the explained growth is greater than actual growth. This is due to the large negative rates of growth of technological change described by the negative time trend coefficients.

Table 4 Comparative Sectoral Sources of Growth of Output, Output per Worker and Output per Hectare: Poland 1960-1982 (%p.a.)

A. Output

	Private Sector	Social Sector
1. Growth Rate	0.7	5.1
2. Explained by Inputs	1.0	6.6
3. Unexplained Growth	-0.3	-1.5
4. (3)/(1)x100	-43	-66

B. Output per Worker

	Private Sector	Social Sector
1. Growth Rate	4.0	0.7
2. Explained by Inputs	2.1	11.4
3. Unexplained Growth	1.9	-10.7
4. (3)/(1)x100	48	-1,530

C. Output per Hectare

	Private Sector	Social Sector
1. Growth Rate	1.6	3.4
2. Explained by Inputs	1.5	6.8
3. Unexplained Growth	0.1	-3.4
4. (3)/(1)x100	6	-100

Source : Author construction. The rate of growth of output explained by inputs was calculated as the sum of the growth rates of each input weighted by its estimated coefficient from the production function. This formulation is a direct derivation from the Cobb-Douglas form used. In addition, for this form of the production function, it is possible to calculate the explained growth of output per worker (hectare) as the sum of the growth rates of all inputs other than labor (land) per worker (hectare) plus the rate of growth of labor (land), where the weights are the input coefficients presented in table 3 for the per worker (hectare) inputs and the sum of the input coefficients minus one for labor (land).

Because of this negative technological effect, inputs as measured should account for more growth than was observed, because factors involved in the adoption and utilization of technology in this sector retarded growth. This relation also characterizes output growth in the private sector, although the degree of the negative effect is less than in the social sector. The results for labor and land productivity growth in the private sector are more typical of this type of exercise, with technological change playing a positive role in generating productivity growth. This indicates that the negative rates of growth of technological change measured by the private sector's small negative time trends affected the process of productivity growth in this sector relatively little.

Finally, the estimated production function coefficients can produce a more complete examination of relative sectoral efficiency than that provided by comparison of sectoral intercepts. Table 5 presents an index of the ratio of the output each sector would have produced using its own inputs and the other sector's estimated production function coefficients to the output it actually did produce. In 1960-1963 each sector would have produced more output with the other sector's production function, with the difference between hypothetical and actual output being larger for the private sector. Over time, the difference between hypothetical and actual output became smaller for both sectors, with the two output measures being nearly equal by the early 1980's. These data suggest that in the early 1960's the production functions of the two sectors crossed somewhere between the relatively lower levels of

Table 5 — Hypothetical Output Produced Using the Other Sector's Aggregate Production Function As A Percent of Actual Sectoral Output

	Private Sector	Social Sector
1960-1963	261	144
1964-1967	213	132
1968-1971	200	127
1972-1975	179	114
1976-1979	141	95
1980-1982	120	106

Source: Author Construction.

aggregate social sector inputs and the higher levels of aggregate private sector inputs. In this situation, no efficiency ranking is possible since each sector appears to be more efficient at the other sector's level of inputs. Over time, hypothetical and actual outputs became more similar, so that by the late 1970's and early 1980's they were nearly the same in both sectors. Again, no strict efficiency ranking is possible, but now the production technologies of the two sectors appear to be similar at all input levels.

V. Policy Conclusions and Prospects for the Future

From the mid-1950's to the early 1980's, policy decisions tended

to keep the share of investment resources devoted to agriculture at levels well below its contribution to output. In the early 1970's, agricultural investment policies deviated from this long-term tendency as agricultural growth was promoted. Although official proclamations often stressed the need to promote private production, throughout the period 1960-1982 there was a bias in favor of directing available resources to socialized farms. Thus, in terms of the allocation of investment resources for increasing mechanization, using high-yielding varieties of seeds and fertilizers and advancing livestock finishing techniques, the weight of policy was to promote the social sector at the expense of the private sector, within an overall framework in which agriculture was given lower priority than other sectors.

