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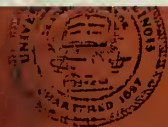


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World War II and Soviet Economic Growth,
1940-1953

Susan J. Linz

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World War II and Soviet Economic Growth
1940-1953

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Abstract

This paper examines the impact of WWII on Soviet economic growth. Part I documents WWII's impact on the Soviet economy between 1939 and 1953 using available Soviet and Western statistics. Part II puts the impact of WWII in perspective by developing a measure of the burden which the economic cost of the war imposed upon the population. Part I also examines the potential for a reduction in the postwar burden of WWII had additional foreign assistance become available. Part III offers some speculations on the cost to the Soviets of "winning" WWII.

World War II and Soviet Economic Growth, 1940-1953

The impact of World War II on the Soviet economy has received little scholarly attention in the West, not because the economic impact was considered unimportant, but because the period from 1940 to 1953 more than any other in Soviet history is characterized by a paucity of economic data. For over a decade, Nove's Economic History of the USSR (1969) remained the primary Western source regarding the countours of the Soviet war effort. Beyond this, little attention has been devoted to the structural changes brought about by WWII. No one, for example, has examined in any detail the quantitative impact on planning, production, or distribution patterns which resulted from i) the long-term increase in female labor force participation rates, ii) the movement of industry to the East, iii) technology transfer in the form of Lend Lease aid or reparations, or iv) new territories annexed during WWII. Even less attention has focused on the impact of WWII on Soviet national policy. Zaleski (1980) and Dunmore (1980) stand alone in their respective examinations of the impact of WWII on planning practices and regional policy. Textbooks on the Soviet economy at most devote only a paragraph or two as transition from the late 1930s to early 1950s. Fortunately, this situation is reversing as more scholars are beginning serious analyses of the war period.

This paper examines the impact of WWII on Soviet economic growth. Part I documents WWII's impact on the Soviet economy between 1939 and 1953 using

available Soviet and Western statistics. In addition to identifying the war's impact on aggregate economic indices, disaggregated data on the industrial sector, labor force, and household consumption are also analyzed. Part II puts the impact of WWII into perspective by developing a measure of the burden which the economic cost of the war imposed upon the postwar population. Calculations by various methods yield estimates of the postwar replacement cost of total material (non-human) war losses ranging from approximately 8 to 10 years' earnings of the 1945 labor force, supporting the Soviet claim that WWII cost two Five-Year Plans (Tamarchenko, 1967, p. 135). The carryover war cost [1] estimates initially presented in Part II include the reduction in the postwar burden resulting from foreign aid and reparation payments received between 1945 and 1953. As such, they do not represent the true cost of WWII to the Soviet people. It is possible, however, to roughly estimate the impact of reparations and other foreign aid ("pipeline" Lend Lease, United Nations Relief and Rehabilitation Administration funds) on postwar recovery efforts. The estimates derived in Part II indicate a contribution of some 1 to 5 years' earnings of the 1945 labor force. That is, had reparations and aid not been received, the postwar burden of WWII would have been substantially higher in the USSR. Part II also examines the potential for a reduction in the postwar burden of WWII had additional foreign assistance (the proposed US loan, Marshall Plan aid) become available. A comparison is made between the impact on postwar recovery efforts and Soviet economic growth potential of additional aid with that of reparations/aid actually received from 1945 to 1953. The results indicate that within the framework employed in this paper, Stalin was

perfectly rational in declining Marshall Plan assistance. Part III offers some speculations on the cost to the Soviets of "winning" WWII.

The Appendix following this essay is an edited version of a paper written in 1944 for the US Office of Strategic Services by Wassily Leontief (1973 Nobel Laureate). The primary focus of his paper was to describe capital reconstruction and postwar development of Soviet national income and consumption. Two scenarios are depicted in his counterfactual analysis including one in which postwar military expenditures return to the 1938 level, reconstruction proceeds without the help of foreign credits, but domestic gold stocks are depleted for 3 years to finance reconstruction. In the second scenario, foreign credits are available to the extent of \$1.5 billion per year for 3 years. Leontief calculated in 1944 that the rate of reconstruction would not be greatly increased should foreign aid become available, making only a few months difference in terms of restoring investment levels. Leontief's previously unpublished findings were made available exclusively for inclusion in this volume for comparison purposes, since both the methodology and results are strikingly similar to those presented in this essay.

I. Impact of World War II on Soviet Economy

The Soviet effort in WWII began in June 1941 with the German invasion, "Operation Barbarossa," and found itself at a disadvantage early on, both militarily and economically. In spite of vast natural resource reserves, high quotas of the initial Five-Year Plans required extensive exploitation of European Russia. As a result, the resource base in eastern regions of the

USSR remained largely untapped. Correspondingly, no real efforts had been made prior to 1941 to urbanize or develop transportation facilities in the East. Moreover, the purges in 1936-37 of top political, economic, and military leaders caused a substantial prewar decline in industrial output (Katz 1975).

Within 6 months of the invasion, German forces occupied or isolated territory which prior to WWII accounted for over 60% of total coal, pig iron, and aluminum production; nearly 40% of total grain production; and 60% of total livestock. Moreover, this area contained 40% of prewar Soviet population, 32% of the state enterprise labor force, and one-third of the fixed capital assets of the state enterprise sector (Nove, 1982, p.271). The speed of the German advance impinged upon Soviet evacuation efforts, but from July to November 1941, over 6 million people and 1,523 industrial enterprises were removed to eastern regions (Urals, West Siberia, Central Asia, Kazakhstan), of which 1,360 were large scale enterprises (employing more than 100-500 people). An additional 150 enterprises were evacuated from behind the Leningrad and Stalingrad fronts in 1942-43 [2]. The magnitude of the evacuation effort and detailed relocation data are described and analyzed by Hunter (chapter 2) and Lieberman (chapter 3).

Evacuation, occupation, and conversion to military production caused a severe decline in aggregate output. Not until March 1942 did industrial output regain its 1940 level. Indeed, 1942 marks the turning point of the Soviet war effort. By the end of that year, the Soviets had regained occupied areas, and industrial output in eastern regions had increased over twofold its 1940 level. These gains were not sufficient, however, to offset the detrimental

Table 1: Soviet War Budget

		1940	1941	1942	1943	1944	1945	1941-45	1946
<i>(Billions of 1960 rubles)</i>									
Uses of funds, non-financial									
A.	Defence outlays	5.7	8.3	10.8	12.5	13.8	12.8	58.2	7.4
B.	Outlays on the national economy	5.8	5.2	3.2	3.3	5.4	7.4	24.4	10.6
	of which:								
C.	All industry	2.9	3.0	1.8	1.8	3.1	4.4	14.0	7.0
D.	Heavy and machine tool industry only	2.6	2.8	1.7	1.6	2.8	3.9	12.8	n.a.
E.	Agriculture (excludes procurement)	1.3	0.9	0.5	0.5	0.7	0.9	3.6	1.3
F.	MTS only	0.8	0.6	0.3	0.3	0.4	0.5	2.1	n.a.
G.	Transport and communications	0.7	0.6	0.4	0.6	0.9	1.1	3.6	1.2
H.	Housing and communal services	0.3	0.1	0.1	0.1	0.2	0.3	0.8	0.4
I.	Trade and agricultural procurement	0.2	n.a.	n.a.	0.1	0.1	0.2	n.a.	0.3
J.	Social-cultural outlays	4.1	3.1	3.0	3.8	5.1	6.3	21.3	8.0
	of which:								
K.	Education & enlightenment	2.2	1.5	1.0	1.3	2.1	2.6	8.5	3.8
L.	Health and physical culture	0.9	0.7	0.7	0.8	1.0	1.1	4.3	1.4
M.	Grants to families	0.1	0.1	0.1	0.1	0.1	0.2	0.7	0.4
N.	Social insurance	0.5	0.3	0.2	0.3	0.4	0.5	1.7	n.a.
O.	Social maintenance	0.4	0.6	1.1	1.3	1.7	2.0	6.6	2.1
P.	Administration	0.7	0.5	0.4	0.5	0.7	0.9	3.1	1.2
Q.	Total non-financial uses above	16.3	17.1	17.4	20.1	25.0	27.4	107.0	27.4
R.	Other, unidentified uses of funds*	0.8	1.7	0.7	0.7	1.1	2.1	6.3	4.9
S.	Total expenditures chargeable against ordinary receipts	17.1	18.8	18.1	20.8	26.1	29.5	113.3	32.1
	of which								
T.	Republic and local budget non-financial outlays	4.2	3.1	2.2	2.6	3.8	4.8	16.5	6.6
<i>(Billions of 1960 rubles)</i>									
		1940	1941	1942	1943	1944	1945	1941-45	1946
Sources of funds									
U.	Enterprise profit withdrawals	2.2	2.4	1.5	2.0	2.1	1.7	9.7	1.7
V.	Turnover tax receipts	10.6	9.3	6.6	7.1	9.5	12.3	44.9	19.1
W.	Total above (U + V)	12.8	11.7	8.1	9.1	11.6	14.0	54.6	20.8
X.	Income tax from cooperatives, kolkhozy, etc.	0.3	0.3	0.2	0.3	0.3	0.3	1.7	0.3
Y.	Income of the MTS	0.2	0.1	0.1	0.1	0.1	0.1	0.4	n.a.
Z.	Transfer of cash balances of socialized sector	—	2.0	—	—	—	—	2.0	—
AA.	Direct taxes and fees from population	0.9	1.1	2.2	2.9	3.7	4.0	13.8	2.3
	of which								
BB.	Agricultural tax	0.2	0.2	0.1	0.4	0.5	0.6	1.8	n.a.
CC.	Income tax	0.4	0.5	0.3	0.6	0.9	1.1	3.4	n.a.
DD.	Housing and cultural tax	0.4	0.4	0.2	—	—	—	0.6	n.a.
EE.	Taxes on bachelors, one-person and childless families	—	0.0	0.1	0.1	0.2	0.3	0.8	n.a.
FF.	War tax	—	—	1.4	1.7	2.1	2.0	7.2	—
GG.	War lottery receipts	—	0.1	0.2	0.3	0.5	—	1.2	—
HH.	Money gifts to Red Army & Defence Funds	—	0.2	0.5	0.5	0.5	0.1	1.8	—
JJ.	Total above (AA + GG + HH)	0.9	1.4	2.9	3.7	4.7	4.1	16.8	2.3
KK.	Local taxes and collections	0.2	0.1	0.2	0.3	0.6	0.6	2.0	n.a.
LL.	Other republic and local non-financial income	0.4	0.5	0.3	0.4	0.5	0.6	2.3	n.a.
MM.	Social insurance contributions	0.9	0.7	0.6	0.7	0.9	1.0	3.9	1.2
NN.	Total non-financial sources of funds above	15.7	16.8	12.4	14.6	18.7	20.7	83.7	24.6
OO.	Other, unidentified sources of funds*	1.2	0.5	2.6	3.3	4.9	6.3	16.7	5.4
PP.	Total non-financial sources of funds	16.9	16.3	15.0	17.9	23.6	27.0	100.4	30.0
	of which								
QQ.	Republic and local budgets	3.9	3.1	2.2	2.6	3.5	4.1	15.5	6.2

