

Agricultural Output and Productivity in the Former Soviet Republics*

Zvi Lerman, Yoav Kislev, and David Biton
Hebrew University

Alon Kriss
World Bank

I. Introduction and Summary

This article is an examination, in two parts, of productivity and changes in agriculture in the 15 new independent states that, until 1991, constituted the republics of the Soviet Union. The first part presents a production function analysis for the Soviet period before 1990. The second part deals with the post-Soviet period of transition, 1990–98, covering both the collapse associated with the dissolution of the Soviet Union and the recovery that began to emerge. The study is preliminary in at least two ways. First, the transition is an ongoing process, and it is safe to expect that accumulating information and experience will change, in the coming years, the lessons of its analysis. Second, information on the agriculture of the former Soviet economies is often more problematic than it is on the agricultural sectors of many other countries, and the available data may be expected to improve as research continues.

Although the pre-1991 economic literature usually treated Soviet agriculture as a single monolithic entity, the agricultural sectors in the 15 republics differed significantly, owing to natural, social, and political factors. Because of these differences, labor productivity—output per worker—in the best performing republic was 2.5 times higher than it was in the agriculturally least productive republic. However, this gap, wide though it seems, was much smaller than the corresponding gap in agricultural productivity among non-Soviet countries. The productivity of Soviet agriculture was comparatively low, but input use was on a par with agriculture in the industrialized countries; technical change, however, was smaller.

After 1991, agricultural production decreased sharply in all the 15 newly independent states. The major factor for this reduction was probably the elim-

ination of subsidies and the dramatic worsening of the terms of trade of agriculture. Other factors may have been a reduction in demand as real incomes fell and disruptions in support services as the central controls collapsed. Output contraction was accompanied by changes in the use of factors of production. The use of most purchased inputs decreased; labor left agriculture in some of the countries, while in others, particularly in the Muslim states of Central Asia, agricultural employment increased. Decreasing output and changes in input use affected productivity. Some countries improved output-to-input ratios, while in others productivity deteriorated. Paucity of data precludes a systematic statistical analysis of the transition period, but examination of the available data suggests that reform policies—land individualization, structural changes in services and institutions—and the performance of the nonagricultural sectors have strongly affected recovery and productivity gains (or losses) in agriculture. The data also indicate that, contrary to frequently voiced assertions, large imports did not replace domestically produced food in the former Soviet republics.

II. The Soviet Period

A. Agriculture in the Soviet Union

The world's industrial revolution was accompanied by a no less dramatic agricultural revolution—food is now in abundant supply, and we eat more and better than our forefathers did.¹ Before World War I, the farm sector of Russia's czarist empire produced enough food both for domestic consumption and for export. Production expanded under the Soviet regime, but nature, impatience, and human blunders combined to prevent agriculture from developing at the rate necessary to satisfy the needs of an economy that was pursuing rapid industrialization and urbanization.

Large parts of the former Soviet Union—the vast tundra and coniferous forests of northern Russia and Siberia—are not fit for agriculture. Farming is therefore practiced in a relatively small part of the former Soviet Union: in its European regions, in a narrow belt stretching across all of southern Siberia, in Transcaucasia, and in the oases of Central Asia. Unfortunately, with few exceptions, farming conditions are not favorable even in these food-producing parts. Most of the grain-growing areas of Russia and Ukraine are colder than many farming regions in the world. Further east and south, Central Asia is a desert. Despite their huge area, the grain-producing regions of the Soviet Union are largely located in a narrow climate zone and are similarly affected by changes in weather. This similarity is the principal explanation for the comparatively large yield variations and food-supply fluctuations that characterized Soviet agriculture.

On three occasions the shortage of food reached famine proportions in the Soviet Union: in 1918–21, in the wake of the communist revolution and the policy of war communism; in 1932–33, at the height of collectivization; and in 1946–47, in the aftermath of World War II. Many perished in each instance. These events, however, occurred under extraordinary circumstances,

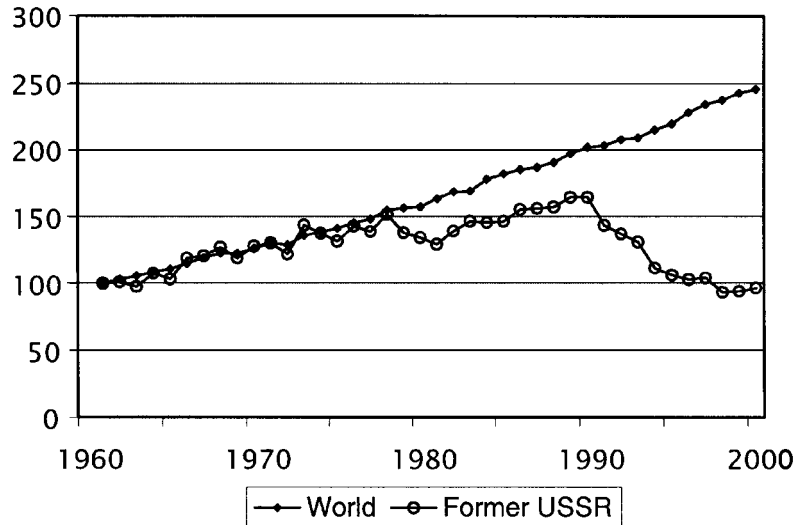


FIG. 1.—Agricultural production indexes: former Soviet Union and the world (1961 = 100). Source: FAO on-line database, available at <http://www.fao.org>.

and, despite the setbacks, the Soviet Union saw periods of expanding food production. According to the official statistics, agricultural production in 1961 was more than twice the 1913 output, and the trend continued thereafter, as figure 1 demonstrates. Output grew at the world pace for the decades of the 1960s and 1970s, but then, following several bad harvests, Soviet agriculture lagged behind the world total (Soviet Union included). Production decreased sharply in the wake of the dissolution of the Soviet Union in 1991, but it has remained stable over the last few years—albeit at the level of the early 1960s. While world agricultural production today is 2.5 times its 1961 level, agriculture in the former Soviet countries has gone back 40 years.

