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PRODUCTION FUNCTIONS AND SOVIET AGRICULTURE:
DIFFERENCES IN TECHNOLOGY BY TYPE OF FARM

Michael L. Wyzan

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There has long been considerable debate in the Soviet Union, and, to a lesser extent in the West, over which of the two Soviet agricultural institutions, the kolkhoz (collective farm) or the sovkhoz (state farm) is the more economically advanced. Nonetheless, sophisticated empirical work on this question has been virtually nonexistent. This paper is a modest attempt at correcting this situation. Production functions are estimated using Soviet agricultural data in order to examine the technological differences and similarities between the farm types.

The outline of this paper is as follows. First, the institutional differences between the types of farm are briefly described. A numerical summary of their significance is provided, followed by a discussion of their operating procedures and the extent to which they are converging in their characteristics. The sense in which the kolkhoz might be considered a labor-managed cooperative is discussed, as are differing opinions as to which is the "superior" organizational form. Second, the data set and specific production function used in the estimations are described. Third, the results of the empirical work are presented. The analysis centers on the reporting, separately by type of farm, of three-input (land, labor, capital) translog production functions for five Soviet crops (grain, sugar beets, cotton, potatoes, and vegetables), grown during 1960-1976. The fourth section concludes.

I

Let us first examine the numbers and sizes of the two institutions. In 1978, there were 26,700 kolkhozy, down from 36,900 in 1965. In that same year, there were 20,484 sovkhozy, up from 11,681 in 1965. Sown area per kolkhoz and number of households per kolkhoz have risen over time, the former from 2848 hectares in 1965 to 3611 hectares in 1978, and the latter from 426 in 1965 to 495 in 1978. On the other hand, sown area per sovkhoz and number of employees per sovkhoz have fallen over the years, the former from 7607 hectares in 1965 to 5483 hectares in 1978, and the latter from 701 in 1965 to 556 in 1978. Finally, the total sown area on kolkhozy has fallen from 105.1 million hectares in 1965 to 96.4 million hectares in 1978, while the total sown area on sovkhozy has risen from 89.1 million hectares in 1965 to 112.4 million hectares in 1978. (Narkhoz, 1978, pp. 261, 262, 275, 278)

The number of kolkhozy has been shrinking when two existing farms are merged to form a larger one or when a kolkhoz is converted into a sovkhoz (the latter supposedly by decision of the general meeting of the kolkhoz, although in practice, by decision of the higher authorities). Amalgamation explains the rising sown area and number of households per farm, while the decline in sown area is the result of conversion. The rising number and sown area of sovkhozy are explained by conversion (over the 1965-1978 period; opening up of new lands was once also a factor). The declining sown area and number of employees per sovkhoz are probably due to the same phenomenon. Kolkhozy are generally smaller by both standards, and newly converted kolkhozy will therefore bring down the sovkhoz averages.

We turn next to a brief survey of the extant institutional differences between the two types of farm. It is generally believed in the West that the remaining divergence between the two forms is quite small. Moreover, it would appear that the kolkhoz and the sovkhoz are converging toward each other from opposite directions. In essence, what has happened is that the collective farm has lost many of the features of a peasant cooperative, becoming more like a state enterprise, while the sovkhoz (along with other state enterprises) has gained some decision-making independence, in the process coming more to resemble the kolkhoz.

Relative to the autonomy of kolkhoz decision-making, Stuart (1972, p. 189) has said,

> The kolkhoz, rather than being a self-governing, semi-autonomous unit maximizing a member dividend, is, in fact, an organization almost wholly subservient to the planning apparatus and operating within a net of institutional, legal, and economic controls serving to constrain the kolkhoz within operational bounds differing little from those of regular state organizations.

Nonetheless, kolkhozy do retain certain features which one would associate with a cooperative enterprise. Their profits are taxed at a flat rate (like the Yugoslav enterprise), while sovkhoz profits are paid into funds, like those of an industrial firm. This has the effect of making kolkhoz purchase prices more important to the personal incomes of kolkhozniki than sovkhoz delivery prices are to those of sovkhoz employees. This difference was particularly noteworthy before the abolition of the <u>trudoden</u> (labor day) system in

July, 1966, when kolkhoznik incomes were (often miniscule) residual shares of kolkhoz net output. Today, although collective farm members do receive a regular, cash, minimum wage payment, higher farm net income still means higher personal incomes. Sovkhoz employees have always received contractual wages, and hence have a material interest in enterprise success only to the extent that bonuses are tied to such success. We observe, therefore, that some difference by farm type in the manner of labor payment persists, although it has diminished since 1966.

Under Soviet law, the collective farm is unique institution, its parameters first specified in the _ustav_ (charter) of February, 1935, and updated in November, 1969. Formally, the kolkhoz maintains the features of the "voluntary" peasant cooperative, being based on the peasant _household_, the common property of which corresponds to personal property elsewhere in the economy. This formal distinction is especially evident as regards the private plots, which are ostensibly covered by different rules on kolkhozy from those governing sovkhozy (Wadekin, 1973, Chapter 2).[1] Kolkhozy are supposed to operate on a democratic basis, with members, or their representatives, making many important decisions, including choosing the farm's chairman (manager). But this "democracy" appears never to have had any practical significance, as even official Soviet accounts note that kolkhoz managers are appointed from above, and the state or Party interferes with or actually makes most important decisions (Stuart, 1972). Accordingly, the unusual legal position of the kolkhoz is not, in and of itself, a significant factor in explaining differences in farm-type performance.