Source: Millar (1980), pp. 109-111.

impact of the "scorched earth" campaigns and wartime losses on aggregate output. National income at the end of the war was still some 20% below its prewar level. Agricultural production did not regain its prewar level until after WWII ended as Nove (chapter 4) and Fitzpatrick (chapter 7) indicate in their detailed analyses of WWII's impact on the agricultural sector.

Millar (1980) offers a seminal analysis of the financial aspects of the Soviet effort in WWII. Indeed, he traces the impact of war costs and structural changes in the war economy using the sources and uses of State Budget funds for the war years. Because the State Budget is so comprehensive in the USSR, including all investment flows in the economy as well as military and non-defense categories of expenditure, Millar is able by analyzing budgetary data to provide a relatively detailed sketch of the magnitude of the Soviet war effort. His war budget table is reproduced here in part (see Table 1) to facilitate explanation of the impact of WWII on aggregate economic indices (lines a,b,j,p). Most striking is the increase in defense outlays (line a) which rose from 33% of all budget non-financial uses of funds in 1940 to nearly 60% in 1942, averaging over 50% for the war period [3]. As Millar points out, the defense category of the State Budget understates total war-related expenditures because of the exclusion of outlays connected with the conversion of plant, equipment, and manpower to war production, and the additional civilian administrative costs occasioned by WWII. These costs are examined in more detail by Lieberman (chapter 3).

Perhaps more than anything else, Table 1 indicates the relative and absolute decline in non-defense outlays during WWII, in addition to documenting the impact on the economy of the loss of some 20 to 50 million

Table 2

Actual and Planned Soviet National
Income: 1940, 1944, 1945, 1950
(billion rubles, 1940 prices)

	1940 (Actual)	%	1944 (Actual)	%	1945 (Actual)	%	1950 (Plan)	%
National Income	377.4	100.0	303.1	100.0	331.1	100.0	504.5	100.0
1. Consumption	279.3	74.0	188.3	60.5	217.7	65.8	366.0	72.5
a. Households	264.3	70.0	150.0	49.5	188.5	56.9	351.0	69.6
b. Military Personnel	15.0	4.0	33.3	11.0	29.2	8.8	15.0	3.0
2. Investment	66.1	17.5	40.6	13.4	48.8	14.7	103.5	20.5
a. Fixed Capital	40.5	10.7	22.7	7.5	27.9	8.4	56.6	11.2
b. Livestock	0.1	0.0	0.1	0.0	1.5	0.5	5.0	1.0
c. Inventories	25.5	6.8	17.8	5.9	19.4	5.8	38.0	7.5
Industrial	18.5	4.9	14.6	4.8	15.0	4.5	30.0	5.9
Agricultural	7.0	1.9	3.2	1.1	4.4	1.3	8.0	1.6
3. Defense	27.0	8.5	76.9	26.1	62.3	19.5	29.0	6.9
4. Other	5.0	1.3	2.3	0.8	2.3	0.7	6.0	1.2

SOURCE:

E. Zaleski, Stalinist Planning for Economic Growth, 1933-1952 (Chapel Hill: University of North Carolina Press 1980) p. 352.

people [4] and 30% of the capital stock. The adverse effect upon household consumption was particularly severe, falling from 74% of national income in 1940 to 66% of a lower national income in 1945. This occurred at a time when grain stocks were reduced to augment consumption (see Table 2, and Nove's discussion in chapter 4), and social security payments (which include payments to families of those killed or disabled in WWII) were rising (Table 1: lines m, n, o). Official Soviet sources report that capital formation also declined drastically during WWII, from 19% in 1940 to 4% in 1942. Indeed, the prewar rate of capital formation was not regained at any time during the war (Tamarchenko, pp. 50-51). Hence, expenditures on the war effort rose at the expense of consumption and investment, from 11% of national income in 1940 to a high of 44% in 1943. Yet, as Millar (p. 112) indicates, citing the official Soviet history of WWII, even this share understates the fraction of real national income that was absorbed by the war effort by some 15% in 1942.

Impact on Industry

WWII caused both short and long-term changes in the Soviet industrial sectors in terms of the level of production, composition of output, and regional emphasis. In total, some 31,850 large industrial enterprises were "put out of production" (although not all were completely destroyed) during WWII (Voznesensky, 1948, p. 95). This figure represents more than 80% of the prewar number of industrial enterprises located in the Ukraine, Belorussia, and the occupied areas of the RSFSR. From 1941-1945, the composition of industrial output adjusted to meet the needs of the war effort (see Table 3). Reconstruction priorities dictated the emphasis on heavy industry in the

Table 3

Distribution by Sector of Soviet Industrial Output, 1940-1950
(percent of gross industrial output)

	Heavy Industry "A" Sector	Defense Industry	Light Industry "B" Sector
1940		61.2	38.8
1941	n.a.	n.a.	n.a.
1942	20.5	63.9	15.6
1943	22.1	58.3	19.6
1944	28.1	51.3	20.6
1945	34.5	40.1	25.4
1946		65.9	34.1
1947		66.0	34.0
1948		67.4	32.4
1949		70.6	29.4
1950 (Plan)		66.0	34.0
1950 (Actual)		72.4	27.6

n.a. = Not available.

Sources: Narodnoe khoziaistva SSSR v 1972 g., p. 162; G. Kravchenko, Ekonomika SSSR v gody Velikoi Otechestvennoi voyny (1970), p. 351.

postwar period as is evident in Table 4. In spite of this, light industry experienced more rapid gains in the immediate postwar period (Table 5).

More long-term in nature was the impact of WWII on the location of industry. New construction in eastern regions was exceedingly rapid in the first two years of WWII. Capital investment in heavy industry directed to the Urals and Western Siberia rose from 13% in 1940, to nearly 40% in 1942 (Sokolov, 1946, p. 20). Evacuation and recruitment policies generated a 65% increase in the industrial workforce in the Urals and Volga regions between 1940 and 1943 (Voznesensky, p. 65). The combined result of these policies was an expansion of industrial output in the eastern regions from 3.94 billion (new) [5] rubles in 1940, to 9.12 billion in 1944 (Voznesensky, p. 46).

Dunmore (pp. 35-7) suggests, however, that the long-term nature of the locational shift should not be overestimated. First, the growth of industrial production in eastern regions was concentrated in the defense sector, possibly exaggerating the extent of wartime industrial growth. Second, although defense production expanded in the East, output of foodstuffs, timber, and construction materials in this region fell substantially during WWII. "To claim that the war gave the eastern areas a greatly expanded base for postwar industrial growth is to ignore the disproportionalities between sectors within that base" (Dunmore, p. 36). Third, the quality of wartime construction in the East was significantly lower than peacetime norms because of the urgency with which these industrial enterprises were built, thereby shortening the life of both the buildings and equipment. Fourth, reconstruction in western regions took priority over industry expansion in the East. In part this was because reconstruction efforts focused on civilian (heavy) industry as opposed

Table 4

Distribution of Soviet Industrial Investment by Sector,
1938-1950
(percent)

	3rd FYP 1938-1941	WWII 1941-1945	4th FYP 1946-1950
Heavy Industry	84.5	93.3	87.9
Ferrous metals	7.1	12.0	10.9
Chemicals	4.7	3.6	3.7
Oil and gas	7.4	7.9	11.5
Coal	6.2	9.8	15.5
Electric power	7.8	6.3	7.6
Machine-bldg	33.5	34.4	16.4
Construction and materials	4.6	5.5	9.4
Forestry, paper, wood-processing	3.5	2.5	4.8
Light Industry	15.5	6.7	12.1
Total	100	100	100

Source: Kapital'noe Stroitel'stvo v SSSR (1961), pp. 66-7.