Throughout its history, the Soviet Union strived to achieve food self-sufficiency, but despite impressive growth, supply remained disappointing and a cause of deep concern. “In the Soviet Union before the Second World War, as in Imperial Russia, the level of grain production was the most crucial economic magnitude.”²² In the second half of the twentieth century, when the rest of the world was enjoying ample food supply and the industrial countries were even burdened by surpluses, in the Soviet Union the “food problem [was], economically and politically, the central problem of the whole five-year plan.”²³

The Soviet regime, particularly in Stalin’s time, reacted with coercion to the inability of the farm sector to supply the growing urban population with adequate amounts of food. Farm products were forcibly procured and, under the stress, miracle cures were embraced: collectivization, economies of scale, Lysenko’s biology, and even an attempt to change the climate. Stalin’s death in 1953 was followed by experiments in agricultural reforms—higher

producer prices, heavy investment, cultivation of virgin lands, growing warm-weather crops (including corn) in cold regions, consolidation of collective farms, food imports. Some of the attempts succeeded, many failed, and the basic structure was not changed. Thus, food shortages continued, and the problem of agriculture remained a central national issue.⁴ And justifiably so: a study of agricultural production in the 20-year period 1960–79 found that “total factor productivity in [climatically comparable] non-Soviet areas is between one and a half and twice that of the USSR.”⁵ Subsequently, it was even suggested that inflated food subsidies were one of the major causes for the collapse of the Soviet regime in 1991.⁶

B. The 15 Republics

Of the 15 former Soviet republics, eight are northern, located in the temperate plains (the Baltics and the core republics; see table 1), and seven are southern, located in Transcaucasia and Central Asia. As the data in table 1 show, the two groups differ in more than just location and climate.

Typically, the northern populations had low rates of growth, less than 1% per year, while the southern populations grew much faster, with yearly rates exceeding 2% in the Muslim republics of Central Asia (table 1). The republics also differed in income. In the late 1980s, on the eve of transition, the gross national product (GNP) per capita in the northern republics was twice that of their southern counterparts. The northern republics fell in the World Bank’s group of higher-middle-income countries, while the southern republics were at the level of the lower-middle-income countries. There was considerable inequality among the Soviet republics; yet all of them were in the middle-income group. The income differences among the Soviet republics were thus substantially smaller than the differences among non-Soviet countries, ranging, by the World Bank grouping, from low- to high-income economies. This attribute of the Soviet system, namely, that the dispersion of the 15 republics was less than the dispersion of countries outside the Soviet Union, will recur again and again as we continue our review.

In terms of labor allocation in the 1980s, only Russia could be considered an industrial country, with 14% of the labor force in agriculture. In the other countries, agriculture had higher shares in employment, with the highest in the southern republics (Moldova, the southernmost member of the northern group, had 37% of labor in agriculture).

The republics differed also in the nature of their agriculture. The northern republics had relatively high shares of livestock in production and no irrigation to speak of (except Moldova). The southern republics had less livestock and, located as they were in a relatively dry climate, most of their arable land was irrigated.

C. Productivity in the Soviet Republics

The period of our analysis of agriculture in the Soviet republics, dictated by the availability of data, covers the years 1965–90. The variables examined

TABLE 1
COUNTRY PROFILES OF THE 15 SOVIET REPUBLICS IN THE PRETRANSITION PERIOD

Country	Population (Millions, 1980) (1)	Population Growth Rate (% per Year, 1980–90) (2)	GNP per Capita (1995 US\$, 1987–90) (3)	Share of Agri- culture in Labor (%, 1980–88) (4)	Share of Livestock in Agricultural Product (%, 1980–89) (5)	Irrigated Land (% of Arable Land, 1989) (6)
Baltics:						
Estonia	1.5	.77	4,646	17	69	1
Latvia	2.5	.62	4,582	16	70	1
Lithuania	3.4	.92	2,902	25	67	2
Core:						
Russia	138.3	.68	3,827	14	61	5
Belarus	9.6	.64	2,637	24	57	2
Moldova	4.0	.90	2,200	37	36	17
Ukraine	50.0	.37	3,389	21	54	8
Kazakhstan	14.8	1.19	2,161	23	59	6
Transcaucasia:						
Armenia	3.1	1.35	2,168	20	51	61
Georgia	5.1	.77	2,295	28	32	58
Azerbaijan	6.1	1.55	1,564	33	32	87
Central Asia:						
Kyrgyzstan	3.6	1.97	1,397	32	57	74
Tajikistan	3.9	3.01	1,033	43	32	86
Turkmenistan	2.8	2.51	2,001	40	34	105
Uzbekistan	15.8	2.58	1,310	38	33	93

SOURCES.—GNP per capita from *World Development Indicators 1999*, CD-ROM (Washington, D.C.: World Bank, 1999). All other data are from *Statistical Yearbook of the USSR* (Moscow: Goskomstat SSSR, various years up to 1990).

TABLE 2

INDICATORS OF AGRICULTURE IN THE PRETRANSITION PERIOD (1980–85 Averages)

Country	Output (Thousands of 1983 Rubles/Worker) (1)	Arable Land (ha/Worker) (2)	Irrigated Land (ha/Worker) (3)	Farm Machinery (hp/Worker) (4)	Livestock (Standard Head/Worker) (5)	Fertilizer (kg/ha Arable Land) (6)
Baltics:						
Estonia	12.5	7.3	.1	38.4	7.0	247
Latvia	10.3	6.7	.1	38.0	6.5	238
Lithuania	11.1	6.6	.1	35.4	7.0	235
Core:						
Russia	8.1	12.0	.5	28.7	6.6	79
Belarus	8.8	5.0	.1	20.9	5.8	266
Moldova	6.0	2.5	.3	14.7	2.5	197
Ukraine	7.9	6.0	.3	18.6	5.1	126
Kazakhstan	7.7	20.7	1.2	35.7	9.0	22
Transcaucasia:						
Armenia	6.1	2.3	1.3	10.8	5.6	191
Georgia	5.2	1.2	.7	5.4	3.4	280
Azerbaijan	6.2	2.2	2.0	9.0	4.6	195
Central Asia:						
Kyrgyzstan	5.7	3.1	2.3	14.0	7.2	182
Tajikistan	5.4	1.8	1.5	10.6	4.0	273
Turkmenistan	5.3	2.6	2.5	12.7	3.9	243
Uzbekistan	5.1	2.1	1.9	11.6	2.7	283

SOURCES.—*Statistical Yearbook of the USSR* (Moscow: Goskomstat SSSR, various years), and calculations in Alon Kriss, "Agricultural Productivity in the Former Soviet Republics" (M.Sc. diss., Hebrew University, Rehovot, Israel, 1994; in Hebrew).