Price and taxation policies reinforced these trends. The policies adopted were in general unfavorable to agriculture as a whole, but the mechanisms of discrimination for socialized and private producers differed. For the social sector, the allocative role of prices was overshadowed by the fact that for political reasons the government maintained low food prices. This subsidization of social-sector producers effectively blocked the use of prices as an incentive mechanism and produced a strong reliance on the bureaucratic incentives of plan fulfillment. It is most likely that the main cause of the relatively inefficient use of new technology by socialized producers was this primacy of bureaucratic resource allocation and performance evaluation. For private producers, the role of prices (especially free market prices) was more directly related to incentives, but these producers could only

receive subsidies if they cooperated with the social sector. This also tied them into the badly distorted price structure of the plan. In addition, taxation of private producers was (until the early 1970's) used as a means to promote additional links between these farmers and the social sector, and this further influenced the ability of private producers to respond to price incentives. Overall, price policies have caused disorganization of agricultural production in both sectors through the introduction and maintenance of distorted relative prices.

Of the institutional factors which impose constraints on the performance and potential improvement of Polish agriculture, the most important are the price and investment policies just discussed. These policies have established a context for agriculture which is not conducive to the efficient allocation of resources within that sector. An additional institutional constraint is the tendency to promote the long-term socialization of agriculture which has created an atmosphere of uncertainty for private producers. Thus, even when the government began to promote greater support for private producers in the early 1970's, this did not have the full desired impact because of a fundamental hesitancy on the part of peasants to accept such changes at face value. If the Polish government wishes to promote increased production and productivity based on improved conditions for private producers, it must recognize this problem (which it has itself created) and take positive steps to address peasant concerns.

The demographic factors which have constrained and will continue to constrain Polish agriculture can be described simply, although their

implications are not straightforward. Polish agriculture began the post-war era with an extremely large percentage of its population engaged in agriculture. The process of transforming the economy into one in which industrial and service production became more important required the transfer of large amounts of labor from agriculture into these sectors. The pool of labor for this process was in the private sector and table 1 shows that a large number of workers indeed moved out of the private sector. Beginning in the 1960's and accelerating in the 1970's, the outmigration of labor from this group of producers has consisted primarily of prime-working-age males. This has led to an aging and feminization of the private agricultural labor force. To the extent that improved agricultural performance in Poland depends on improved conditions for the private sector (a contention supported by the main results of this study), it will be necessary to retain and perhaps attract back some of this labor. The flight from agriculture could threaten to increase the rate of socialization of agriculture in an undesirable manner.

Technological constraints on agricultural performance and potential differ between the social and private sectors. For the state farms, the limiting factor has not been the availability of technological resources, but their effective use. In fact, these farms seem to be particularly well-suited for taking advantage of the benefits of large-scale technologies, but the policy environment in which they operate has greatly reduced their ability to implement such technologies successfully. A large part of agriculture's contribution to the increase in Poland's external debt in the late 1970's can be traced directly to the

ineffective adoption of potentially valuable technologies (Boyd, 1986). For private producers, the constraint has been less the utilization than the availability of advanced technology. The adoption of mechanized and chemical/biological technologies does seem to have been important in maintaining the productivity of this sector in the face of a large outflow of labor and a generally hostile policy environment. Thus, in terms of future policy with respect to technology in agriculture, the best outcome would stem from an increased flow of resources to private producers combined with changes in price policies to promote increased efficiency on socialized farms.

Polish agriculture has in the past provided a strong base for the overall development of the economy. Despite significant weaknesses which have developed over the last 30 years, it still retains the potential to do so. The principal strengths of Polish agriculture lie in its endowment of good agricultural land and climate and its long agricultural tradition. These factors, combined with effective policies to promote agricultural productivity (even in the context of a decline in the overall importance of agriculture as other sectors develop) would provide the necessary foundation for long-term improvement. However, this also indicates the main potential weakness of Polish agriculture - policy-induced drags. If the government continues to slight private producers with regard to availability of resources and access to markets and to maintain a badly distorted price and incentive structure for socialized farms, then agriculture will continue to exert a negative influence on the overall performance of the economy.

If, on the other hand, the Polish government commits itself to effective promotion of private production and at the same time takes steps to rationalize production among socialized producers, the benefits would be large. This would provide a sound basis for increased industrial and service production and an overall broadening of the Polish economy, it would provide an important example of rationalization and productivity increase that could be used in other sectors and it could allow agriculture to return to its historic role as a significant earner of hard currency which would help to alleviate pressures on all sectors caused by Poland's large external debt.[10] The potential benefits of these changes are significant, but their realization requires a bold commitment to policies that the government has found politically unacceptable in the past. This fact indicates how unlikely it is that such dramatic changes will occur, although the evident need for such changes may ultimately carry greater weight.