Table 5

Sectoral Increases in Soviet Industrial Output, 1945-1950
(output in percent of previous year)

	Heavy Industry "A" Sector	Light Industry "B" Sector
1945	82	109
1946	73	114
1947	123	122
1948	129	121
1949	125	108
1950	126	115

Source: Calculated from Narodnoe khoziaistva SSSR v 1972 g, p. 195.

to armaments production which predominated in the East. In 1944, "liberated areas" received a greater share of capital investment in 1944 than in 1940 (Kravchenko, p. 221). Lastly, reconstruction efforts in western regions employed the latest technology, while "new" plants in the East utilized old technology and evacuated equipment.

Impact on Population and Labor Force

The most pervasive impact of WWII in the USSR is found in the devastating human loss incurred by the war. The 1939 census reports 170.6 million people living in the 1939 territory, and approximately 20 million living in the newly acquired territory [6]. This puts the 1939 Soviet population in present boundaries at 190.7 million. A rough estimate, based on a 2.5% annual increase in population, puts the 1959 population at 240 million, but the 1959 census shows only 208.8 million people. The correspondingly adverse affect of WWII on the workforce is shown in Table 6.

A direct result of these war-related population losses is found in the excess number of women relative to men. A detailed analysis of the composition of wartime population loss is provided by Fitzpatrick (chapter 7). In 1939, the number of women in the USSR exceeded that of men by some 7 million. By 1959, there were 20 million more women than men, and almost all of this surplus was concentrated among women 32 years old and older. Anderson and Silver (chapter 10) examine the socio-demographic consequences of these wartime population losses, with particular emphasis on the impact on non-Russian nationalities.

An indirect consequence of WWII stems from the postwar industrialization drive which was influenced not only by reconstruction efforts, but also by the

Table 6

Soviet Employment and Wage Data, 1940-1953

	Average annual employment ^a (millions)	Average annual wage (new rubles) ^b	Average annual industrial workforce (millions)
1940	31.2	397	8.3
1941	27.4	n.a.	7.8
1942	18.4	n.a.	5.5
1943	19.4	n.a.	n.a.
1944	23.6	n.a.	n.a.
1945	23.7	521	7.2
1946	30.6	570	10.2
1947	32.1	683	11.0
1948	34.3	723	12.1
1949	36.1	745	12.9
1950	38.9	767	14.1
1951	40.7	791	14.9
1952	42.2	807	15.5
1953	43.7	815	n.a.

^aWorkers and salaried officials in national economy, excludes collective farm workers and military personnel.

^bPost 1961 rubles.

Source: Trud v SSSR (1968) p. 22; Narodnoe khoziaistva SSSR (1956), p. 189; G. Kravchenko, Voennaia ekonomika SSSR, 1941-1945 (1963), pp. 98, 218; Promyshlennost SSSR (1964), p. 84.

USSR's emergence from WWII as a major world power. The impact of these conditions is evident on postwar rural-urban distribution patterns.

Historically, the majority of Russians lived in rural areas: in 1913, only 18% of the population lived in urban centers; in 1939, less than one-third. Yet by 1959, almost half (48%) lived in urban areas. Indeed, the urban population rose from 60 to 100 million people from 1939 to 1959, while over this same 20 year span, the rural population fell from 130 to 109 million (Schwartz, 1961, p. 109). The impact of the rapid postwar growth in urban areas is documented by Fitzpatrick (chapter 7). Bubis and Ruble (chapter 9) examine postwar rural-urban distribution patterns in detail for Leningrad, and their implications for Party membership and leadership.

Another consequence of WWII is found in the shift in population to the East. Some 47 million people were located in eastern regions in 1939. By 1959, this figure reached 63 million. During the same period, Kazakhstan experienced a 50% increase in population (6.1 to 9.3 million), while the population west of the Urals rose only from 144 to 146 million (Schwartz, p. 109). Nove (chapter 4) provides a vivid description of the movement east by the peasantry.

Mobilizing sufficient labor resources for the war effort involved strengthening labor discipline codes and imposing restrictions on labor mobility and individual employment choice. An October 1940 decree authorized compulsory transfer of engineers, technicians, and skilled workers from one enterprise to another. In July 1941, this right was granted to a number of regional and provincial committees, allowing for forced assignment of certain military personnel and workers to jobs in agriculture, industry, and

construction. A decree in December 1941 forbade workers in war industries to leave jobs for the duration of the war, and in September 1941, another decree extended this to transport workers and workers in areas near the front. Additional restrictive decrees were issued in April and May, 1943 (Shigalin, 1960, pp. 240-41). The impact of these policies on the distribution of the industrial labor force is shown in part in Tables 7 and 8, and described in more detail in Fitzpatrick (chapter 7).

The impact on labor recruitment and mobilization for the war effort was most pronounced as a result of the February 1942 decree which required the labor services of all men between the ages of 16 and 55, and all women 16-45 years old. Over 730,000 civilians were mobilized; 565,900 from urban areas, 168,000 from rural areas. Of these, 191,000 were sent to war industries (Shigalin, p. 242).

In addition to direct controls over labor to offset the manpower shortages resulting from occupation losses and increased military service, other policies were adopted during WWII to combat declines in industrial production, including: lengthening the working day 1 to 3 hours, suspending vacations, emphasizing the replacement of male with female labor, and additional training. From June to December 1941, nearly 1 million housewives and schoolgirls (grades 8-10) were brought into the production process. The proportion of women in the total labor force rose from 38% in 1940, to 53% in 1942, reaching 55% by 1945. In industry, women represented 41% of the workforce in 1940, 52% in 1942 (59% in the electric industry in 1942) (Zhenshchina, 1960, p. 35, Kravchenko, p. 99). Kravchenko (pp. 97-8) also reports actions taken to train skilled workers, declaring that in 1942, for

Table 7

Regional Distribution of Soviet Industrial Labor
Force: 1940, 1945, 1950
(thousands)

	1940	% of total industrial labor force	1945	% of total industrial labor force	1950	% of total industrial labor force
USSR	13079	100	10665	100	15317	100
RSFSR	9025	69.0	8076	75.7	10827	70.7
Siberia and Far East	881	6.7	1231	11.5	1752	11.4
Ukraine	2614	20.0	1256	11.8	2509	16.4
Belorussia	394	3.0	152	1.4	346	2.3
Moldavia	23	0.2	30	0.3	52	0.3
Lithuania	6	0.4	50	0.5	97	0.6
Latvia	113	0.9	75	0.7	171	1.1
Estonia	73	0.6	55	0.5	106	0.7
Georgia	130	1.0	125	1.2	175	1.1
Armenia	44	0.3	45	0.4	81	0.5
Azerbaidzhan	139	1.1	124	1.2	173	1.1
Uzbekistan	182	1.4	239	2.2	254	1.7
Kazakhstan	177	1.4	304	2.8	365	2.4
Kirgizia	36	0.3	55	0.5	66	0.4
Tadzhikistan	31	0.2	33	0.3	44	0.3
Turkmenistan	41	0.3	46	0.4	51	0.3

Source: Trud v SSSR (1967) pp. 42-71; Dokuchaev Rabochii klass (1973) p. 43; Dokuchaev Rabochii klass (1972) p. 48.

Table 8

Distribution of Manual Work Force by Industrial
Sector: 1940, 1950

	1940		1950		1950
	# of workers (thousands)	% of total manual workforce	# of workers (thousands)	% of total manual workers	(1940=100)
Heavy Industry	6476	65.0	8794	71.9	136
Coal	436	4.4	733	6.0	168
Electric power	108	1.1	131	1.1	121
Ferrous metals	405	4.1	605	4.9	149
Chemicals	297	3.0	332	2.7	112
Machine-bldg and metal-working	2575	25.8	3332	27.3	129
Light Industry	3495	35.0	3432	28.1	98
All Industry	9971	100.0	12226	100.0	123

Source: Trud v SSSR (1967) pp. 84-5.

example, 80% of all industrial workers took training courses. A parallel effort was made to train tractor drivers and agricultural mechanics.

A final consequence of WWII on the Soviet population and labor force entails the war's impact on forced labor. One US estimate puts the number of persons in concentration camps in 1948 at 13 million (Schwartz, 1949, p. 116). Other estimates range from 2-3 million to 20 million (Jasny, 1951, pp. 405- 07). Forced labor supplies included German prisoners, other enemy soldiers, and "politically dangerous" Soviet citizens (returning military personnel, former kulaks, religious officials, and political or minority group dissidents). An excellent discussion of conscript and convict labor is provided by Fitzpatrick in chapter 7.