We have seen that kolkhozy have approached sovkhozy as kolkhoz-
niki have received regular cash incomes and other forms of monetiz-
tion have taken hold (such as cost accounting), and that the dif-
ferences between the types of farm due to the collective's peculiar
status have never amounted to much. At the same time, it appears
that sovkhozy have been nearing kolkhozy from another direction.
Over the years, kolkhozy have been expected to exhibit a greater
degree of financial independence from the state. They have received
fewer state benefits, have not had access to interest-free capital,
and have been ineligible for grants from the state budget. Because
they were not to be bailed out of dire economic straits, and because
purchase prices were so important to income distribution and "ex-
panded reproduction" (the wherewithal for investment), they have
historically been paid higher prices for their outputs.

In fact, it has been a goal of recent Soviet policy to increase
the financial independence of the state farm, in order that it more
resemble the collective farm in this regard. This is reflected in
the movement in 1975 of the former to full khozraschet. A recent
Soviet source (Morozov, 1977, p. 78) defines this concept as follows:

> This refers to a system under which all expenditures that
> are incurred in carrying out [the sovkhozy's] planned pro-
> duction and delivery assignments are met from their own
> revenues. This includes a level of profit that will per-
> mit the state farm to expand its output. Financing from the
> state budget is no longer required, and whenever such funds
> are still given they play an auxiliary role.

According to the same source, sovkhozy are now supposed to be
given only the following targets: volume of basic agricultural

products to be purchased, the overall wage fund, the overall volume
of profit, subsidies from the budget, payments for productive assets,
the volume of centralized capital investment, and assignments for
the introduction of new technology. Kolkhozy, however, officially
retain more independence, being responsible only for the first target
listed above (Morozov, 1977, p. 107).[2] It would seem, therefore,
that, although the sovkhoz has approached the kolkhoz in its degree
of decision-making independence, there remains some distance between
them. This situation parallels the fact that the kolkhoz has ap-
proached, but not reached, the sovkhoz's degree of monetization.

For the purposes of the present study, we are especially con-
cerned with differences by farm type which specifically relate to
the production process. Labor inputs are treated separately below;
we are, at this point, interested only in managerial, land, and capi-
tal inputs. At one time, there were considerable differences in
managerial motivation by farm type. Historically, kolkhoz chairmen
have not been paid much better than the average kolkhoznik and their
bonuses have been a much smaller portion of their total remuneration
than for industrial managers. Today, however, the kolkhoz chairman
has had potential pay raised, placed largely in monetary terms,
based on monetized targets, and in general made congruent to the
situation for sovkhoz managers. Managerial motivation is probably
no longer a source of significant difference by farm type.[3]

Turning to land utilization, Stuart (1972, pp. 114-115) observes
that the extent to which kolkhoz managers can shift the use of sown
area among crops is quite limited. Furthermore, land use patterns
within kolkhozy seem to be quite stable, with specialization not

much of a factor. (On this, see Gray, 1979.) Sovkhozy, on the other hand, are quite often made to specialize in a specific crop, although this is probably due more to greater flexibility on the part of the sovkhoz labor force (i.e., less traditional resistance to change) than to optimizing responses to price signals. Such signals are quite clouded for both types of farm, in view of the zonal differentiation of purchase prices.[4] In any case, it will be interesting to observe whether or not the productivity of land differs on specialized sovkhozy from unspecialized kolkhozy. One thing we can see with confidence is that the greater average physical area of state farms means that each sovkhoz employee has more land with which to work.

As far as capital allocation is concerned, some differences by farm type may persist, in view of the greater degree of financial independence expected of the collective farm. Higher purchase prices and the abolition of the Machine Tractor Stations (1958) have increased both the means and the necessity for self-finance of kolkhoz investment. This phenomenon is heightened by the fact that kolkhoz management seems very reluctant to borrow and prefers to finance expansion with retained net income. In 1958, the norm for investment as a fraction of net income was abandoned, and, interestingly, the size of deductions for capital investment fell (Stuart, 1972, p. 132). This is noteworthy insofar as it suggests a degree of independence in this area of decision making, and parallels a similar phenomenon in Yugoslavia, wherein there was a genuine shift to self-management after 1965 (Schrenk, Ardalan, and El Tatawy, 1979, Chapter 7). On the other hand, precisely for what the saved funds can be utilized is still tightly controlled. As the list above of targets suggests,

state farms still receive centralized investment funds and budgetary subsidies. In the end, it is probably fair to say that kolkhozy are expected to be self-financing to a sufficient extent to make this an area of distinction between the types of farm.[5] It should also be observed at this point that sovkhozy seem to be more capital-intensive than kolkhozy, a fact which will be of some importance later.

We have seen that there is a degree of convergence between the farm types, but that there probably remain some differences. We turn now to a discussion of the extent to which the kolkhoz resembles the self-managed cooperative of Western literature and Yugoslav experience. In the 1960s, there was a series of articles by well-known economists treating the kolkhoz as such an organization (Domar, 1966; Robinson, 1967; Oi and Clayton, 1968). The general feeling, however, as exemplified by the Stuart quote early in the paper, is that it is inappropriate to regard the kolkhoz in this manner. It has been observed that the voluntary and democratic elements of the collective are largely ephemeral. On the other hand, there are some aspects that give one pause--freedom to decide investment rates, workers being paid on a share of residual income basis, lack of access to government subsidies, and so on.

This is significant for the present purposes because of the existence of ways in which production function estimation can shed light on such questions. Sapir (1980), for example, uses such analysis to attribute the slowdown in Yugoslav economic growth to a rising capital-labor ratio (brought about by the inherent incentive structure of the post-1965 self-managed economy), and a low elasticity of substitution. It is possible to make a similar examination of

the kolkhoz. One basic implication of a truly worker-managed economy is a rise in the relative price of labor.[6] This suggests that labor would have a higher estimated average and marginal product on the kolkhoz than on the sovkhoz.