TABLE 3
AGRICULTURE IN THE HAYAMI AND RUTTAN SAMPLE

	Newly Settled	Industrialized	Latin America	Egypt+	Asia	Other
Output and inputs (1979–81 averages):						
Output (wheat units/ worker)	180.5	53.4	14.1	2.9	2.7	17.4
Arable land (ha/worker)	78.7	7.9	4.9	1.4	.6	7.5
Capital (hp/worker)	91.6	28.8	1.27	.13	3.12	5.94
Livestock (head/ worker)	48.8	10.5	9.4	.6	1.4	6.0
Fertilizer (kg/ha)	80.1	219.1	38.9	128.0	24.4	52.6
Growth accounting (1960–90):						
Output (% per year)	1.96	1.84	3.04	2.44	2.78	2.84
Technical change (% per year)	1.01	1.18	–.59	–.61	–2.53	.02
Conventional inputs (share in %)	48	36	120	125	191	99

SOURCE.—David Biton, “Productive Efficiency and the Agricultural Labor Market in International Comparisons” (M.Sc. diss., Hebrew University, Rehovot, Israel, 1998; in Hebrew).

NOTE.—Egypt+ refers to Egypt, Libya, and Mauritius. See appendix for comments on the data.

are reported in table 2 (in the appendix we comment on the data and their sources). Labor productivity—output per agricultural worker—was highest in the Baltics and lowest in Central Asia. Land endowments were highest in Kazakhstan and Russia, the principal grain-producing republics. In the southern republics, the land-to-labor ratio was comparatively low, but most of the cultivated area was irrigated. The Baltics had the highest capital-to-labor ratio (capital was measured by horsepower of farm machinery) and more livestock per worker than any of the other republics except the sheepherding Kyrgyzstan. Fertilizer was allocated in larger quantities to the more intensively cultivated areas, among them the Baltic republics and the irrigated lands of Central Asia, than it was to the extensively cultivated grain-producing plains—particularly those in Russia and Kazakhstan.

Although the Soviet republics differed substantially in labor productivity, these differences were smaller than among non-Soviet countries. We offer two comparisons, one to agriculture in an international sample and the other to the United States. The international comparison is motivated by the fact that the Soviet Union, with its republics stretching across parts of Europe, Central Asia, Siberia, and the Far East, spanned technological, social, and cultural variability of international magnitude. Table 3 reports productivity and factor allocation in the Hayami and Ruttan sample of 42 countries.⁷ Output is measured in table 3 in wheat units and cannot be compared directly to ruble values in table 2, but differences may be compared. While the ratio of labor productivity in Estonia to that in Uzbekistan was 1:2.5, labor productivity in

the industrialized countries in the Hayami and Ruttan sample was almost 4 times higher than it was in Latin America. The difference between the newly settled countries and Asian agriculture was much larger.

Despite its size and diversity, the Soviet Union was a single country with a single agricultural policy. The second comparison is, therefore, to U.S. agriculture. Output per worker in the United States in 1981 varied from \$9,257 in West Virginia to \$79,108 in Delaware.⁸ This is a ratio of 1:8.5 (omitting three small states, the ratio between Tennessee and Colorado was 1:3.5). Although the U.S. economy is quite homogeneous, with free movement of factors and technology and competitive markets, the American spread of labor productivity was larger than productivity gaps in the Soviet Union.

While output is measured differently in tables 2 and 3, inputs are measured in essentially the same units. It is amazing that intensity of all factors—land, machinery, livestock, and fertilizer—in the Soviet republics was on a par with that in the industrialized countries in the Hayami and Ruttan sample. The frequently reported poor labor productivity (and total factor productivity) in the Soviet Union may have been a reflection of inefficient use of nonlabor inputs, machinery in particular.⁹

As is typical of less developed countries, agricultural labor in Central Asia was growing in absolute numbers over the period 1965–90 (not in table 2), while in the European republics it was decreasing. Both demography and general economic conditions were responsible for the differences in trends in agricultural labor. The central Asian republics had comparatively high birth rates and faster increases of the labor force. Given their smaller manufacturing and service sectors (as reflected by higher shares of labor in agriculture; see table 1), the central Asian countries lacked the ability to create non-farm employment opportunities for the growing numbers of workers.

D. Production Functions and Technology

The estimated production function was of the Cobb-Douglas type with republic and time dummies added in some of the regressions. The estimates were at the per-worker level, accepting the assumption of constant returns to scale (the sum of the coefficients in a regression, not reported here, with the observations representing republic totals was .960). The technology—the contribution of the factors of production—is reported in table 4; republic dummies and calculated technical change are reported below. Regressions 1–3 in table 4 were estimated for the pooled sample of all 15 republics; regressions 4 and 5 were estimated separately for the northern (nonirrigated) and for the southern (irrigated) republics. The variable “Arable Land” in regression 5 was separated into “Irrigated Land” and “Nonirrigated Land.”