Impact on Household Consumption

A comparison of money incomes and expenditures of Soviet households in 1940 and 1945 yields some insight into the impact of WWII on civilian consumption patterns (see Table 10). Wages, salaries, and other payments (including military pay) in 1945 exceeded the 1940 level by some 2.3 billion rubles, in spite of restrictive wartime policies over wages (see Table 6). Income from the sale of products in collective farm markets rose fourfold (by 9.4 billion rubles) from 1940 to 1945 as a result of wartime food shortages. Similar wartime increases are found in the pensions and allowances category of household income which rose from .73 billion rubles in 1940, to 2.37 billion in 1945. In spite of these increases, however, the share of total consumption in national income was much lower in 1945 than in 1940 (see Table 2), despite the fact that the 1945 level of national income was lower than that of 1940.

TABLE 10: Soviet Household Income and Expenditures: 1940, 1945-1953
(billion new rubles)

	Income									
	1940	1945	1946	1947	1948	1949	1950	1951	1952	1953
1. Total money income	23.75	36.47	43.94	50.83	42.85	45.25	50.09	53.76	56.98	59.73
a. Wages and salaries	12.37	14.22	17.44	21.93	24.79	26.87	29.83	32.19	34.04	35.61
b. Other payments	3.83 ^a	2.92	3.58	4.42	4.40	4.44	4.74	4.91	4.98	4.94
c. Income of cooperative artisans	2.06	.49	.58	.69	.79	.82	.84	.93	.95	.96
d. Money payments to collective farmers for trudodni	1.13	.68	.66	.70	.75	.93	1.18	1.29	1.34	1.84
e. Income from sale of farm products to state procurement agencies	.50	.16	.12	.20	.24	.26	.26	.26	.25	.66
f. Income from sale of farm products on collective farm markets	2.56	12.00	14.50	15.07	4.96	4.01	4.33	4.32	4.56	4.15
g. Pensions and allowances	.73	2.37	2.64	3.29	2.68	3.32	3.45	3.59	3.76	3.89
h. Stipends and scholarships	.24	.31	.37	.39	.41	.44	.45	.49	.52	.57
i. interest on loans and savings	.28	.41	.68	.74	.18	.30	.43	.56	.76	1.07
j. Military pay	n.a.	1.34	1.45	1.05	1.02	1.05	1.05	1.90	2.32	2.36
k. Other money income	n.a.	1.42	1.74	2.19	2.48	2.69	2.98	3.22	3.40	3.56
l. Insurance payments and credits for construction of private houses	.05	.15	.18	.16	.16	.12	.10	.10	.10	.12

Expenditures										
	1940	1945	1946	1947	1948	1949	1950	1951	1952	1953
2. Total expenditures	23.70	36.53	45.09	54.66	42.36	47.34	51.02	54.38	57.07	59.37
a. State and cooperative retail trade sales to households	16.20	15.21	22.87	30.60	28.69	31.00	33.26	35.13	36.41	39.84
b. Collective farm market sales to households	12.83 ^b	11.59	14.01	14.56	4.05	4.22	4.67	4.83	5.10	4.64
c. Housing	2.10 ^b	.29	.31	.32	.33	.35	.37	.39	.40	.42
d. Services	n.a.	1.22	1.83	2.45	2.30	4.19	4.49	4.39	4.55	4.98
e. Tuition payments	n.a.	.04	.05	.06	.06	.07	.07	.08	.08	.09
f. Party trade union and other dues	.16	.28	.31	.39	.46	.50	.54	.57	.65	.66
g. direct taxes	1.26	5.16	3.38	3.83	4.18	4.34	4.69	5.35	5.85	5.74
h. Net increase in savings and loans	1.15	2.74	2.33	2.45	2.29	2.67	3.03	3.64	4.03	3.00
3. Surplus of income over expenditures	+ .05	- .06	-1.15	-3.83	+ .49	-2.09	- .93	- .62	- .09	+ .36

n.a. = Not available.

^aIncludes military payment.

^bIncludes services and tuition payments.

SOURCE: Zaleski, Stalinist Planning for Economic Growth 1933-1952 (Chapel Hill: University of North Carolina Press, 1980), Tables 112, 113 114, pp. 442-447.

Additional insight regarding the impact of WWII on civilian household consumption is found in war-related rationing practices adopted to mobilize resources for the war effort. The first rationing decree (July 1941) affected Moscow, Leningrad, and the surrounding provinces (21 urban areas, 17 districts), and encompassed such products as bread, macaroni, sugar, butter, fat, groats, meat and meat products, and fish. In addition, a number of manufactured products were rationed: cotton, linen, and rayon fabrics, ready-made clothes, leather and rubber shoes, and soap. Rationing was extended to different products, and to different cities and provinces, as the war wore on.

The magnitude of war-related rationing is best illustrated by the number of individuals actually involved in the rationing process. The Commissariat of Trade (under which was officed the Administration for Rationed Supplies) supervised the centralized allocation of consumer goods. As Zaleski (p. 351) reports, administratively, this occupied 14,000 persons in 3,100 offices at the end of the war, with some 13,000 persons working in 1,900 control offices to supervise the distribution of ration cards, which in turn employed 400,000 individuals (although only 20% were full-time) to actually distribute ration cards in industrial enterprises and apartment organizations. Nearly 61 million people in urban areas were affected by rationing in 1941. By 1944, this figure had risen to 76.8 million. In December 1945, 80.6 million Soviet people were supplied with bread under the rationing system (of which some 26.8 million lived in rural areas). Needless to say, the results of the vast apparatus of distribution and control were not always satisfactory either to the state or the Soviet people.

Impact on Economic Growth

World War II caused a severe setback in the growth of Soviet output. The ground lost in terms of the growth rate was not recovered by 1953, nor even by 1961. In large part this stems from the reduction in Soviet population and labor force, not only of the losses immediately attributable to WWII, but also from the reduction of the Soviet leadership's capacity to expand the labor force.

Also contributing to the detrimental impact of WWII on the aggregate growth rate of the economy was the long-term character of the 30% loss of capital stock. The nature of this loss includes direct destruction, curtailed investment, and hence, a reduction in productive capacity not only during WWII, but also for an indefinitely long period after the war. Available data (Moorsteen and Powell, 1966, p. 386) suggest that had it been possible to maintain the investment growth rate indicated by prewar trends, the absolute volume of investment realized in each of the post-1950 years would have been achieved 6 to 7 years earlier, or alternatively, would have exceeded actual investment in each year by some 80%. From this it follows that it was not the case that the value of fixed capital stock, having regained its prewar level sometime in 1949 (Moorsteen and Powell, p. 322), was thereafter unaffected by the impact of WWII.

A conventional method for analyzing the impact of WWII on Soviet economic growth examines the war's impact on the level of capital, labor and other inputs, and changes in their productivity. Moorsteen and Powell (pp. 314-379) compiled sufficient data on Soviet employment, capital stock, capital-labor and capital-output ratios, and input productivity measures to put together a

rough sketch of WWII's impact on Soviet economic growth potential in the immediate postwar period.

An important consequence of WWII on Soviet economic growth potential involved the acquisition of new territory. New territory brought under Soviet domain not only additional land and capital stock, but also additional labor. The impact on employment of acquiring new territory was more pronounced in the industrial sector than in agriculture, although both sectors exhibited significant if only temporary labor force increases. A comparison of 1940 and 1945-46 employment figures (Moorsteen and Powell, p. 365) shows a war-related reduction in agricultural employment, caused not only by wartime losses from German occupation and destruction, but also from substantial numbers of agricultural workers who joined the Red Army, and when demobilized, found (or were assigned) employment in urban industrial centers. Included in these agricultural employment figures is the increase in the labor force which resulted from higher wartime and postwar female labor force participation. For the nonagricultural sector, WWII's impact was similar with respect to higher female labor force participation. Indeed, measured in 1937 man-years and adjusted for changes in hours, total employment in this sector in 1945 exceeded that of 1940. Tremendous war-related population losses had an adverse effect upon Soviet labor force growth potential, however, Prewar increases in total employment (approximately 3% from 1928 to 1940) were more than halved as a result of WWII (1% increase in total employment 1945-1961).

The war-related annexation of new territory also allowed for an expansion of sown area, from 137.7 million hectares in 1939 to 150.4 million in 1940 (Moorsteen and Powell, p. 366). The devastating impact of WWII is clearly

seen in the reduction of sown land by 1945, in comparison with that of the 1928 area. As Nove (chapter 4) points out, not until 1948 was the prewar figure of sown land attained (not until 1951 using current boundaries). This holds in spite of the expansion of agricultural production in the East. Johnson (1963) suggests that as far as grain yields were concerned, the expansion of territory did not greatly alter average quality of sown land.

The impact of WWII on Soviet capital-output and capital-labor ratios was pronounced. The average capital-output ratio (computed as the ratio of net capital stock to GNP in 1937 prices) rose irregularly in the prewar period (from 1.68 in 1928, to 1.93 in 1940). At war's end, it had reached 2.01, rising to 2.10 in 1946, before falling, and remaining below 2 until after 1953 (Moorsteen and Powell, pp. 367-8). Wartime devastation of capital stock and slow assimilation of foreign technology would account for these changes, as would reconstruction priorities favoring heavy industry. The capital-output ratio in nonagricultural sectors behaved broadly like that of the total, although the increase over the 25 year period from 1928 to 1953 was less. The extremely high ratio for housing reflects, in addition to the usual factors making for a high capital intensity in this sector, the low level of official rents in the Soviet Union. A comparison of pre and postwar capital-labor ratios reflects, perhaps more than anything else, the differential impact of WWII on the growth rates of capital and labor.