There are, however, two contradictory tendencies, two factors which might make for relatively low labor productivity on the kolkhoz. First, it is quite possible for the collective farm to be a cooperative in the sense of payment of members by residual shares, but one directed by a salaried manager, rather than by workers. This might be called a "directed cooperative." As Nimitz (1967, pp. 195-196) has pointed out, the cost of labor to the kolkhoz chairman (before 1966, at least) was "infinitely collapsible," in that net output was to be divided among however many workers had contributed labor days. As long as the marginal product of a worker was positive, there was no reason not to add him to the labor force. This would reduce everyone else's share, and, hence, a worker-managed collective would never follow such a rule; the typical Soviet manager, however, known for his hoarding of scarce resources, might well do so.

Today, the presence of a minimum wage means that all workers do have a positive cost associated with them. Nonetheless, to the extent that the kolkhoznik remains a residual legatee, and that the chairman is all-powerful, the incentive for labor-hoarding remains. Sovkhoz employees are paid a fixed wage, which, except for bonus payments, is unrelated to enterprise net output; this peculiar incentive situation, therefore, does not exist in the state sector.

The second factor contributing to lower kolkhoz labor productivity is the relatively poor quality of its labor force. In 1967,

Nimitz (p. 194) estimated that 30% of the collective farm labor force consisted of people who would not work if they lived in a city--youths 12-15, the disabled, and the aged, especially older women ill-suited to physical labor. Although these substandard workers form the bulk of the labor inputs to the private plots, the persistent rural labor shortage (especially during the harvest) necessitates their employment in the collective fields as well. This is much less of a problem on state farms, where industrial wage scales are said to prevail.

The pay differential is probably sufficient to guarantee a superior labor force on the sovkhoz, although the general undesirability of rural employment, especially for the young and the educated, probably means that the average sovkhoz worker is inferior (by qualification) to the average industrial employee. Labor productivity would also be expected to be higher on the state farm because sovkhoz employees have more complementary inputs with which to work. In sum, we can say that if the kolkhoz were a labor-managed cooperative we would expect to observe higher labor productivity thereupon, whereas if it were a "directed" cooperative, especially in the light of its substandard labor force, we would expect to observe lower labor productivity. The empirical portion of this paper addresses this question.

Finally, a word is in order on which type of farm is to be considered the more economically advanced. There is, of course, the ideological notion that the kolkhoz form is an inferior type of property in a socialist society. As Stuart (1972, p. 8) has observed, "[f]rom an ideological standpoint, the state farm is a 'full partner'

while the kolkhoz form of property holding is viewed as inferior."
This is presumably the rationale for the policy of converting kol-
khozy into sovkhozy--it is hoped that aggregate economic performance
will be improved as the proportion of land on state farms is increased.
In fact, at one time at least, it was thought that the kolkhoz would
eventually be eliminated as an organizational form. Stuart (1972,
pp. 4-5), after describing many of the traditional shortcomings of
Soviet agriculture, finds no reason to dispute the contention that
the kolkhoz is economically inferior.

On the other hand, Soviet economists do not necessarily agree
with this assessment. Writing in 1965, Buzdalov notes that, despite
the fact that the sovkhoz is supposed to set an example for the
kolkhoz, actual indices demonstrate the inferiority of the former.
"According to annual data, sovkhozy at present, despite a more tech-
nically armed labor force, receive less gross output from each hec-
tare of land than kolkhozy . . . The same can be said for indices of
productivity, and likewise cost" (p. 3). He goes on to note that
this relatively poor performance even applies to "older" sovkhozy,
in addition to newly converted ones, which might be expected to do
worse, given the fact that it is generally the less profitable kol-
khozy which are converted.

Buzdalov blames the poor sovkhoz performance on insufficient
management, uninspired planning, and voluntarism with regard to sov-
khoz decisions. He criticizes the conversion campaigns as detri-
mental--the sovkhoz share of agricultural production should grow
only after they have proved themselves to be at least as viable as
kolkhozy.[7] We therefore observe two highly contradictory views of

the relative status of the two types of organization. This interesting question is empirically examined below.

II

The data set used in this study, some econometric considerations engendered by its idiosyncracies, and the translog production function are discussed in Wyzan(1981) and will only be briefly described here. Figures, gathered from official Soviet sources, are available on five crops, grain, sugar beets, cotton, potatoes, and vegetables. Other crops, such as sunflowers or flax, are not included because there are no published data on labor inputs into their production. For each type of farm, the data on each crop are in the form of a pool of cross-sectional and time-series observations, with each time-series covering some fraction of (or in some cases all of) the period 1960-1976.

The cross-sections are formed by nine Soviet republics, Armenia, Azerbaidzhan, Estonia, Lithuania, Moldavia, RSFSR, Tadzhikistan, the Ukraine, and Uzbekistan. The other six republics, including the important agricultural areas of Belorussia and Kazakhstan, are omitted from this study because it is impossible to divide total crop outputs by type of farm based on the contents of their statistical yearbooks. Altogether, there are 243 observations for grain (121 kolkhoz and 122 sovkhoz), 143 for sugar beets (71 kolkhoz and 72 sovkhoz), 74 for cotton (evenly divided by farm type), 229 for potatoes (114 kolkhoz and 115 sovkhoz), and 147 for vegetables (74 kolkhoz and 73 sovkhoz), for a total of 836 cases.

As already mentioned, all figures come from official Soviet sources and are not qualitatively adjusted. Land is measured in

thousands of hectares of "sown area," and labor in thousands of man-hours.[8] The latter are found in the annuals as labor-intensity data--man-hours per centner of output; total labor inputs are obtained by multiplying these intensities by appropriate physical weight output data, which are available in thousands of metric tons. Capital services pose a particularly difficult problem, in that no crop-specific Soviet capital data are available. In this study, the number of a certain type of machine in existence in each year is used as a proxy for capital inputs. Grain combines are used in grain cases, cotton machines in cotton cases, and tractors elsewhere.[9]

The three input translog production function used in the estimations is written

$$(1) \quad \ln Q_i = b_0 + \lambda t + b_1 \ln R_i + b_2 \ln L_i + b_3 \ln K_i + b_4 (\ln R_i)^2 +$$
$$b_5 (\ln L_i)^2 + b_6 (\ln K_i)^2 + b_7 (\ln R_i)(\ln L_i) +$$
$$b_8 (\ln R_i)(\ln K_i) + b_9 (\ln L_i)(\ln K_i) + \mathcal{E}_i$$

where the subscript i indexes a particular observation, Q is output, R is land, L is labor, K is capital, t is a time index equal to one for the first year of the data set, two for the second year, and so on, meant to capture neutral technological change, and the vector of disturbances $(\mathcal{E})$ satisfies the full ideal conditions (Berndt and Christensen, 1973).