The findings of table 4 further highlight the differences between the northern and the southern republics. The separating factors are irrigation and livestock. The share of irrigated agriculture in the northern republics is negligible, and the variable is not included in the regression; on the other hand, irrigated land is an important factor for southern agriculture and its coefficient

TABLE 4
PRODUCTION FUNCTION

	REGRESSION				
	1. All 15 Republics (<i>n</i> = 390)	2. All 15 Republics (<i>n</i> = 390)	3. All 15 Republics (<i>n</i> = 390)	4. 8 not Irrigated (<i>n</i> = 208)	5. 7 Irrigated (<i>n</i> = 182)
Dummy variables	None	Republic	Republic + year	Republic	Republic
Intercept	-1.50 (-8.02)	-1.025 (-4.43)	3.111 (7.09)	-.796 (-2.74)	-1.650 (-2.97)
Arable land	.150 (8.16)	-.007 (-.11)	.205 (3.31)	.257 (3.04)	-.001 (-.40)
Irrigated land211 (2.05)
Livestock	.012 (.48)	.143 (2.06)	.636 (8.11)	.453 (4.80)	.104 (.88)
Machinery (in hp)	.164 (5.32)	.143 (3.85)	-.302 (-5.57)	.043 (1.11)	.113 (1.48)
Fertilizer	.249 (14.04)	.218 (9.23)	.076 (3.15)	.143 (7.12)	.379 (9.28)
Sum of coefficients	.575	.497	.615	.896	.806
<i>R</i> ²	.865	.942	.961	.962	.766

SOURCE.—Authors' estimations based on per-worker variables.

NOTE.—For each republic, 26 years of observations (1965–90). Not irrigated: Lithuania, Latvia, Estonia, Ukraine, Belarus, Moldova, Kazakhstan, Georgia, 208 observations. Irrigated: Azerbaijan, Armenia, Uzbekistan, Kyrgyzstan, Turkmenistan. Figures in parentheses are *t* values. See appendix for comments on the variables.

in regression 5 is .211. The share of livestock in the northern republics is estimated at .453 (regression 4), while in regression 5 for the irrigated southern republics the coefficient of this variable is not significantly different from zero. The coefficients of machinery in regressions 4 and 5 were not significant; evidently, the differences over time in machine intensity within the groups were too small to support stronger estimates.¹⁰

The republic effects in the regressions are reported in table 5 for the northern republics relative to Russia and for the southern republics relative to Georgia. In the Soviet era, all the northern republics (except Kazakhstan) were more productive than Russia. This was particularly true of Moldova, a republic endowed with fertile soil and warm weather. Among the southern republics, Georgia was the most productive, with Turkmenistan and Uzbekistan the least productive. Although we prefer regressions 4 and 5 to the pooled estimates, we report in table 6 (col. 8) the republic dummies from regression 2 as they rank productivity in agriculture for all the 15 republics. These dummies indicate large differences in productivity between northern and southern agriculture.

Three columns in table 5 report growth accounting by Solow's method for the 26-year period 1965–90. Take Lithuania as an example. Agricultural output in the republic grew over the 26-year period by 1.51% per year and technical change was .03% per year. The growth of the conventional inputs

TABLE 5
PRODUCTIVITY DIFFERENCES AND GROWTH FOR THE 15 SOVIET REPUBLICS, 1965–90

COUNTRY	REPUBLIC DUMMIES (%) (1)	GROWTH ACCOUNTING		
		Output (% per Year) (2)	Technical Change (% per Year) (3)	Share of Conventional Inputs (%) (4)
Northern republics:				
Lithuania	37.4	1.51	.03	98.0
Latvia	25.2	1.32	-.14	110.6
Estonia	39.0	1.38	-.24	117.4
Russia	0	1.63	.12	92.6
Ukraine	28.4	1.67	.31	77.8
Belarus	30.8	1.93	-.06	103.1
Moldova	65.9	1.71	-.12	107.0
Kazakhstan	-23.8	2.98	.87	70.8
Southern republics:				
Georgia	0	2.01	-.08	104.0
Azerbaijan	-32.5	3.71	-.84	122.6
Armenia	-17.6	.84	-.16	119.0
Uzbekistan	-49.2	3.87	-.23	105.9
Kyrgyzstan	-39.0	2.88	-.40	113.9
Tajikistan	-35.9	3.19	-.58	118.2
Turkmenistan	-55.5	5.24	.07	98.7

SOURCE.—Alon Kriss, "Agricultural Productivity in the Former Soviet Republics" (M.Sc. diss., Hebrew University, Rehovot, Israel, 1994; in Hebrew) and authors' calculations.

NOTE.—The republic dummies in col. 1 are from regressions 4 and 5 in table 4. Technical change (col. 3) is the difference between output growth (col. 2) and change in input. The weights in the calculation of the change in input were the coefficients in regressions 4 and 5 in table 4 and the labor coefficient taken as the complement of the sum of the coefficients to one.

(labor and those in regression 4 in table 4) was thus 1.48% per year, accounting for 98% of the growth in agricultural output. In other words, over the 26-year period 1965–90, the share of technological change in growth was 2% (.03/1.51). The contribution of the conventional inputs to output was, in most cases, close to 100%, and for many republics—those with negative technical change—it was higher than 100%. Comparison with table 3 shows that, in terms of the components of growth accounting, the Soviet republics behaved like the less developed countries. They were far from the performance of agriculture in the newly settled and the industrialized countries, where technical change was more than 1% per year and the conventional inputs contributed to growth less than 50%.

To summarize the discussion of the Soviet period, we note that substantial differences were found between the northern and the southern republics and, in particular, between their agricultural sectors. But, as a rule, these differences were smaller than the gaps in corresponding magnitudes among countries in the non-Soviet world and among American states. We also found that technological change in agriculture in the Soviet republics was small or even negative.

TABLE 6
CHANGES IN PER CAPITA INCOMES AND IN AGRICULTURE IN THE POST-SOVIET PERIOD (%)