APPENDIX A

I use a Cobb-Douglas production function which permits useful specification of policy, environmental and system effects (despite its limitations on substitutability) through its disembodied technological change component. Thus, the sectoral aggregate production function is:

$$(1) \qquad X_{jkt} = \Lambda_{jk}(t) \prod_{i=1}^{m} Z_{jkt}^{i\ \beta^{i}_{jkt}}\ e^{u_t} \quad ,$$

where $\Lambda(\cdot)$ is the disembodied technological change function;

Z^i is the i^{th} input (labor, land, livestock, machinery, fertilizer);

j is the regional observational unit (see Appendix C);

t is the temporal observational unit (the year); and

u is the error term.

I assume that all inputs are quality-adjusted and that the remaining factors affecting output (the main one being the weather) do so randomly, via u.

I specify $\Lambda(\cdot)$ to identify and capture the separate influences of policy, environment and organization. In particular, I assume:

$$(2) \qquad \Lambda_{jk}(t) = e^{\{(1+d_p)(\alpha_k^0 + \Sigma_{r=1}^{h}\ \alpha_{kr} d_r + \Sigma_{t=1}^{n}\ \alpha_{kt} d_t)\}} \quad ,$$

where d_p is one for observations on the private sector, zero elsewhere;

d_r is one for observations on region r, zero elsewhere;

d_t is year for observations in subperiod t, zero elsewhere; and

k as the sectoral subscript is p (for the private sector) for all coefficients interacting with d_p and s (for the social sector) elsewhere.

Putting (2) into (1) and taking the natural logarithms of both sides yields:

$$(3) \qquad x_t = (1+d_p)(\alpha_k^0 + \Sigma_{r=1}^{h}\ \alpha_{kr} d_r + \Sigma_{t=1}^{n} \alpha_{kt} d_t + \Sigma_{i=1}^{m} \beta_{ik} z_{ikt}) + u_t \quad ,$$

where x is the natural logarithm of X and the z_i are the natural logarithms of the Z_i. Regional subscripts have been suppressed for clarity, although such variation remains in the data used for analysis.

APPENDIX B

Table B1 Summary Statistics for Variables Used in Estimation of Equation (3)

Natural Logarithm of	Mean	Standard Deviation	(max,min)
Private Sector			
Output	23.28	0.68	(24.95, 20.94)
Labor	11.65	0.99	(13.61, 9.71)
Land	12.96	0.99	(14.60, 11.43)
Livestock	12.76	0.69	(14.42, 11.14)
Machinery	11.44	1.08	(13.32, 8.74)
Fertilizer	10.56	0.60	(12.55, 8.91)
Social Sector			
Output	21.41	1.08	(23.54, 18.55)
Labor	9.80	0.62	(11.30, 8.04)
Land	10.89	1.31	(12.93, 8.06)
Livestock	10.70	1.15	(12.76, 8.13)
Machinery	10.54	1.20	(12.56, 6.70)
Fertilizer	9.10	1.34	(11.75, 5.80)

Table B2 Sectoral Labor and Land Productivities and Productivity Growth Rates: Southeast Poland 1960-1982

A. Productivity (x 1,000 zlotys)

	Output per Worker		Output per Hectare	
	Private Sector	Social Sector	Private Sector	Social Sector
1960-1963	45.9	86.3	23.1	17.6
1964-1967	53.9	67.1	25.1	19.5
1968-1971	65.4	71.6	28.8	24.7
1972-1975	83.0	65.7	31.7	25.5
1976-1979	107.4	130.3	32.7	83.7
1980-1982	119.4	78.5	31.7	50.0

B. Productivity Growth Rates

	Output per Worker			Output per Hectare		
	Private Sector	Social Sector	Social / Private	Private Sector	Social Sector	Social / Private
1960-1963	100	100	1.9	100	100	0.8
1964-1967	118	78	1.2	109	111	0.8
1968-1971	142	83	1.1	125	140	0.9
1972-1975	181	76	0.8	137	145	0.8
1976-1979	234	151	1.2	142	476	2.6
1980-1982	260	91	0.7	137	267	1.6