This function is probably most appropriately viewed as a second order Taylor-series expansion around the means of output and each input, rather than as an exact representation of the productive technology. It allows one to estimate the nature of returns to scale and factor substitution, instead of imposing untested restrictions on them. Regions of non-convex isoquants are present whenever any

coefficient $b_4, \ldots, b_9$, is significantly different from zero. Neutral technical progress can be treated in an additive manner, as demonstrated in equation (1).

Before moving on, a number of features of this functional form deserve mention. In line with the definition of the translog function as a Taylor-series expansion, all output and input data were divided by their respective means before estimation. This causes the means of R, L, and K all to become one, and hence the means of lnR, lnL, and lnK all become zero. This procedure has several implications, in view of the fact that estimated scale and substitution effects, being variable, must be evaluated at the means of the data set.

First, the output elasticities (factor shares under cost mini-mization) are linear functions of the logs of each input. For example,

$$(2) \quad \frac{\partial \ln Q}{\partial \ln R} = b_1 + 2b_4 \ln R + b_7 \ln L + b_8 \ln K .$$

Because the means of lnR, lnL, and lnK are all zero, the mean value of the output elasticity of land is simply b_1. It follows directly that b_2 is the mean estimated output elasticity of labor, and b_3 plays this role for capital. Second, returns to scale, m, being the sum of the output elasticities, are also a linear function of all inputs. It is easy to show that they are given by

$$(3) \quad m = b_1 + b_2 + b_3 + (2b_4 + b_7 + b_8)\ln R + (2b_5 + b_7 + b_9)\ln L + (2b_6 + b_8 + b_9)\ln K .$$

This function is evaluated at every point in the data set on a crop, and then these calculations are averaged to obtain the mean scale effects for that crop.

Finally, the three partial elasticities of substitution, σ_{RL},

σ_{RK}, and σ_{LK} are calculated according to a formula given by Berndt and Christensen (1973, p. 97), evaluated at each point in the data set on a crop, and then averaged. The translog function is especially useful for this purpose, in that (unlike the CES function, for example) it allows three different partial elasticities to be estimated, two of which can be negative. This makes it possible to have complementary factor pairs.

III

In this section, the data and methods described in section III are used to examine the issues raised in section I. There are essentially three questions to be studied. First, we wish to examine, separately by crop, the differences by farm type in the basic productive technology. Two methods of ascertaining whether or not the production function parameters are statistically significantly different are presented. Second, it is of interest empirically to examine the question of whether or not the kolkhoz in any way resembles a worker-managed cooperative. Finally, the estimated production functions, factor productivity comparisons, and estimated scale and substitution effects are used in an attempt to ascertain which institution is the "superior" one.

The first question of interest is the possible existence of statistically significantly different production functions by type of farm. Translog estimates for both types for each crop are reported in Table 1. We are interested especially in the coefficients of land, labor, and capital (the second through fourth columns), because these are the mean estimated output elasticities of the respec-

Table 1

Translog Results Separately by Type of Farm

Kolkhozy

Crop	Intercept	Land	Labor	Capital	Land^2	Labor^2	Capital^2	Land*Labor	Land*Capital	Labor*Capital	λ^c
Grain	-.361**[a]	.757**	.137	.362**	.576	.182	.019	.010	-.934	.200	.034**
	(-5.51)[b]	(5.59)	(1.61)	(2.79)	(1.29)	(1.11)	(.105)	(.018)	(-1.31)	(.452)	(5.09)
Sugar	-.206**	.255	.875**	.929**	3.26*[a]	-.652	-.307	-1.47	1.02	-1.62**	.023**
Beets	(-2.85)	(1.38)	(6.91)	(.187)	(2.03)	(-1.43)	(-.850)	(-1.00)	(.704)	(-2.78)	(3.10)
Cotton	-.196**	.450	.294	.063	-15.30	.880	.039	12.17	-2.48	.432	.020**
	(-4.71)	(1.01)	(1.13)	(.920)	(-1.07)	(.262)	(.390)	(.915)	(-1.47)	(.494)	(5.90)
Potatoes	-.162*	.007	.790**	.481*	-.846	-.776	-1.48*	.679	-1.73	-1.40	.021*
	(-1.99)	(.044)	(5.56)	(2.46)	(-1.53)	(-1.54)	(-2.51)	(.916)	(-1.86)	(-1.46)	(2.58)
Vegetables	-.261	-.085	.929**	.737*	.178	.164	1.09*	-.222	2.95*	-1.92*	.016
	(-1.76)	(-.460)	(6.51)	(2.12)	(1.34)	(.435)	(2.24)	(-.290)	(2.26)	(-2.40)	(1.14)

Table 1 (continued)