Country	GNP/Cap 1987–90 to 1997 (1)	Agricultural Output 1990–95 (2)	Agricultural Labor 1990–95 (3)	Agricultural Output 1995–99 (4)	Agricultural Labor 1995–98 (5)	Use of All Inputs 1992–97 (6)	Productivity 1992–97 (7)	Republic Dum- mies 1965–90 (8)
Baltics:								
Estonia	-20.6	-41.4	-57.6	-1.0	-22.2	-43.1	14.2	19.4
Latvia	-38.6	-53.3	-7.8	-18.0	2.6	-39.2	-6.1	8.5
Lithuania	-30.6	-41.8	13.2	4.6	-6.7	-24.4	18.3	13.2
Core:								
Russia	-41.6	-32.8	.2	-14.0	-10.5	-32.1	7.4	0
Belarus	-22.4	-26.5	-14.4	-12.4	-17.6	-20.5	2.9	-.2
Moldova	-70.9	-34.9	13.9	-21.8	-2.2	-19.3	2.4	6.1
Ukraine	-57.2	-34.2	-6.1	-24.9	-6.3	-29.2	2.5	4.6
Kazakhstan	-40.9	-44.5	-16.4	-1.7	-5.0	-42.3	-5.2	8.0
Transcaucasia:								
Armenia	-58.7	4.8	93.7	9.4	2.9	-24.4	22.9	-14.0
Georgia	-70.0	-38.5	31.3	9.2	71.7	-8.8	32.9	-10.2
Azerbaijan	-68.5	-47.7	-2.7	9.8	-2.5	-29.6	-3.9	-16.9
Central Asia:								
Kyrgyzstan	-41.5	-38.2	35.5	44.6	8.0	-5.2	-1.7	-17.5
Tajikistan	-69.1	-45.2	31.4	.3	-1.1	-17.3	-11.5	-22.4
Turkmenistan	-67.9	-31.9	21.4	n.a.	13.3	7.2	-29.4	-27.5
Uzbekistan	-25.8	-10.8	11.9	9.8	-.7	6.2	-10.7	-26.5

SOURCES.—Col. 1, *World Development Indicators 1999*, CD-ROM (Washington, D.C.: World Bank, 1999); cols. 2–5, *Statistical Data of the Commonwealth of Independent States 1999*, CD-ROM 4/1999 (Moscow: Statkom SNG, 2000), and official country statistics for the Baltics; col. 6, authors' calculation using the sources of cols. 2–5 and the FAO on-line database (<http://www.fao.org>); cols. 7–8, authors' calculations.

NOTE.—Estonia, Latvia, and Georgia had labor data only up to 1997. Lithuania did not report labor for 1990 and 1991. To be consistent with the information for other countries, the percentage changes in these cases were adjusted proportionately to the full period. Productivity was calculated as the difference between change in output from 1992 to 1997 (not in the table) and change in resource utilization (col. 6). The entry for Turkmenistan is for the period 1992–96. Republic dummies are relative to Russia, from regression 2 in table 4.

III. The Post-Soviet Period

The dissolution of the Soviet Union in 1991 was followed by an economic upheaval from which the former Soviet republics (now independent countries) have yet to recover. In Estonia, the per capita GNP in 1997 was 21% lower than for the last 3 years of the Soviet era (table 6, col. 1); the corresponding magnitude for Moldova was 71%.

This part describes the developments in agriculture in the 15 former Soviet republics in the post-Soviet period and attempts to explain the changes that have occurred. One of our goals is to determine to what extent specific features observed in the Soviet era can also be identified as affecting agriculture in transition countries after 1991.

A. The Elimination of Subsidies

Before its dissolution, the Soviet Union was spending 10% of its national income, or 20% of the government budget, on food subsidies.¹¹ A large share of this support was devoted to reducing consumer prices, particularly of meat and milk, but producer prices were also supported generously. Detailed data are not available, but by Organization for Economic Cooperation and Development (OECD) estimates for four republics (Estonia, Latvia, Lithuania, and Russia), the producer subsidy equivalent (PSE) in the late 1980s was between 70% and 80%, while at the same time the average PSE for the OECD countries was less than 40%.¹² The PSE may not measure all of the support, because ailing farm enterprises that could not survive even with supported prices were often rescued financially by the central government. The estimates we have are for only four republics, but one may safely assume that, under the Soviet regime, the farming sectors in all the 15 republics enjoyed similar degrees of support, with differences, if any, reflecting product mix and differential support by line of production.

The situation changed dramatically after 1991. The OECD's PSE estimates for the four countries (former Soviet republics) were negative for 1992, reflecting taxation of agriculture. Subsequently, the support increased, and in 1998 the PSE estimates were between 10% and 19%. The policies of the 15 independent states are no longer dictated from a single center, yet the collapse of the central government and elimination of central sources of funds forced all former republics to curtail significantly the support of farm and food prices (although financial rescue of insolvent large farms in the form of periodic debt write-offs and bailouts may still be practiced).

The elimination of subsidies changed drastically the profitability in agriculture. Again, only limited information is available. The average share of unprofitable farms in five former Soviet republics (Russia, Ukraine, Belarus, Moldova, and Kazakhstan) increased from less than 5% in 1990–93 to more than 60% in 1998.¹³ The terms of trade reported for 1997 for nine republics for which information is available were one-third or less of their 1990 level.¹⁴ These changes markedly affected production in the farm sector of the former Soviet republics.

B. Production and Efficiency

Agricultural production decreased sharply over the first several years after the collapse of the Soviet Union, as the graph of aggregate output in figure 1 reveals. As reported in table 6, general economic activity also contracted considerably. Changes in agricultural production in the transition period in table 6 are divided into two subperiods: the years of decline, 1990–95, and the beginning of recovery since 1995.¹⁵ For the latter period we have information on output up to 1999 and on labor up to 1998 (1997 for three countries). In the first period, output fell everywhere except in Armenia. Labor movements accompanied output changes: agricultural employment grew in nine countries and decreased in six (col. 3). Particularly large increases in agricultural labor are observed in the Muslim countries, where population growth is rapid. Nonetheless, the same held true in non-Muslim countries, in that many returned to work the land when the urban economy became uncertain and the land-reform policies afforded access to subsistence farming. The returning workers contributed to production and mitigated its decline.

Armenia is a striking example. The country suffered a devastating earthquake in 1988 that destroyed much of its industry and infrastructure. In addition, the Nagorno-Karabakh conflict with Azerbaijan triggered a regional blockade that disrupted critical imports of energy and other inputs. The non-agricultural sectors were in total disarray in the early 1990s, and labor migrated to rural areas. The government responded to the growth of the rural labor force by implementing a swift land reform that involved redistribution of most of the arable land from collective farms to individuals. As a result, agricultural employment in Armenia increased by 94% between 1990 and 1995, and Armenia was the only country registering increased production over this period.

As output dropped or increased only slightly and employment expanded, labor productivity—output per worker—declined in Armenia and almost everywhere else in the former Soviet republics. The declines in output in the period 1990–95 were so large that labor productivity declined even in countries where labor was leaving agriculture: production fell proportionately more than the number of workers. The only exception is Estonia, where labor exit from agriculture, 58%, was proportionately larger than output decline.