Productivity is cited as a major factor in explaining growth in any industrialized economy. The disruptive effects of war on productivity are no doubt pervasive. Low productivity during the war and initial postwar period is expected, perhaps unavoidable, because of the conversion to and from

military production. It is not clear, however, that the overall impact of war on productivity will necessarily be unfavorable. War may impede technological developments in some areas while stimulating it in others. Moreover, even though war disrupts the functioning of existing administrative agencies, it does provide an opportunity for eliminating bureaucratic rigidities. The pervasive, yet somewhat obscure, nature of WWII's impact on several productivity measures is well-documented by Moorsteen and Powell (pp. 370, 378-9).

The delayed reaction of WWII in terms of growth rates, the "economic miracle" of the 1950s in which West Germany and Japan each recovered rapidly from a substantial degree of wartime devastation, did not occur in the Soviet Union. Extensive controls over the economy, a commitment to rapid growth, the lack of an occupying power, and a firmly established political regime with no domestic opposition would appear to be conducive conditions for economic growth. Yet, the Soviets experienced a relatively long period of remarkably low productivity growth after WWII. Certainly such factors as conversion to and from military production, the state of repair of the capital stock, bottlenecks and shortages in the supply of agricultural materials to nonagricultural areas, hours adjustments of labor inputs, unmeasured changes in the quality of labor, and the overall disorganizing effects of war, both during the hostilities and after the conflict ended, affected input productivity, and hence Soviet economic growth, at least until 1953.

The productivity estimates provided by Moorsteen and Powell are problematic, however, because they are sensitive to interest rate estimates, the method of aggregating inputs, and the adjustment of labor inputs for hours

worked [7]. While it is abundantly clear that WWII altered factor proportions, thereby influencing productivity, it is more difficult simply by examining the data to identify the impact of the war on the level of technology, on economies of scale and scale effects, or on efficiency, all of which are determinants of productivity. These data need to be utilized in an analytical framework which identifies the magnitude of the war effort. The methodology employed below in generating war cost estimates provides one possible analytical framework, and yields additional insight regarding the impact of WWII on Soviet economic growth.

II. War Cost, Postwar Burden and Economic Growth

Measuring the economic impact of war necessarily employs an opportunity cost approach where the opportunity cost, by comparing potential and actual output levels, captures foregone civilian production and capacity expansion, or alternatively, reduced civilian consumption, or additional work effort required by the war [8]. Analyzing the impact of WWII on the Soviet economy using an opportunity cost approach is appropriate whether war cost is measured in terms of costs absorbed during the conflict (Millar and Linz 1978, 1980) or costs absorbed in the postwar period (Linz 1983) because these are not separate costs analytically, only temporally. Wartime costs include, for example, direct government expenditures on the war effort, wartime loss of national income because of damaged or destroyed factors of production, loss of personal consumption resulting both from lower wartime national income and the increased share of government expenditures in national income, reduced leisure

time, and extra effort and resources required to convert to wartime production. War costs not absorbed during the conflict carryover into the postwar period and include such components as the cost of continued lower national income because of the net loss of factors of production, depleted capital stock, reduced birthrates and labor force growth rates, and additional medical costs for the wounded and disabled who demand special care after the war ends. Carryover war cost does not represent any additional war cost, however. Rather, the term is used to represent the extent to which unabsorbed war cost is allocated to the postwar period thereby affecting economic growth potential.

Linz (1983) provides 3 estimates of the carryover war cost for the Soviet experience in WWII. The first estimate uses Soviet claims and sources to establish a rough estimate of the carryover war cost absorbed between 1945 and 1953. To check whether this is a reasonable interpretation of the magnitude of the postwar impact, the second estimate employs Soviet national income data, and the third, aggregate output data in a production function framework. An idea of the postwar burden imposed upon the Soviet people is obtained by calculating each estimate in terms of years' earnings, or work effort, of the 1945 labor force. The estimates range from 8 to 10 years' earnings when considering only the material losses generated by WWII, supporting the claim that WWII cost two Five-Year Plans. If war-related population losses are taken into account, as they necessarily are in the production function analysis, the carryover war cost estimates rise to 18 to 25 years' earnings.

By any measure, the postwar impact of WWII imposed a tremendous burden on the leadership's economic growth efforts, and upon the postwar population as a whole. Indeed, the magnitude of these carryover war cost estimates put into perspective Soviet reparation demands after WWII, and yield further insight into the economic relationships established after the war between the USSR and Eastern Europe. In the context of the debate regarding the origins of the Cold War [9], understanding the postwar impact of WWII and the extent to which it was reduced by actual foreign assistance programs ("pipeline" Lend Lease, United Nations Relief and Rehabilitation Administration funds, and reparations) paves the way for an examination of the extent to which additional foreign aid (the proposed US loan, Marshall Plan aid) would have reduced the postwar burden, or carryover cost, of WWII to the Soviet people.

This section develops 3 separate measures of the impact of actual aid and reparations on Soviet postwar recovery efforts. Similar analysis is conducted for the potential aid programs. To facilitate comparison between the aid impact estimates derived here (and the war cost estimates described above) each is expressed in terms of years' earnings, or work effort required by the 1945 labor force to generate an equivalent impact domestically.

Impact of Actual Aid

The impact of actual reparation payments and other forms of economic assistance on the Soviet economy has not previously been calculated, primarily because of measurement problems. Attempts have been made, however, to estimate total economic aid and reparations to the USSR between 1945 and 1953. The most comprehensive effort, found in Nutter (1962, pp. 351-4), gives an estimate range of \$9.1 to \$21.2 billion. The smaller figure values

aid and reparations in "1938 dollars", the higher estimate is in terms of "current" or 1945 dollars. This range represents a lower bound estimate of reparations and aid actually received because it does not take into account: proceeds from joint stock companies established in East European countries; transit privileges; discriminatory trading prices (except for Polish coal); levies for support of occupation troops and administration; forced labor of war prisoners and interns; or the value of machinery and equipment in occupied territories dismantled by Soviet occupation forces before the end of the war. Moreover, Nutter (p. 353) concludes that these figures understate the true value of reparations received, whether valued in 1938 or 1945 prices, because prices of goods and services received as reparations were discounted substantially in favor of the USSR.

To determine the impact on Soviet postwar recovery efforts of this lower bound estimate of reparations and aid received between 1945 and 1953 requires of conversion of the estimates from dollar to ruble values. Pick (1959, p.343) reports the official exchange rate during the war and immediate postwar period at 5.3 rubles to \$1. Using the official exchange rate, however, fails to provide a meaningful measure of either the true value or significance of reparation payments or other forms of economic aid to the USSR. As Holzman (1968, p. 814) points out, the official exchange rate "has served as little more than an accounting device for converting foreign currency prices of Soviet exports and imports into rubles for the purposes of constructing foreign trade accounts in local currency."

During the 1930s and 1940s, exchange rates between the ruble and other foreign currencies were set arbitrarily by the Soviet government. The ruble

was grossly overvalued as judged by any comparison of its purchasing power with the purchasing power of nominally equal amounts of dollars, pounds, and so on. During WWII, official exchange rates remained unchanged, despite the great inflation of nonrationed consumer goods. Holzman (1968) therefore offers an alternative exchange rate range, based on comparisons of domestic and foreign price trends, of 2.5 to 3.5 rubles to \$1 for the postwar period. While his exchange rates provide a more accurate picture than one based on the official rate, they are not quite appropriate for the purposes of this paper because they deal almost exclusively with exports, without considering the differences in degrees of overvaluation of exports and imports. Moreover, because domestic prices in the immediate postwar period did not accurately reflect costs of production, the ratio between world market prices and domestic prices is understated.

A more meaningful method of converting dollar values into ruble values to determine the magnitudes these reparation and aid estimates represent in the postwar Soviet economy is derived using Lend Lease information. First, Lend Lease aid was similar to postwar aid and reparations in that it was constrained by available supplies. Second, both ruble and dollar estimates of Lend Lease aid are readily available, although both the Soviets and US would have a tendency to misrepresent the actual value of Lend Lease aid. The Soviets claim that Lend Lease aid amounted to 5 billion rubles. They also state that Lend Lease aid came to about 4 percent of their wartime national income (Tamarchenko, p. 57, Cherniavski, 1964, pp. 19-20). US records show Lend Lease aid to the USSR totalled some \$11 billion by the end of 1945 (Jones, 1945). The first claim, 5 billion rubles to \$11 billion, results in a ruble-dollar exchange rate of .5R to \$1.

Calculating an exchange rate based on the second claim requires an estimate of Soviet national income during the war, Yw. Available Soviet sources do not contain estimates of wartime national income, but do provide national income indices (1940=100) for the war period: 92 in 1941, 66 in 1942, 77 in 1943, 88 in 1944, and 83 in 1945 (Kravchenko, p. 351). Bergson and Heymann (1954, p. 24) estimate the 1940 level of national income at 45.8 billion rubles (1940 prices). Hence, Yw equals 184 billion rubles, and Lend Lease aid (at 4 percent of Yw) totalled some 7.4 billion rubles, yielding a second exchange rate estimate of .7R to \$1. For comparison purposes, results using each exchange rate described above are provided in Table 11.