Sovkhozy

Crop	Intercept	Land	Labor	Capital	Land^2	Labor^2	Capital^2	Land*Labor	Land*Capital	Labor*Capital	λ^c
Grain	-.089	.840**	.040	.380**	-2.02	-.375	-.279	2.13*	1.35	-.37	.009
	(-1.23)	(5.12)	(.490)	(3.09)	(-1.76)	(-1.21)	(-1.16)	(2.03)	(1.50)	(-1.20)	(1.31)
Sugar	-.700**	-.012	1.03**	-.516*	-.046	-.199	-.510	-.110	.190	.0001	.08
Beets	(-5.14)	(-.07)	(7.36)	(-2.27)	(-.100)	(-.412)	(-1.91)	(-.146)	(.438)	(.0003)	(5.40)**
Cotton	-.200**	.862**	.187	.109	.864	.413	-.239	-1.71	.606	.153	.018**
	(-3.38)	(5.26)	(1.36)	(1.06)	(.725)	(.411)	(-1.09)	(-.795)	(1.38)	(.317)	(2.95)
Potatoes	-.224*	.101	.724**	.483**	.084	-.094	.413*	.123	-1.00	.221	.020
	(-2.15)	(.668)	(6.05)	(2.82)	(.310)	(-.473)	(2.11)	(.321)	(-1.62)	(.571)	(1.87)
Vegetables	-.477**	.137	.924**	.095	.360	.425	.550	-.205	-1.44	.591	.043**
	(-4.20)	(.839)	(7.47)	(.431)	(.567)	(1.94)	(1.80)	(-.193)	(-1.68)	(.700)	(4.01)

Notes to Table 1

Note: The heading of each column refers to the logarithm of the relevant variable, with, for example, Capital^2 denoting the coefficient on the square of the log of capital, and Land*Labor denoting the coefficient on the product of the logs of land and labor, and so on.

[a]Two asterisks mean that the regressor is significant at .01; one means that it is significant at .05.

[b]t-statistics are in parentheses below each estimated coefficient.

[c] λ is the coefficient on the time index t.

Table 2

Translog Results With a Dummy Variable

Denoting Farm Type

Crop	Intercept	Land	Labor	Capital	Land^2	Labor^2	Capital^2
Grain	-.253**[a]	.696**	.053	.283**	.308	.145	-.066
	(-6.02)[b]	(6.98)	(.296)	(3.60)	(.831)	(1.25)	(-.789)
Sugar	-.496**	.097	.894**	-.067	.106	-.129	-.231
Beets	(-6.56)	(.749)	(8.49)	(-.481)	(.261)	(-.355)	(-1.27)
Cotton	-.181**	.694**	.379**	.029	-.090	-.697	-.093
	(-5.02)	(5.28)	(3.36)	(.662)	(-.095)	(-.825)	(-1.36)
Potatoes	-.167*[a]	-.021	.788**	.569**	-.236	-.056	.293*
	(-2.57)	(-.212)	(9.30)	(5.11)	(-1.14)	(-.346)	(2.29)
Vegetables	-.315**	-.048	.960**	.523**	.406	.370	.516*
	(-3.46)	(-.434)	(10.84)	(2.76)	(1.06)	(1.95)	(2.24)

Land*Labor	Land*Capital	Labor*Capital	λ^c	Dummy[d]
.149	-.490	.055	.023**	.008
(.358)	(-1.58)	(.322)	(5.93)	(.319)
-.428	.328	-.349	.055**	-.004
(-.689)	(.889)	(-.981)	(6.95)	(-.108)
.718	.064	.159	.019**	-.030
(.420)	(.195)	(.520)	(6.44)	(-1.50)
.258	-.417	-.042	.017**	-.013
(.807)	(-1.19)	(-.158)	(2.61)	(-.527)
-.471	-.434	.178	.026**	-.009
(-1.10)	(-.885)	(.399)	(3.02)	(-.315)

Notes to Table 2

Note: The heading of each column refers to the logarithm of the relevant variable, with, for example, Capital^2 denoting the coefficient on the square of the log of capital, and Land*Labor denoting the coefficient on the product of the logs of land and labor, and so on.

[a]Two asterisks mean that the regressor is significant at .01; one means that it is significant at .05.

[b]t statistics are in parentheses below each estimated coefficient.

[c] λ is the coefficient of the time index t.

[d]The variable Dummy = 0 if the observation comes from a kolkhoz; Dummy = 1 if it comes from a sovkhoz.

tive inputs, and the coefficient λ, denoting the rate of neutral technical progress. At first glance, we observe that for three crops, grain, cotton, and potatoes, the mean output elasticities are quite similar for kolkhozy and sovkhozy; for the latter two crops, neutral technical progress is virtually identical. For the other two crops, sugar beets and vegetables, the differences between comparable estimated coefficients are quite large.

There are two ways in which we can be more precise about this matter. First, the production functions fit separately by farm type to data on each crop are estimated "together" as a pair of seemingly unrelated regressions (Zellner, 1962). This allows the production function parameters to be more efficiently estimated, taking into account the correlation between disturbances in observations which are identical except for farm type. It allows a non-zero covariance to exist between "matched" disturbances representing, say, potatoes on Armenian kolkhozy in 1963, and potatoes on Armenian sovkhozy in that year, and a zero covariance between every "unmatched" pair. More important than increased efficiency (the efficient estimates are not presented here) is the fact this process makes possible the performance of an F-test for coefficient equality across farm types; we are interested in simultaneously testing the ten hypotheses that the coefficients on land are equal, those on labor are equal, and so on, up to and including the hypothesis of equal coefficients on technical progress.

The results of this procedure are as follows. The F value for cotton (with 10 and 52 degrees of freedom) is 2.01, which is not statistically significant. For potatoes, F (with 10 and 206 degrees

of freedom) is 2.02, which is significant at .05, and, for grain, F
(with 10 and 220 degrees of freedom) is 2.17, also significant at
.05. For vegetables, we have an F (with 10 and 122 degrees of free-
dom) of 2.56, which is significant at .01, and, for sugar beets, we
obtain an F (with 10 and 120 degrees of freedom) of 5.75, also sig-
nificant at .01. On the whole, therefore, except for sugar beets,
we find relatively minor technological differences by farm type.