The second period examined in table 6 was to be a period of recovery. Utilizing the available information, we report here output changes from 1995 to 1999 and labor changes only up to 1998. Agricultural output increased in seven countries (col. 4). It continued to decrease in the other seven, but the downward movement decelerated in all countries (Turkmenistan did not report output beyond 1996). Even if a real recovery cannot be identified, a mitigation of the deteriorating trend is discernible: labor productivity improved in nine countries; in some of them, labor exit from agriculture exceeded the decline in output (col. 5), and in others (e.g., Armenia) output grew more than labor use. As the changes were not uniform, the dispersion of performance in agriculture increased markedly. Even disregarding Estonia as a possible outlier,

the coefficient of variation of labor productivity in the former Soviet republics increased between 1990 (not in the table) and 1998 by more than 60%.

Labor movement and productivity are important indicators of changes in welfare, but labor is only one factor of production. The use of other factors also decreased, particularly the use of fertilizer, livestock, and machinery (agricultural land was naturally less affected). Column 6 reports our calculation of the change in the quantity index of a composite basket of all inputs from 1992 to 1997 (the index was not computed to 1998, since three countries lacked labor data for the last year).¹⁶ The inputs are those listed in table 2, and to calculate the index we weighted the changes in each input by the corresponding production function coefficients (regressions 4 and 5 in table 4). Estonia and Kazakhstan reduced input use by more than 40%. The northern countries in general reduced input use more than the southern countries, where input use actually increased in Turkmenistan and Uzbekistan—mostly owing to increased employment in agriculture in these countries.

The residual difference between the growth of output and the growth of inputs is attributed generally to technical change; in other words, it represents productivity improvements (col. 7). The term productivity is used here with reservation. In many cases, real input prices rose drastically following deregulation, and real prices received by producers declined. This led to a worsening of the terms of trade, and producers could not afford to use purchased inputs at the previous levels. In other cases, feed, fertilizer, or spare parts may have been simply unavailable at any price. Thus, not all changes in input use reflected rational economic decisions. Indeed, we should not expect to have optimal input combinations under conditions of rapid transition. Still, a smaller decrease of output relative to inputs indicates improved efficiency and productivity. We see from column 7 that, in the northern countries, productivity generally improved—primarily owing to reduced use of inputs, not gains in output (Latvia and Kazakhstan are the only exceptions, showing a decrease in productivity). Among the southern countries, productivity improved by 23% and 33%, respectively, in Armenia and Georgia, the two countries that resolutely switched from large-scale collective agriculture to small-scale individual farming. Productivity deteriorated in Central Asia, at least partly owing to the fast population growth that created a need to absorb labor in agriculture.

C. Food Supply

As we have seen, agricultural production declined considerably after the disintegration of the Soviet Union, both in countries where productivity decreased and in countries that enjoyed improvements in the utilization of resources. It has often been claimed that domestic production was replaced by imported food.¹⁷ In the first two columns of table 7, we have attempted to evaluate this assertion. Column 1 reports the ratio of import surplus (import minus export) to agricultural output for the 5-year period 1992–96 (determined by data availability). As column 1 shows, only Estonia and Russia had import sur-

TABLE 7

CHARACTERISTICS OF THE FORMER SOVIET REPUBLICS IN THE POST-SOVIET PERIOD

COUNTRY	FOOD SUPPLY		POLICY REFORMS			NONAGRICULTURAL SECTOR	
	Import Surplus (% of Agricultural Output) 1992–96 (1)	Calories per Capita per Year 1992–96 (2)	Share of Individual Farms 1997 (%)		ECA Policy Index 1997 (5)	Per-Worker Value Added (Nonagricultural % of Agricultural) 1994–96 (6)	Share of Nonagricultural Sectors in GDP 1994–96 (7)
			Land (3)	Production (4)			
Baltics:							
Estonia	37	2,705	63	n.a.	7.8	171	92
Latvia	7	2,962	95	n.a.	7.6	142	90
Lithuania	–3	2,950	67	n.a.	7.0	132	88
Core:							
Russia	24	2,913	11	55	6.0	172	93
Belarus	10	3,177	16	45	1.6	94	83
Moldova	–21	2,925	27	51	5.8	87	69
Ukraine	6	3,044	17	53	5.4	101	83
Kazakhstan	–3	3,155	20	38	5.8	170	87
Transcaucasia:							
Armenia	6	1,930	32	98	7.4	23	58
Georgia	8	2,152	24	76	6.2	52	64
Azerbaijan	11	2,151	9	63	5.0	129	76
Central Asia:							
Kyrgyzstan	1	2,358	23	59	5.8	49	55
Tajikistan	n.a.	2,274	7	39	3.8	n.a.	n.a.
Turkmenistan	n.a.	2,547	.3	30	1.8	n.a.	n.a.
Uzbekistan	–5	2,646	4	52	2.2	103	69

SOURCES.—Cols. 1–2, FAO on-line database (<http://www.fao.org>) and authors' calculations; cols. 3–4, *Statistical Data of the Commonwealth of Independent States 1999*, CD-ROM 4/1999 (Moscow: Statkom SNG, 2000), and official country statistics for the Baltics; col. 5, Csaba Csaki and Achim Fock, "The Agrarian Economies of Central and Eastern Europe and the Commonwealth of Independent States: An Update on Status and Progress 1998" (Environmentally and Socially Sustainable Development Working Paper no. 13, World Bank, April 1999); cols. 6–7, *World Development Indicators 1999*, CD-ROM (Washington, D.C.: World Bank, 1999), and authors' calculations.

NOTE.—The import-surplus ratio in col. 1 was calculated by dividing import surplus in dollars (FAO) by agricultural output (value added in agriculture from World Bank's World Development Indicators database multiplied by 1.67, reflecting the assumption that value added was 60% of output).

pluses that could cover a significant part of the reduction in output after 1990. However, even in Estonia, the country with the highest import surplus ratio, output fell between 1990 and 1995 by 41% (table 6, col. 2), while import surplus was only 37% of the lower, post-1991 output. In the other countries, import surplus was much smaller; Moldova, Kazakhstan, and Uzbekistan even recorded export surpluses.