Using the Holzman and Lend Lease exchange rates, the impact of reparations and economic aid on Soviet postwar recovery is examined first by calculating the ruble value of reparations and aid as a percent of cumulative postwar national income, Ypw. Once again, available Soviet sources do not provide estimates of national income for the period 1945-1953, but do contain national income indices (1940=100) for this period: 85 in 1945 (Kravchenko, p. 351), 78 in 1946 (Narodnoe khoziaistvo, 1970, p. 533), 93 and 116 in 1947-48 (Ekonomicheskaya zhizn, book 1, 1967, p. 411), 136 and 164 in 1949-50 (Vikentev, 1957, p. 140), 184 and 204 in 1951-52 (Narodnoe khoziaistvo, 1956, p.36), 204 in 1953 [10]. Hence, Ypw totalled 577.7 billion rubles (1940 prices) between 1945 and 1953. Holzman's exchange rates yield reparations and aid estimates ranging from 22.8 to 73.8 billion rubles between 1945 and 1953 (Table 11: lines b,f), implying a 4 to 13% contribution to postwar national income during this period (lines c,g). Lend Lease exchange rates result in an aid estimate range of 4.6 to 14.8 billion rubles, contributing some 1 to 3% of cumulative (1945-1953) national income.

Table 11: Actual and Potential Aid Estimates, 1945-1953

		Dollar values (billions)		Ruble values (billions)			
				Official 5.3R to 1	Holzman 3.5R 2.5R	Lend Lease .7R .5R	
a.	Actual Aid						
b.	1938 prices	9.1	48.2	31.8	22.8	6.4	4.6
c.	% Ypw		8.3	5.5	3.9	1.1	0.8
d.	Δ Q1*			28.3	21.2	6.9	5.1
e.	Δ Q2**			2.1	2.0	1.7	1.6
f.	1945 prices	21.2	111.8	73.8	52.8	14.8	10.5
g.	% Ypw		19.4	12.8	9.1	2.6	1.8
h.	Δ Q1			59.4	48.2	14.5	10.7
i.	Δ Q2			2.3	2.2	1.9	1.8
j.	Potential Aid						
k.	loan + ERP1	2.4	12.7	8.4	6.0	1.7	1.2
l.	% Ypw		2.1	1.4	1.0	0.3	0.2
m.	Δ Q1				6.5		1.4
n.	Δ Q2				1.7		1.3
o.	loan + ERP2	4.2	22.3	14.7	10.5	2.9	2.1
p.	% Ypw		3.9	2.5	1.8	0.5	0.4
q.	Δ Q1			14.6		3.6	
r.	Δ Q2			1.9		1.5	

Source: see text.

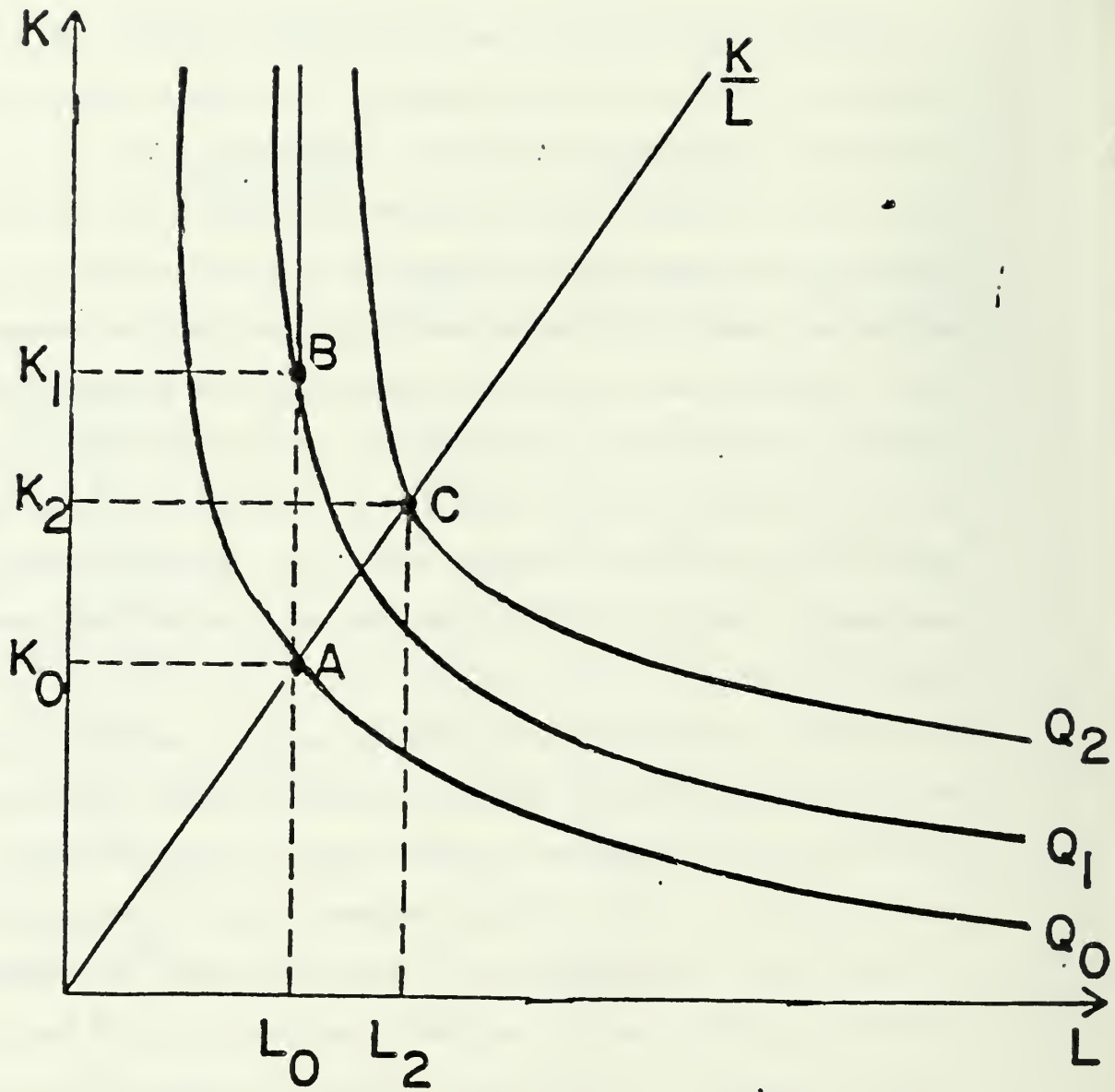
*Change in aggregate output when all aid goes to capital formation.

**Change in aggregate output when all aid goes to labor or wage goods.

An idea of the contribution made by reparation payments and economic aid is found in a comparison with the amount of work effort required to generate an equivalent amount of national income domestically. That is, to generate a similar total increase in national income would have taken the 1945 labor force of 27.2 million workers and salaried officials (Zaleski, p. 607), earning an average 521 rubles per year (Trud, 1968, p. 138), between 1.6 and 5 years' earnings based on Holzman's exchange rates, or 4 months' to 1 years' earnings using Lend Lease exchange rates. This compares with total material war cost estimates of between 3 and 7 years' earnings of the 1940 labor force (Millar and Linz 1978 1980, Saryadar 1980) [11]. Had reparations and aid not been received, the burden of WWII upon the Soviet people would have been appreciably higher.

An alternative method of analyzing the impact of economic aid and reparation payments between 1945 and 1953 uses aggregate output data within a production function framework to relate output to available supplies of capital and labor. Actual levels of aggregate output cited in Soviet sources for 1945 to 1953 clearly include all reparation payments and economic aid received during this period. What would the level of output have been without reparation payments or economic aid? A graphical interpretation is useful for illustrating a number of feasible decision rules regarding reparations and aid which Soviet planners would necessarily have faced in 1945. Figure 1 identifies pre and post aid output levels. Given the Soviet system of central planning and priorities, it makes no sense to assume that capital and labor receive their marginal products, hence the price ratios have been omitted from Figure 1.

Figure 1



Prior to receiving aid, the economy operates at point A, given existing technology and actual stocks of capital and labor. When reparations and other economic assistance became available, one decision rule would have allowed for the entire amount of aid to go toward capital formation. Under this decision rule, the original capital stock would be augmented by the foreign resource inflow from K_0 to K_1 , shifting the isoquant out from Q_0 , the non-reparations level of output, to Q_1 . Because labor has been constrained to its original level, L_0 , by this decision rule, point B marks the relevant combination of capital and labor used to produce Q_1 . A similar analysis follows for a decision rule which allows all aid to go toward labor or consumer goods.

Alternatively, Soviet planners would necessarily have considered the impact on aggregate output of using aid to augment both capital and labor. Under this decision rule, in addition to acquiring capital goods, aid would also have been used to purchase foodstuffs or other consumer goods for payments-in-kind to attract youths, women, and demobilized soldiers to the cities or industrial centers where these goods were in short supply. As seen in Figure 1, this yields a greater impact on output than that resulting from using all aid in either capital or labor formation. Output reaches a maximum, Q_2 , under the assumption of perfect convertibility of foreign resource inflow (reparations and other economic aid) to the optimal levels of capital (K_2) and labor (L_2). The contribution of reparations and other economic aid must fall within the range defined by Q_0 and Q_2 .