The results of the second method of ascertaining divergence by
farm type are presented in Table 2. Here, a dummy variable equal to
zero for all kolkhoz observations and one for all sovkhoz observa-
tions is included in regressions estimated for the entire data set
on a crop. As can be readily seen from perusing the table, this
dummy variable is never statistically significant. In sum, by both
methods, we observe only modest technological differences by type of
farm.

It is interesting to speculate as to why the extent of techno-
logical differences by farm type varies among crops. The relative
significance of the two institutions varies considerably by product.
Total grain output in 1978 was 52% from kolkhozy (and 47% from
sovkhozy), while sugar beet output was 90% from kolkhozy (and 10%
from sovkhozy), and cotton output was 70% from kolkhozy (and 30%
from sovkhozy). Potatoes come predominantly from the private sector
(61%), with the remainder being 23% from kolkhozy and 16% from
sovkhozy, and vegetables (of which 29% come from the private sector)
are 28% from the collective farm and 43% from the state farm.
(Narkhoz, 1978, p. 196).

A regional explanation may be useful in shedding light on this
question. The division of the output of a crop by type of farm

for the nation as a whole reflects the prevailing division in the republics which dominate the production of that crop. A particularly interesting case is sugar beets, the percentage of which obtained from kolkhozy is the highest of all crops. Recall that we found the most significant farm type difference in technology for this crop. Most of sugar beet output (60% in 1978) comes from the Ukraine, where the kolkhoz predominates; another 4 % derives from Moldavia and Lithuania combined, both of which are very kolkhoz-oriented republics. These are all areas of non-Russian peasants (non-Slavic in the latter two cases) and part (in the case of the Ukraine) or all of their rural populations have been collectivized relatively recently. The kolkhoz tends to predominate in such areas. The small percentage of sugar beet output which does come from the sovkhoz most likely is obtained from relatively newly utilized area in Kazakhstan and Kirghizia. Hence, for sugar beets, farm type differences may really be regional differences (Hultquist, 1967).

Grain, for which relatively small farm type differences were found, is split about evenly in the country as a whole between collective and state farms. In 1978, the RSFSR was responsible for 58% of grain output, and grain output tends to be quite evenly split by type of farm in this huge republic. If the two organizational forms are evenly distributed across the landscape of the Russian republic, this might explain the failure to find particularly significant technological differences between forms. Similarly, the lack of difference by farm type for cotton might be explained by the fact that all cotton is grown in Central Asia (and Azerbaidzhan) and hence regional differences are unlikely to be significant. The significant

difference in vegetable growing technology may have a different sort of explanation--it may reflect the comparison of specialized sovkhozy and non-specialized kolkhozy whose primary enterprises are other crops. Vegetables are the only crop for which the sovkhoz dominates social sector production and it is quite possible that different production methods are used on these large specialized farms from those used on unspecialized kolkhozy.

We turn next to the question of whether or not the kolkhoz resembles a labor-managed firm. Specifically, we are interested in the magnitude of the average and marginal productivities of labor. Because the translog function, having been estimated on predivided data (see section II), forces the mean marginal products and mean output elasticities of each input to be equal, it is best not to use it to find mean marginal factor productivities. Table 3 presents the mean marginal products of land and labor, as estimated from a Cobb-Douglas production function. We observe that the estimated marginal product of labor is higher on sovkhozy for every crop but vegetables, and even for this crop the average product of labor (not reported) is higher. The evidence therefore suggests that the impact of more complementary inputs with which to work and a higher quality labor force seems to outweigh any tendencies to conserve on labor use which would inhere in a truly labor-managed firm.

Lastly, we are concerned with the question of which type of farm is the "superior" one. There is a number of angles from which to approach this problem: factor productivities can be examined, and returns to scale, factor substitution, and the rate of technical progress can be compared. There has been a tendency merely to

Table 3

Mean Marginal Products of Land and Labor

As Estimated from a Cobb-Douglas Production Function

Kolkhozy

	Land	Labor
Grain	1.05	-.006
Sugar Beets	18.95	.010
Cotton	1.32	.0008
Potatoes	6.18	.0067
Vegetables	-1.39	.005

Sovkhozy

Grain	.858	.013
Sugar Beets	.297	.416
Cotton	.653	.0023
Potatoes	6.64	.012
Vegetables	18.19	-.013

examine labor productivity in making comparisons. Clearly, in line with the analysis above, if we fail to procede beyond this comparison, albeit an important one given the Soviet labor shortage, we will find the sovkhoz to be superior. However, a complete comparison must take into account the productivity of every factor and total factor productivity, the latter embodied in returns to scale.

Keeping this in mind, we observe that the marginal product of land, as reported in Table 3, is higher on kolkhozy for grain, sugar beets, and cotton, and virtually identical by farm type for potatoes. Although Soviet data make it difficult to obtain yields (average land productivities) separately for the two organizational forms for most crops, it is possible for grain, and kolkhozy do obtain higher yields. In our data set, average yields of grain are 14.9 metric tons per hectare on kolkhozy and 12.6 metric tons per hectare on sovkhozy. Because capital is measured by proxy, estimated mean capital productivities would not be particularly meaningful. However, Galsanov (1980) has recently reported that kolkhozy obtain more gross output per rouble of loan funds and require smaller amounts of their own funds to produce 1000 roubles of gross output than sovkhozy. This would seem indirectly to indicate a higher marginal product of capital on collective farms.