If these estimates are correct, food supply must have declined in the 15 former Soviet republics. Indeed, a reduction of basic food supply is indicated also by another set of data. Column 2 presents average caloric intake for 1992–96 from food balances of the United Nations Food and Agriculture Organization (FAO). Twelve of the 15 former Soviet republics had food intakes of less than 3,000 calories per capita per day in the post-1990 period, and the average for the former Soviet Union was 2,660 calories per capita per day. A decade earlier, the Soviet Union reported a daily intake of 3,371 calories per capita. By these numbers, aggregate food supply—domestic and of foreign origin—must have decreased substantially in the former Soviet republics. Competition with imports may have intensified after 1991, but it was not the flooding of the markets by products from abroad that caused home production to contract.

Contraction of caloric intake in the former Soviet republics was accompanied by substantial changes in the composition of food consumption. On average, for nine countries, the per capita consumption of meat decreased by 33% between 1991 and 1998, milk by 25%, and eggs by 40%.¹⁸ The per capita consumption of potatoes and vegetables increased slightly over the same period. Evidently, these changes reflect the drastic increase in consumer prices that followed the elimination of subsidies after the collapse of the Soviet Union.

Returning to FAO food balances, energy intake in 1992–96 was 3,202 calories per capita per day for the developed countries and 2,601 calories for the developing countries (the 15 former Soviet republics are in neither of these groups). By column 2, food intake in the northern republics was between the values for the developing and the developed countries, while the population in the southern republics ate less than the average of the world's poor developing economies.

D. Economic Environment and Factors Affecting Recovery

We turn now to examine the economic environment and the factors that may have affected agricultural development in the 15 former Soviet republics. The immediate effects of the traumatic changes in 1990–91 are recorded in columns 1–3 of table 6; the subsequent years are a period when recovery, or at least mitigation of the initial decline, could be expected to take place (this period is reflected by the rest of the columns in table 6).

The first question we ask is whether the recovery was affected by the productivity of agriculture in the Soviet republics before 1991. Except for Armenia and Georgia, countries that shifted to individual agriculture while

recovering from natural disaster and war devastation, the southern republics registered reduction in productivity (col. 7 in table 6). The more productive agricultural sectors in the northern countries recovered more than the relatively less efficient sectors.

Republic coefficients from the pooled regression 2, utilizing data for both the northern and the southern countries for the pre-1990 period, are presented in column 8 of table 6. Productivity in the southern republics was estimated to be substantially lower than in the northern ones. Comparing to column 7 in the table, we see that, in general, countries that showed relatively high performance in the pre-1990 era (as judged by the republic dummies) registered productivity improvements after 1992 (the Baltics). The underperformers from the pre-1990 period (the central Asian countries) registered continued productivity declines after 1992. The core republics retained their middle-of-the-road position in terms of performance and productivity after 1992. As indicated above, and also below, Georgia and Armenia were special cases.

Each of the 15 new independent states modified to a different extent the economic structure of collective agriculture inherited from the Soviet Union. Columns 3 and 4 in table 7 report the percentage of agricultural land in individual use and the share of individual agricultural production for 1997 (the last year for which such data are available). Individual agriculture in the former Soviet Union increased significantly after 1991 as a result of land-reform and farm-restructuring programs. Today, individual agriculture comprises three components: (1) small household plots of rural residents on corporate farms (former *kolkhozy* and *sovkhozy*), (2) plots cultivated by urban residents near cities, and (3) new individual farms outside collective or corporate enterprises. The first two groups are traditional components that survived throughout the Soviet era. Most of the output of the individual sector comes from the household plots of rural residents, which average less than 1 hectare.

The individual sector produces large shares of food output on small land areas. Thus, in Russia, the share of land in the individual sector is 11%, while the share in production is 55%. These gaps in the shares of land and production are attributable to the specialization of the individual sector in the production of high-value products that do not require large tracts of land (the corporate sector produces mainly extensively cultivated grain and technical crops). These specialization patterns have increased after 1991. Thus in Russia, the individual sector was producing 30% of the vegetables in 1990, and its share rose to 81% in 1998; in Moldova, the corresponding magnitudes were 8% and 71%.¹⁹ Similar changes are reported for the other countries. In addition to vegetables, the individual sector dominates the production of potatoes, meat, milk, and, to a lesser extent, eggs. By specializing in high-value and labor-intensive products, the individual sector could follow low-input farming practices, particularly avoiding the reliance on machinery and equipment.

Estonia, Lithuania, Armenia, and Georgia individualized land use and

showed productivity gains (privatization did not help Latvia, though). Southern countries that have not implemented significant land individualization register the largest reductions in productivity.

A more general policy indicator is the World Bank's Europe and Central Asia (ECA) policy and institutional reform index in column 5 of table 7. This is a weighted average of scores on a scale of 1 to 10 for policies that affect the economic environment of agriculture, including trade and price liberalization, land reform, emergence of land market transactions, privatization of services and supplies, and development of rural finance and public institutions.²⁰ In addition to individualization of land, this index also reflects constraints on buying, selling, and leasing of land by individual farmers; these often preclude transfer of resources to the most efficient producers. The northern countries, especially the Baltics, received comparatively high scores; the southern countries scored lower. The index is highly correlated with productivity gains in column 7 of table 6. Thus, implemented policies affected recovery.

As we have seen, efficiency and recovery involve both production and use of inputs. A major input is labor. Modern agriculture in the industrialized countries is characterized by the exit of labor and intensification of the use of machines and purchased inputs. Agriculture in the former Soviet republics contracted essentially in all its dimensions; arable land was the only variable that did not decline (and even here we find an exception: Kazakhstan decommissioned large areas of presumably marginal productivity, thus reducing its arable land resources by about 20% after 1992). We cannot explain all the changes, but we may attempt to shed some light on labor exit. For labor to leave, economic remuneration elsewhere must be higher and jobs have to be available in other sectors. As a proxy for remuneration, we report in column 6 of table 7 the ratio of value added per worker in the nonagricultural sectors of the economy to value added in agriculture. In the Baltic countries, Russia, and Kazakhstan, income outside agriculture was substantially higher than in agriculture; in the other countries, agriculture provided close or even better income opportunities. The share of nonagricultural sectors in GDP (col. 7 in table 7) may serve as a proxy for the probability to find employment in town. This share is higher in the northern countries than it is in the southern ones. Labor exited from agriculture (cols. 3, 5 in table 6) wherever it was motivated by higher relative income and by availability of employment opportunities.