Table B2 (continued) Sectoral Labor and Land Productivities and Productivity Growth Rates: Southwest Poland 1960-1982

A. Productivity (x 1,000 zlotys)

	Output per Worker		Output per Hectare	
	Private Sector	Social Sector	Private Sector	Social Sector
1960-1963	59.0	113.4	20.5	30.6
1964-1967	67.8	120.8	23.3	19.1
1968-1971	78.8	137.5	26.4	24.1
1972-1975	108.0	157.5	32.9	31.4
1976-1979	127.7	156.7	29.4	45.8
1980-1982	137.3	120.4	30.1	34.5

B. Productivity Growth Rates

	Output per Worker			Output per Hectare		
	Private Sector	Social Sector	Social / Private	Private Sector	Social Sector	Social / Private
1960-1963	100	100	1.9	100	100	1.5
1964-1967	115	107	1.8	113	62	0.8
1968-1971	134	121	1.7	128	79	0.9
1972-1975	183	139	1.5	160	103	0.95
1976-1979	216	138	1.2	143	150	1.6
1980-1982	233	106	0.9	146	113	1.1

Table B2 (continued) Sectoral Labor and Land Productivities and Productivity Growth Rates: Northeast Poland 1960-1982

A. Productivity (x 1,000 zlotys)

	Output per Worker		Output per Hectare	
	Private Sector	Social Sector	Private Sector	Social Sector
1960-1963	66.3	130.6	22.9	20.1
1964-1967	78.9	135.8	26.3	22.7
1968-1971	86.6	153.9	27.9	26.5
1972-1975	117.0	181.2	33.5	34.6
1976-1979	170.2	174.3	33.7	44.0
1980-1982	167.9	161.6	32.3	40.6

B. Productivity Growth Rates

	Output per Worker			Output per Hectare		
	Private Sector	Social Sector	Social / Private	Private Sector	Social Sector	Social / Private
1960-1963	100	100	2.0	100	100	0.9
1964-1967	119	104	1.7	115	113	0.9
1968-1971	131	118	1.8	122	132	0.9
1972-1975	177	139	1.5	147	172	1.0
1976-1979	257	133	1.0	147	220	1.3
1980-1982	253	124	0.95	141	203	1.3

Table B2 (continued) Sectoral Labor and Land Productivities and Productivity Growth Rates: Northwest Poland 1960-1982

A. Productivity (x 1,000 zlotys)

	Output per Worker		Output per Hectare	
	Private Sector	Social Sector	Private Sector	Social Sector
1960-1963	65.3	137.6	22.5	17.6
1964-1967	75.8	159.3	27.3	22.5
1968-1971	80.4	165.7	29.5	25.2
1972-1975	110.4	225.7	37.0	36.0
1976-1979	220.7	193.5	42.9	37.1
1980-1982	191.2	185.4	36.2	35.9

B. Productivity Growth Rates

	Output per Worker			Output per Hectare		
	Private Sector	Social Sector	Social / Private	Private Sector	Social Sector	Social / Private
1960-1963	100	100	2.1	100	100	0.8
1964-1967	116	122	2.1	116	128	0.8
1968-1971	123	131	2.1	120	143	0.9
1972-1975	169	165	2.0	136	204	1.0
1976-1979	338	191	0.9	141	211	0.9
1980-1982	293	161	1.0	135	204	1.0

Table B3 F-Tests of Constrained versus Unconstrained Versions of the Sectoral Aggregate Production Functions, Equation (3)

Constrained Version	Unconstrained Version 2	3	4	5	6
1	51.2	35.8	24.4	18.5	14.9
2		19.7	10.7	7.3	5.7
3			1.7	1.2	0.9
4				0.7	0.6
5					0.5

The numbered versions of the aggregate production function are distinguished by which input coefficients are held to be the same in the two sectors.

Version #1 constrains all five inputs to be the same in the social and private sectors;
2 allows labor to vary between the sectors, all other inputs being held the same in both sectors;
3 allows labor and land to vary, all other inputs constrained to be equal in the two sectors;
4 allows labor, land and machinery to vary, holding all others the same;
5 lets labor, land, machinery and fertilizer coefficients vary between sectors and holds livestock the same; and
6 lets all input coefficients vary between the two sectors.