Further, by observing the estimated scale and substitution effects reported in Table 4, we find even more evidence in favor of the kolkhoz. Returns to scale are very high for both types of farm (a similar finding was reported in Wyzan, 1981), and are higher on kolkhozy for three of the four crops reported.[10] Looking at the estimated partial elasticities of substitution in the same table, it is of interest to know how many of these elasticities are negative or

Table 4

Mean Estimates of Scale and Substitution Effects
Derived from the Translog Production Function[a]

Kolkhozy

Crop	Returns to Scale	Elasticities of Substitution		
		σ_{RL}	σ_{RK}	σ_{LK}
Grain	1.25	.382	-.769	.262
Cotton	.926	.025	-.302	.323
Potatoes	1.53	.389	-.823	-.198
Vegetables	1.49	-.533	.729	.350

Sovkhozy

Crop	Returns to Scale	Elasticities of Substitution		
		σ_{RL}	σ_{RK}	σ_{LK}
Grain	1.22	.311	.035	-.832
Cotton	1.15	-.208	.245	.810
Potatoes	1.33	.573	-.791	.170
Vegetables	1.15	.133	-.680	.169

[a]Results for sugar beets were unreliable and are not presented.

greater than one. In such cases, optimistic growth forecasts can be made for the relevant crop, because the growth weight (output elasticity) of the faster-growing factor will rise. For kolkhozy, five of the twelve elasticities of substitution reported are negative, while for sovkhozy four are (none is greater than one for either crop). This result suggests that the outlook for future output growth is at worst no bleaker on collective farms than on state farms.

Two other small pieces of evidence may be cited in favor of the contention of kolkhoz superiority. First, as reported in Table 1, neutral technical progress is more rapid on collective farms for grain, cotton, and potatoes. Second, we observe that the coefficient on the dummy variable for farm type included in the regressions reported in Table 2 is such as to suggest greater overall efficiency on kolkhozy for all crops but grain. The dummy variable is, however, always statistically insignificant, and hence it is perhaps best not to put much faith in this finding.

IV

In the first part of this paper, we observed that the kolkhoz has approached the sovkhoz in its degree of monetization, treatment of private plots, and manner of managerial motivation. We also noted that the sovkhoz has approached the kolkhoz in its degree of financial independence. Nonetheless, it seems that some (at least official) institutional differences persist. The extent to which the kolkhoz might be judged a labor-managed firm was considered; we observed that other factors, such as fewer complementary inputs,

a less qualified labor force, and the "directed cooperative" hypothesis, probably cancel out any of the effects, especially on labor productivity, which might be expected on such an institution. Lastly, we noted the controversy surrounding the question of which farm type is economically "superior."

Empirically, we found that the differences in technology by farm type are relatively small. For those crops, such as sugar beets, for which major differences do exist, regional explanations were proffered. To the extent that there are differences, they mostly redound to the credit of the kolkhoz--higher yields and capital productivity, higher returns to scale, more optimistic growth prospects, and faster technical progress. The one indicator on which the sovkhoz is clearly superior--labor productivity--can be explained by the greater availability of land and capital to state farm employees. No evidence was found in support of the view that the kolkhoz is a labor-managed firm.

In concluding, two comments are in order. First, the results of this paper should serve as a lesson to those who would study productive relationships from the point of view of the productivity of a single factor. The previous Western contention that the sovkhoz is superior seems to have been based, at least partially, on comparative observations of labor productivity. In this paper, we have seen how misleading such an approach can be. Second, the results presented herein should give Western scholars some idea why slowing down the conversion campaign was a goal of the 1965 Brezhnev reforms; were the sovkhoz the more economically advanced form, this would hardly have been necessary or desirable.

NOTES

1. As Wadekin (1973, p. 28) notes, on kolkhozy ". . . archaic familial
legal rights of ownership [are retained], observing the principle of
equal rights for each member of the family." Furthermore, those who
leave the collective are subjected to special penalties as far as
property rights are concerned not applicable elsewhere in the economy.
In general, however, it is believed that the treatment of private
plots is no longer a source of significant difference between farm
types. Once, the residual-receiving kolkhozniki derived their main
subsistence from the plots, while sovkhoz and other state employees
had less need for their plots, which were generally smaller. However,
vast improvements in purchase prices and minimum collective farm
wages since Stalin's demise have made the necessity of private plots
rather similar throughout the economy. See Wadekin (1973, p. 4).

2. Despite the officially small number of targets (by historical
standards anyway), these guidelines are apparently often violated.
Yefremov (1976) cites the provision of more than the specified number
of indicators (e.g., quarterly assignments in addition to annual ones),
the withdrawal of the farm's power to channel depreciation deductions
into its expansion fund, and the lack of responsibility on the part
of suppliers of industrial machinery for the final results of produc-
tion. See also Ovsyannikov (1975). This retreat from decentralizing
reform has, of course, occurred throughout the Soviet economy in
the 1970s. See Schroeder (1979).

3. Stuart (1972, pp. 101-102) reports that in 1961, only 7.6% of the
income of kolkhoz chairmen was in bonus form. By way of contrast,
Adam (1980, pp. 359-360) reports that, since 1977, there has been a

ceiling on the bonuses of top management of 50% of base salary.
Further, the latter author mentions a 1974 Gosbank study in which
it was found that 23.5% of managers received bonuses totalling 38-
50% of earnings, 48.8% received bonuses of 51-60% of earnings, 16.3%
received bonuses of 65% of earnings, and another 11.4% apparently
received an even higher percentage of their earnings in this form.
If the truism that sovkhozy are exactly like industrial enterprises
can be believed, then there must be some remaining divergence by
farm type in managerial motivation.

4. Buzdalov (1965, p. 9) provides evidence that sovkhozy specializing
in the production of a certain product as a rule do so no more effi-
ciently (either in terms of yield, cost, or labor productivity) than
those which are unspecialized.

5. One area of financial similarity between the forms is that both
types can borrow at the same infinitessimal interest rates (1% for
short-term capital and .75% for long term capital). See Morozov
(1977, pp. 99-101).

6. It can be shown that a labor-managed firm which maximizes net in-
come per worker will hire fewer workers than an identical firm which
maximizes profits, so long as economic profits are positive.