These observations raise a question to which we have referred in passing. As indicated in column 1 of table 6, income fell drastically in all 15 countries, and the reduction of income probably reflects economic upheavals. One would expect such changes, particularly if abrupt, to be accompanied by significant increases in unemployment. Yet the World Bank's world development indicators show only single-digit rates of unemployment (if at all) in the 15 former Soviet republics. It is therefore impossible to incorporate unemployment and its effects in the analysis, but we have to qualify the discussion by noting

that unemployment and underemployment are hard to measure in transition economies and that their absence from the official records does not mean that they do not exist.

IV. Concluding Remarks

The dissolution of the Soviet Union was followed by large changes in the agricultural sectors of its former republics. These changes must have caused tremendous difficulties to rural families. As we have seen, the transition was not realized in the same way in all the republics. In some, labor returned to agriculture; in others, large numbers left the land. Some republics improved the efficiency of production during transition; in others it deteriorated. Food supply contracted slightly in the northern republics but decreased markedly in the southern group. To a large extent, these differences reflect predetermined conditions: comparatively fertile land in Europe and harsh desert in the south, fast growth of Muslim populations, and the relative smallness of the nonfarm sectors inherited from the Soviet period. However, the public policies of the new independent states struggling with transition, while constrained by natural circumstances and past legacies, also influenced the fate of their agriculture. Early restructuring of laws and institutions in some countries enabled more efficient adaptation to the new circumstances. This conclusion is offered as the moral of our story.

Appendix

The data for the productivity analysis of the 15 Soviet republics (tables 2 and 4) were collected from USSR statistical yearbooks for various years, supplemented, where necessary, by statistical yearbooks of the different republics. The data for the analysis reported in table 3 are from Hayami and Ruttan, extended to cover all agricultural labor (male and female) and the year 1990 using information from the International Labour Organisation (ILO)²¹ and FAO.

The variables for the 15 Soviet republics (tables 2 and 4) were defined and constructed as in Hayami and Ruttan with three major modifications: labor is both male and female workers; land is arable (pastures are not included); livestock does not include draft animals. In the southern Soviet republics, irrigated land and dry land were taken as separate variables. The groups of Hayami and Ruttan countries in table 3 are defined as follows:

Newly settled: United States, Canada, Australia, and New Zealand;

Industrialized: United Kingdom, Switzerland, Sweden, Spain, Norway, Netherlands, Italy, Ireland, Denmark, Finland, France, Germany (Federal Republic), Greece, Belgium, Austria, Israel, and Japan;

Latin America: Venezuela, Paraguay, Peru, Argentina, Mexico, Brazil, Chile, and Colombia;

Egypt+: Egypt, Libya, and Mauritius;

Asia: Sri Lanka, Philippines, Pakistan, India, and Bangladesh;

Others: South Africa, Turkey, Yugoslavia, Portugal, and Syria.

Notes

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4. For a critical review, see Zhores A. Medvedev, *Soviet Agriculture* (New York: Norton, 1987).

5. Karen McConnell Brooks, "Productivity in the Soviet Agriculture," in Johnson and McConnell Brooks (n. 3 above).

6. D. Gale Johnson, "Why Is It So Difficult to Replace a Failed Economic System? The Former USSR," in *The Economics of Agriculture*, vol. 1, *Selected Papers of D. Gale Johnson*, ed. John M. Antle and Daniel A. Sumner (Chicago: University of Chicago Press, 1996).

7. Yujiro Hayami and Vernon Ruttan, *Agricultural Development* (Baltimore: Johns Hopkins University Press, 1985). Data extended to 1990 by David Biton, "Productive Efficiency and the Agricultural Labor Market in International Comparisons" (M.Sc. diss., Hebrew University, Rehovot, Israel, 1998; in Hebrew).

8. Based on data for 43 states in U.S. Department of Agriculture, *Agricultural Statistics 1982* (Washington, D.C.: Government Printing Office, 1983), tables 573, 574, 609. (After 1982, farm labor information was limited to 28 states.)

9. Johnson and McConnell Brooks; Medvedev.

10. With republic dummies, the variability is only over time.

11. Johnson, "Why Is It So Difficult," p. 224.

12. Organization for Economic Cooperation and Development, *Agricultural Policies in Emerging and Transition Economies 1999* (Paris: Center for Cooperation with Non-Members, 1999).

13. Csaba Csaki, Zvi Lerman, and Sergey Sotnikov, "Farm Debt in the CIS," World Bank Discussion Paper no. 424 (World Bank, Washington, D.C., 2001), p. 46.

14. Central Statistical Bureau of the Commonwealth of Independent States (CIS), CD-ROM database (Moscow, 1999). The 1997 terms of trade, relative to 1990, were: Azerbaijan, 4%; Belarus, 27%; Kazakhstan, 14%; Kyrgyzstan, 23%; Moldova, 14%; Russia, 34%; Tajikistan, 34%; Uzbekistan, 16%; and Ukraine, 27%.

15. In the transition countries of central and eastern Europe, agriculture switched from decline to recovery earlier, in 1993–94.

16. Columns 6 and 7 were calculated by the Solow method, which was also used in table 5.

17. For example, Csaba Csaki and Achim Fock, "The Agrarian Economies of Central and Eastern Europe and the Commonwealth of Independent States: An Update on Status and Progress 1998," Environmentally and Socially Sustainable Development Working Paper no. 13 (World Bank, Washington, D.C., April 1999).

18. Central Statistical Bureau of the CIS, CD-ROM database. The countries are listed in note 14.

19. Ibid.

20. Csaki and Fock.

21. International Labour Organisation, *Economically Active Population 1950–2010* (on diskettes).