For each version, the particular input coefficients allowed to vary were chosen as those which minimized the residual sum of squares for a given number of constraints imposed. The statistics presented are distributed $F(m,n-k)$, where m is the number of constraints imposed and n-k is the number of degrees of freedom in the unconstrained version. N-k varies from 1171 for version #6 to 1176 for version #1. Reading any row from left to right, m begins at 1 for the first entry and increases by one for each subsequent entry.

APPENDIX C

Table C1 Political Regions of Poland: 1960-1982

A. 1960 - 1974

1. Bialystok
2. Bydgosz
3. Gdansk
4. Katowice
5. Kielce
6. Koszalin
7. Krakow
8. Lublin
9. Lodz
10. Olsztyn
11. Opole
12. Poznan
13. Rzeszow
14. Szczecin
15. Warszawa
16. Wroclaw
17. Zielona Gora

B. 1975 - 1982

1. Warszawa
2. Bialo Podlaska
3. Bialystok
4. Bielsko-Biala
5. Bydgoszcz
6. Chelm
7. Ciechanow
8. Czestochowa
9. Elbag
10. Gdansk
11. Gorzow Wielkopolski
12. Jelenia Gora
13. Kalisz
14. Katowice
15. Kielce
16. Konin
17. Koszalin
18. Krakow
19. Krosno
20. Legnica
21. Leszno
22. Lublin
23. Lomza
24. Lodz
25. Nowy Sacz
26. Olsztyn
27. Opole
28. Ostrotek
29. Pila
30. Piotrkow Trybunalski
31. Plock
32. Poznan
33. Przemysl
34. Radom
35. Rzeszow
36. Siedlce
37. Sieradz
38. Skierniewice
39. Slupsk
40. Suwalki
41. Szczecin
42. Tarnobrzeg
43. Tarnow
44. Torun
45. Walbrzych
46. Wloclawek
47. Wroclaw
48. Zamosc
49. Zielona Gora

Table C2 Production Function Regions: Combinations of Political Regions

A. Southeast

1960-1974: Katowice, Kielce, Krakow, Lublin, Rzeszow

1975-1982: Bialo-Podlaska, Bielsko-Biala, Chelm, Czestochowa, Katowice, Kielce, Krakow, Krosno, Lublin, Nowy Sacz, Przemysl, Radom, Rzeszow, Tarnobrzeg, Tarnow, Zamosc

B. Southwest

1960-1974: Bialystok, Warszawa, Olsztyn

1975-1982: Bialystok, Ciechanow, Lomza, Olsztyn, Ostrotek, Plock, Siedlce, Suwalki, Warszawa

C. Northeast

1960-1974: Bydgosz, Lodz, Opole, Poznan, Wroclaw

1975-1982: Bydgoszcz, Jelenia Gora, Kalisz, Konin, Legnica, Leszno, Lodz, Opole, Piotrkow Trybunalski, Poznan, Sieradz, Skierniewice, Torun, Walbrzych, Wloclawek, Wroclaw

D. Northwest

1960-1974: Gdansk, Koszalin, Szczecin, Zielona Gora

1975-1982: Elbag, Gdansk, Gorzow Wielkopolski, Koszalin, Pila, Slupsk, Szczecin, Zielona Gora

Map C1 The Polish People's Republic

The regional divisions on the map correspond with the borders of the political regions of the country from 1960 to 1974. For the years 1975-1982, the precise boundaries vary somewhat, although the main bodies of the regions overlap.

FOOTNOTES

1. The social sector in agriculture consists of state farms, which are operated as large-scale enterprises in which the workers are essentially employees of the state and for which the central planners establish production and input plans and targets. Private farms, which comprise the bulk of the agricultural producers in Poland, are basically small-scale, individual peasant holdings. There is a co-operative sector of agriculture, which consists of various types of producer cooperatives, socialized but not directly state-controlled. The number of these farms is small and I have chosen to omit them and to focus on a comparison of state socialized versus private producers.

2. According to the 1931 census, 60% of the total population was engaged in agriculture, with 97% of these being in rural areas (Thomas, 1952, p. 61).