Translating this graphical interpretation into actual figures requires certain information regarding the structural parameters of the Soviet economy in the postwar period -- elasticities of output with respect to capital and

labor, and a technology measure, for example. Estimating a production function for the postwar period yields precisely these parameters. Results obtained using a Cobb-Douglas specification and the ordinary least squares (OLS) estimation procedure are shown in Table 12.

Under the first decision rule where all aid goes to capital formation, the contribution of reparations and other aid to aggregate output would have fallen within the range of 21.1 to 59.4 billion rubles using Holzman's exchange rates (Table 11: lines d,h) and CD1 parameters (Table 12), or between 1 and 3% of cumulative postwar aggregate output (Moorsteen and Powell, p. 361). To produce an equivalent increase in aggregate output domestically would have required the 1945 labor force to work between 1.5 and 4.2 years. This compares with a similar impact estimate of 1.6 to 5 years' earnings based on national income data. Using the aid estimate derived from Lend Lease exchange rates, this decision rule implies a contribution of some 5.1 to 14.5 billion rubles (Table 11: lines d,h), requiring additional work effort of 3 months to 1 year, which again is very similar to estimates derived above based on national income data. Had all aid gone to augment labor (Table 11: lines e,i), the corresponding impact on output would have been much less, between 1.7 and 2.3 billion rubles, requiring some 1.5 to 2 months additional work effort to generate an equivalent impact domestically.

None of these estimates, however, represents the maximum impact reparations and aid would have had upon output for at least two important reasons. Looking only at the impact on output of augmenting either capital or labor ignores the long-run effects of net additions to capital stock or labor. This aspect might be examined within the context of a Harrod-Domar

Table 12: Estimated Parameters of a Cobb-Douglas* Production Function
for the Soviet Economy, 1945-61

	Bo	B1	ESS	R ²
CD1**	3.86	.88	.07997	.9501
standard error	.020	.052		
t-statistic	66.7	16.9		
CD2***	2.00	.89	.07809	.9513
standard error	.051	.052		
t-statistic	13.6	17.1		

Source: Moorsteen and Powell (1966, pp. 352-365).

* To reduce problems of multicollinearity and heteroskedasticity, the Cobb-Douglas production function was estimated in intensive form (Intriligator 1978, pp. 150-95). For further discussion of specification and parameter values see Linz (1983).

**Q = nonagricultural NNP, 1937 prices; K = nonagricultural capital services valued at 8% interest rate, 1937 prices; L = nonagricultural employment, adjusted for changes in hours, 1937 man-years.

***Q = nonagricultural NNP, 1937 prices; K = nonagricultural capital services valued at 20% interest rate, 1937 prices; L = nonagricultural employment, adjusted for changes in hours, 1937 man-years.

type growth model. In addition, because it makes no sense to assume perfect competition where capital and labor receive their marginal products given the Soviet system of central planning and priorities, only the boundary solutions can be determined (that is, all aid going to either capital formation or labor). Allocating reparations and other economic aid optimally between capital and labor would necessarily have had a greater impact on aggregate output than any of the estimates obtained above. Moreover, as stated above, the reparation and aid estimate itself is a lower bound estimate.

These results indicate that, whether measured with respect to national income or aggregate output, the impact of reparations and economic aid was substantial. Roughly measured, to generate an equivalent increase in income or output would have required additional work effort by the postwar labor force of some 3 months' to 1 years' earnings (1.5 to 5 years' earnings using Holzman's exchange rates). Had the Soviets not received any postwar assistance, the postwar burden, or carryover cost of WWII to the Soviet people, would have been markedly greater than current estimates indicate (Linz 1983).

Impact of Potential Aid

Soviet reconstruction efforts were aided significantly by reparations, pipeline Lend Lease, and UNRRA assistance. Each of these, however, represented a source of conflict between the US, Great Britain, France, and USSR. The earliest and most pervasive source of conflict arose over Soviet reparations claims, especially with respect to Germany. Discord over Poland, Romania, Hungary, and Czechoslovakia after the Potsdam Agreement further inflamed the reparations issue, and the tenuous relationship between the

Allies began deteriorating rapidly. Lend Lease posed another source of postwar confrontation specifically between the US and USSR. The US did not like the sporadic releases to the Soviet press during the war press which never really informed the Soviet people of the importance of Lend Lease to their war effort, nor did the Soviets like Truman's abrupt termination of Lend Lease once Germany surrendered. Soviet-American confrontation also arose over UNRRA aid. Although UNRRA had been organized and funded (primarily by the US) to provide food, medical care and other assistance to war-devastated areas, protests intensified in the immediate postwar period that UNRRA funds (US dollars) were being used to fund Communist expansion. As a result, UNRRA assistance was cancelled in 1946, despite existing economic conditions in the USSR and Eastern Europe.

In place of the increasingly unpopular Lend Lease and UNRRA aid, the US proposed a loan of \$1 billion in 1945 to aid Soviet reconstruction efforts. Discussions of a loan to the USSR had been initiated much earlier, however. US Ambassador Harriman went to Moscow in October 1943 to meet with A.I. Mikoyan (Soviet Commissar for Foreign Trade) to talk about US assistance in their reconstruction efforts. Indeed, the loan was perceived by business and government leaders alike as a way to help avoid the anticipated postwar depression in the US. In January 1945, Molotov (Soviet Foreign Minister) met with Harriman with the Soviet's first formal request for a postwar loan of \$6 billion. By this time, conflicting interests with respect to the Soviet Union's reconstruction efforts were evident, and the loan had become more of a diplomatic tool than an economic opportunity. In spite of cooling relations between the US and USSR, however, Harriman informed the Soviets in August 1945

that the Export-Import Bank was willing to consider Soviet proposals for postwar aid, and at Truman's request, \$1 billion was earmarked by the Bank for possible loan to the USSR.

Negotiations were stalled and the loan "lost" for the first 6 months of 1946 while the US State Department waited, hoping Soviet reconstruction needs would require them to come to the US to make concessions regarding reparations and other issues, and the Moscow waited, believing the US needed to finance exports to the USSR to head off a depression. By the end of 1946, the loan was no longer a current issue and the general question of US assistance in Soviet reconstruction efforts was not mentioned again until June 1947, when Secretary of State Marshall gave his famous commencement speech at Harvard offering a general plan for European recovery.

When the US offered the Soviet Union economic assistance under the "Marshall Plan" in 1947, the Soviet leadership declined participation. A number of Western scholars contend that the aid was offered in such a way as to preclude any real participation by the USSR [13]. Had they agreed to join in what became known as the European Recovery Program, what amount of aid could the Soviets have expected? Between April 1948 and June 1952, the European Recovery Program gave over \$13 billion in aid (Ferrell, 1978, p.86). Over half of this sum was distributed among Great Britain, France, and Italy. Germany received approximately \$1.4 billion. Assuming that another participant in ERP would have changed the relative shares, rather than the total funds appropriated by Congress, yields an upper bound estimate of potential aid to the USSR equalling the share actually granted to Great Britain, \$3.2 billion. Political conditions at the time, however, suggest

that this sum might be high. Alternatively, it is possible to assume that the Soviet Union would have received as much as Germany, the perpetrator of WWII.

The traditional story implies that the impact of these two potential aid programs would have been substantial, allowing the Soviets to recover their prewar economic capacity much more rapidly and/or easily than actually occurred. It is useful, therefore, to compare these potential programs with those actually received because it is quite clear that the loan and ERP aid were offered as substitutes for continued reparation payments and other existing (or terminated) aid programs. As indicated above, the loan and ERP assistance at best would have amounted to some \$2.4 to \$4.2 billion from 1945 to 1953 (Table 11: lines k,o). This represents 6 to 15 billion rubles using Holzman's exchange rates, or 1 to 3 billion rubles using Lend Lease exchange rates. As such, these two potential aid programs would have amounted roughly to some .2 to 2.5% of cumulative postwar national income (lines l,p), representing approximately 5 months' to 1 years' earnings of the 1945 workforce using Holzman's exchange rates, 1 to 3 months using Lend Lease exchange rates.

Using the aggregate production function analysis described above, under the first decision rule where all aid goes to capital formation (Table 11: lines m,q), output would have increased by 6.5 to 14.6 billion rubles using Holzman's exchange rates, or 1.4 to 3.6 billion rubles using Lend Lease exchange rates. To generate a similar increase domestically would have required additional work effort by the 1945 workforce of 1 month to 1 years' earnings. Under the second decision rule where all aid goes to augment labor (lines n,r), output would have increased by 1.7 to 1.9 billion rubles

(Holzman's exchange rates), or 1.3 to 1.5 billion rubles (Lend Lease exchange rates), requiring some 1 to 2 months' additional work effort to generate an equivalent increase domestically.