7. In fact, decelerating the rate of conversion was one of the
stated goals of the 1965 Brezhnev agricultural reforms. Since then,
in the 1960s and 1970s, there has been the formation of the inter-
kolkhoz associations (not specifically dealt with in this paper), or
MOs, an attempt to strengthen the kolkhoz sector through the integration
of various functions across farms. According to Miller (1976), the
MOs, in the course of performing this integrative role, have come to

resemble state enterprises, especially the large scale vertically integrated production and processing centers for single products like wine or vegetable oils. Many integration schema deprive the individual kolkhozy of their operational autonomy. There is apparently some feeling in the Soviet Union that this integration process is a way of eliminating the ideologically retrograde kolkhoz once and for all; Miller (1976) envisualizes "the progressive absorption of the kolkhoz component by the growing state agri-business sector." On the other hand, certain factions, in particular the leadership of the Moldavian Party, seem to continue to view the kolkhoz in a favorable light.

8. The failure qualitatively to adjust land inputs, the fertility of which must vary considerably across such a large nation, deserves further comment. Two pieces of evidence suggest that this may not be a major problem. First, regional dummy variables included in estimated (translog) production functions all proved statistically insignificant for every crop. Second, Clayton (1980, p. 453) notes that Soviet land data adjusted by a method of her own devising, when employed in an aggregate production function, give insignificantly different results from unadjusted data.

9. Tractors are used in all vegetable cases because of the absence of a specific type of machine used in their production. Although some figures are available on beet combines and potato combines, such data cannot be obtained for every republic, and hence it was deemed best to use tractors in each sugar beet and potato case. For dis-cussions of the econometric implications of the use of a proxy variable and of omitting other inputs, such as fertilizer, see Wyzan (1981).

10. The high estimated returns to scale, of course, merely tell us

that, for the specific technologies the Soviets have chosen to exploit, large scale production will be cheaper than small scale production. They do not tell us that smaller farms (e.g., the private plots or hypothetical small capitalistic enterprises), _mutatis_ _mutandis_, are not more efficient.

REFERENCES

Adam, Jan. "The Present Soviet Incentive System." Soviet Studies
    32 (July 1980): 349-365.

Berndt, Ernst, and Christensen, Laurits. "The Translog Function and
    the Substitution of Equipment, Structures, and Labor in U.S.
    Manufacturing 1929-68." Journal of Econometrics 1 (March
    1973): 81-113.

Buzdalov, I. "Problemy Rosta Effektivnosti Sovkhoznogo Proizvodstva."
    Voprosy Ekonomiki, no. 3 (1965): 3-12.

Clayton, Elizabeth. "Productivity in Soviet Agriculture." Slavic
    Review 39 (September 1980): 446-458.

Domar, Evsey. "The Soviet Collective Farm as a Producer Cooperative."
    American Economic Review 56 (September 1966): 734-757.

Galsanov, M. "Kredit i Organizatsiia Sredstv." Ekonomika Sel'skogo
    Khoziaistva, no. 2 (1980): 24-26.

Gray, Kenneth. "Soviet Agricultural Specialization and Efficiency."
    Soviet Studies 31 (October 1979): 542-558.

Hultquist, Warren. "Soviet Sugar-Beet Production: Some Geographical
    Aspects of Agro-Industrial Coordination." In Soviet and East
    European Agriculture, pp. 135-151. Edited by Jerzy Karcz.
    Berkeley: University of California Press, 1967.

Miller, Robert. "The Future of the Soviet Kolkhoz." Problems of
    Communism 25 (March-April 1976): 34-50.

Morozov, V. Soviet Agriculture. Translated by Inna Medova. Moscow:
    Progress Publishers, 1977.

Nimitz, Nancy. "Farm Employment in the Soviet Union, 1928-1963."
    In Soviet and East European Agriculture, pp. 175-205. Edited
    by Jerzy Karcz. Berkeley: University of California Press, 1967.

Oi, Walter, and Clayton, Elizabeth. "A Peasant's View of a Soviet
Collective Farm." American Economic Review 58 (March 1968):
37-59.

Ovsyannikov. I. "Polnee Ispol'zovat' Vozmozhnosti Khozrascheta."
Ekonomika Sel'skogo Khoziaistva, no. 12 (1975): 28-33.

Robinson, Joan. "The Soviet Collective Farm as a Producer Coopera-
tive: Comment." American Economic Review 57 (March 1967):
222-223.

Sapir, Andre. "Economic Growth and Factor Substitution: What Hap-
pened to the Yugoslav Miracle?" The Economic Journal 90
(June 1980): 294-313.

Schrenk, Martin, Ardalan, Cyrus, and El Tatawy, Nawal. Yugoslavia:
Self-management Socialism and the Challenges of Development.
Baltimore: The Johns Hopkins University Press, 1979.

Schroeder, Gertrude. "The Soviet Economy on a Treadmill of 'Reforms.'"
In U.S. Congress, Joint Economic Committee, Soviet Economy in a
Time of Change, pp. 312-340. Washington, D.C.: Government
Printing Office, 1979.

Stuart, Robert. The Collective Farm in Soviet Agriculture. Lexing-
ton, Mass.: D.C. Heath & Co., 1972.

Tsentral'noe Statisticheskoe Upravlenie. Narodnoe Knoziaistvo SSSR
V 1978 Godu. Moscow: "Statistika," 1979. (Referred to in the
text as Narkhoz, 1978.)

Wadekin, Karl-Eugen. The Private Sector in Soviet Agriculture.
Translated by Keith Bush. Berkeley: University of California
Press, 1973.

Wyzan, Michael. "Empirical Analysis of Soviet Agricultural Produc-

tion and Policy." Forthcoming, <u>American Journal of Agricultural Economics</u> 63 (August 1981).

Yefremov, G. "Shift to Full Economic Accountability." <u>Current Digest of the Soviet Press</u> 28 (4 February 1976): 19.

Zellner, Arnold. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias." <u>Journal of the American Statistical Association</u> 57 (June 1962): 348-368.