3. The principal sources from which the data for this study were taken were official publications of the Central Statistical Office (Glowny Urzad Statystyczny). These included various years of the Statistical Yearbook (Rocznik Statystyczny), the Statistical Yearbook of Wojewodstwa for 1975 to 1982 (Rocznik Statystyczny Wojewodstw) and the Statistical Yearbook of Agriculture (Rocznik Statystyczny Rolnictwa i Gospodarski Zywnoscowej). These data were supplemented by those in Korbonski and Lazarcik (1972) and others. The output figures used are for gross agricultural output and are basically the official data. For some years, in the period 1960-1974, not all regional/sectoral figures were provided. In these cases, regional total figures for crop production and stock production were allocated by each sector's share in production of the four basic grains (for crop production) and in livestock input (for stock production). The labor figures for the social sector are for full-time employment in the sector. For the private sector, employment was estimated by constructing regional figures for total agricultural labor force, removing social sector employment and then adjusting for changes in the age and sex composition of the rural population based on data from the population censuses. Land is in hectares of arable land. Livestock is measured as an aggregate of all cattle, swine, sheep and poultry in the sector. For the aggregation weights used see Hayami and Ruttan (1971, p. 313). Machinery is measured as tractor horsepower available in the sector and fertilizer is tons of chemical fertilizer consumed.

4. The composite picture of the evolution of agricultural price, tax and investment policies was compiled from several sources. Rather than refer repeatedly to the same sources throughout this section, I list here the main sources referred to and use textual references

only for specific points of fact. General overviews of policies include Feiwal (1971), Landau and Tomaszewski (1985) and O'Hagan (1978). Materials dealing specifically with the private sector include Ciepiak (1978) and Szurek (1982). Works which summarize policies and focus on specific periods or prospects include Romanowski (1977), Simatupang (1981) and Cook (1984). In addition, collected works on particular aspects of Polish agriculture and rural life were used; these include Turowski and Szwengrub (1976) and Galaj and Rajtar (1977).

5. The datings of these periods do not coincide precisely with the actual dates of the Five Year Plans, but predate them by one year. The FYP, as the official statement of the government's plans, reflects both the accepted realities of the recent past and the desired path for the near future. For this reason, the FYPs often ratify changes in policy direction that have resulted from the problems of the previous plan and thus reflect a continuity with events that actually began before the dates of the FYP itself.

6. The period 1960-1955 was covered by the Six Year Plan.

7. The sources and basic points of construction of the data have been presented above in footnote 3. Additional points to note here are: (i) output is gross; this is the appropriate type of measure to use in the production function I estimate below, but does give different results from other measures; (ii) labor in the private sector has been adjusted for changes in the age/sex composition of this labor force and thus conveys the impression that a larger number of physical individuals was leaving agriculture than was actually the case; (iii) livestock, as an aggregate measure, only imperfectly captures such factors as quality changes in the existing stock; (iv) machinery is measured as tractor horsepower available in the sector and should be adjusted for changing utilization rates; this could be significant for the private sector, in which the amount of horsepower increased so dramatically in the 1970's; (v) fertilizer measures only chemical fertilizers consumed and thus is not a complete measure of all fertilizer consumption.

   Additional works which were consulted which explicitly compare the performance of private and socialized producers and which rely on data from official sources are Menteuffel (1970), Marcinko (1974) and Lawnicak (1983). These comparisons are carried out with nationally aggregated data and are thus not able to distinguish regional environmental factors, as is done in this study.

8. These are "quality-adjusted" workers and thus represent more than the physical number of workers who found employment in other sectors, due to the changing age/sex composition of the private labor force (see footnotes 3 and 7).

9. The main source of this material is Kostrowicki, et al. (1978). I also estimated the production functions based on regions similar to those presented in Szurek (1982) and found that they did not provide statistical explanatory power as great as the regions presented.

10. All of this discussion of the potential benefits of increased production and trade is, of course, predicated on the ability of Polish producers to obtain access to Western markets. This has always been possible in the past: when Poland had a surplus to sell it could. But the events surrounding the Chernobyl nuclear accident raise important qualifications. If Western countries maintain a ban on imports of food from Poland because of potential contamination, then the possible benefits of policy changes will be reduced, although the gains from improved internal efficiency would remain.

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