Calculated in this rough manner, and compared to the cost of WWII to the Soviet people, the potential impact of receiving the loan and ERP assistance was relatively modest. This is especially striking in comparison with the impact of actual reparations and aid. It does not necessarily follow, however, that the loan or ERP aid would have been insignificant. It is possible to conceive of a situation where it would have been significant at the margin. That is, the loan and ERP aid would necessarily have been used to eliminate bottlenecks in the economy (electricity generation, or improving transport facilities, for example) by acquiring the most effective technology or facilities. Reparations, on the other hand, did not represent state-of-the-art technology or equipment. As such, ERP funds might have allowed for an earlier recovery of the prewar level of output, or, for example, legislation which made it imperative for women and youths to remain in the workforce after the war might not have been necessary. There is no a priori reason to think, however, that a marginal rather than an average capital-output ratio is relevant for analyzing the impact of these potential aid programs upon Soviet reconstruction efforts since a large section of European Russia was fought over with a "scorched earth" policy twice [14].

A simple four equation model may be employed to simulate the impact of additional aid on the size or productive capacity of the postwar economy to check the reasonableness of the estimates derived above. The equations are written below in their estimating form. An underlying assumption of this

model is that potential aid enters the Soviet economy as additional investment.

The Cobb-Douglas production function (equation 1) as estimated above (see Table 12) is employed to relate aggregate nonagricultural output to capital and labor.

For a closed economy, the relationship between investment and capital accumulation is given by the following accounting identity:

$$(2) \quad I(t-1) \equiv K(t) - K(t-1) + R(t)$$

where I is gross annual investment in fixed capital (Moorsteen and Powell, p.358); K , the aggregate capital stock at the beginning of time period t (Moorsteen and Powell, p. 315), and R is the annual retirement of the capital stock. For any t , the following behavioral relationship is expected:

$$(2.1) \quad R(t) = [1-p]K(t)$$

where the annual rate of depreciation is given by $[1-p]$. Write (2.1) for period $t-1$ and insert into (2):

$$(2.2) \quad I(t-1) \equiv K(t) - K(t-1) = [1-p]K(t-1)$$

which yields, in estimating form:

$$(2.3) \quad K(t) = pK(t-1) + gI(t-1) + u(t)$$

where g is expected to equal 1.

Investment in this model depends upon the current level of planned output and the previous period's level of investment. That is, assume investment is the process of adjusting the level of actual capital stock, K , to the desired level, K^* :

$$(3) \quad I(t) = K^*(t) - K(t-1).$$

Assuming K^* is proportional to the desired level of output, Q^* :

$$(3.1) \quad K^*(t) = bQ^*(t)$$

implies that:

$$(3.2) \quad I(t) = bQ^*(t) = K(t-1).$$

Let $g(1)$ be a proxy for K where:

$$(3.3) \quad K(t) = \int_{t=0}^{t-1} I \, dt.$$

Then, written in estimating form:

$$(3.4) \quad I(t) = a(2) + b(2)Q(t) + g(2)I(t-1) + z(t).$$

Finally, employment is assumed to grow at an exogenously determined rate:

$$(4) \quad \ln L(t) = \ln L(0) + w \ln t + e(t)$$

where L is nonagricultural employment in man-years (Moorsteen and Powell, p. 365).

The system of four equations is recursive (that is, no two endogenous variables are determined in the same time period), so each equation can be estimated individually. Estimation results for the production function are shown in Table 12. Calculating the mean average percentage error (MAPE) indicates that this specification of the production function forecasts with a 2% error on average. A more conservative criterion, the root mean squared error (RMSE), was found to be 2.6% [15]. Errors arising from simulation and forecasting will, therefore, range between 2 and 2.6% on average.

Estimating equation (2.3) using OLS yields the following results:

$$K(t) = .941K(t-1) + 1.346I(t-1)$$

standard error	.038	.302	$\bar{R}^2 = .9990$
t-statistic	24.88	4.45	D.W.=2.7776

implying that about 6% of the capital stock depreciates annually. This corresponds closely with Moorsteen and Powell's findings of 5 to 7% annual depreciation. The relatively high standard error of the investment coefficient indicates its instability. The fact that the interval in which the estimate lies spans from 1 to 1.6 may be explained by the limitations of the data. Changes in investment and capital stock are highly correlated over time and the reduced form equation used here is not picking up the exact relationship between the two with respect to depreciation.

In spite of data problems, equation (2.3) simulates and forecasts actual values rather well. The deviation of estimated values from actual values falls between 1 and 2%. In addition, it generates an investment elasticity of .09, which is consistent with the expected relationship between investment expenditures and actual capital stock. That is, the change in capital stock should equal net investment, and annual investment should be about 10% of capital stock to include replacement as well as net additions to maintain economic growth.

Estimating equation (3.5) yields the following results:

$$I(t) = -5.451 + .102Q(t) + .766I(t-1)$$

standard error	.038	.123	$\bar{R}^2 = .9920$
t-statistic	19.21	6.21	D.W. = 1.23

This specification of the investment function does not track as well as the previous two equations. On average, the forecasting error ranges between 5 and 7%.

Lastly, estimating (4):

$$\ln L(t) = 3.038 + .045t$$

standard error	.002	$\bar{R}^2 = .9270$
t-statistic	19.21	D.W. = .2960

Calculating the MAPE and RMSE yields a forecasting error range of about 2-3%.

It is now possible to determine the extent to which an exogenous change in investment would have affected Soviet aggregate output in the postwar period. To calculate the impact and long-run multipliers, it is first necessary to approximate the nonlinear production function using a linearized version. A Taylor series expansion of the production function yields capital and labor coefficients of .32 and .68 respectively, with 1949 as the base year. Solving the system of difference equations and differentiating with respect to $a(2)$ (see equation 3.4) yields an impact multiplier of .43. That is, for a given exogenous change in investment of 1 billion rubles in time t , for example, aggregate output will rise by some 430 million rubles in period $t+2$. The total effect of such a change in investment on aggregate output was found to be an increase of 9.35 billion rubles.

The magnitudes of both the impact and long-run multipliers are intuitively appealing for several reasons. The relatively small impact multiplier reflects the chronic difficulties of carrying out investment plans cited in Soviet sources. The long-run effects indicate both the fact that investment plans are used to eliminate bottlenecks in the economy, especially after WWII, and the rather low efficiency of investment resulting from the wide dispersion of investment projects and delays arising from unfinished construction (Lokshin 1937, 1952). To determine the responsiveness of aggregate output to

changes in the level of investment, the investment elasticity was calculated and found to be approximately .10 for the postwar period, 1945-53.

Calculation of these multipliers and the elasticity of investment allows for determination of the effect of potential foreign assistance on postwar aggregate output. Had the \$1 billion loan been granted in 1946 and used to purchase industrial machinery and equipment, for example, aggregate investment would have been 2-11% higher in 1946-47. The impact of such an exogenous increase in investment would not be evident in the economy immediately. Given an elasticity of .10, a substantial change in aggregate output is not expected to occur in the short-run. The model presented above indicates a 2-period lag before aggregate output would rise. Hence, an additional .5 to 3.5 billion rubles of investment in 1947 would result in an increase in aggregate output of .21 to 1.5 billion rubles by 1949, generating a total increase of some 4.7 to 32.7 billion rubles. Similarly, had the Soviets received \$1.4 to \$3.2 billion of ERP funds in 1948 (best scenario possible), aggregate investment would have increased by some 3.5 to 11 billion rubles (using Holzman's exchange rates) or .7 to 2.2 billion (using Lend Lease exchange rates). The impact of such an exogenous increase in investment would have driven aggregate output up by some .3 to 5 billion rubles by 1950.

The combined effect of these potential aid programs is clearly much less than that of reparation payments during the same period. This is evident in a comparison of the additional work effort of some 1 months' to 1 years' earnings required by the labor force to generate domestically an impact similar to that of the potential aid programs. Similar results are provided by Leontief (see Appendix) on the basis of analysis conducted in 1944 for the

OSS. Indeed, his results coincide very closely with those derived using Lend Lease aid estimates. Viewed in isolation, these figures are substantial. Relative to the magnitude of the postwar burden, or carryover cost of WWII to the Soviet people (Linz 1983), however, these estimates appear modest.

III. Speculations on the Cost of Winning WWII

Although the total real cost of WWII to the Soviet Union has yet to be fully measured, there is not doubt that the economic cost of the war imposed a tremendous burden upon the Soviet people, both in absolute terms and relative to other participants. A significant portion of total material war cost carried over into the postwar period, adversely affecting economic growth efforts. In large part, certain costs were made unavoidable for the USSR by the onset of the Cold War. There is, however, no a priori reason to believe that the net effect (cost) of WWII was negative when taking into account political and social factors. Acquisition of new territory and new technology, in addition to the political and social cohesion resulting from sustaining a successful war effort, are benefits which have been omitted from the economic analysis presented here. Furthermore, little emphasis was placed on the role of actual reparation payments in Soviet postwar recovery efforts. Considering the magnitude of reparation payments relative to potential foreign assistance implies that Stalin was perfectly rational in refusing to make political concessions in return for US economic assistance after WWII. Moreover, considering only the absolute amount of aid ignores the significance of the marginal contribution, which might well have been vital.

Unfortunately, insight into this aspect benefits more from hindsight than from counterfactual analysis.

There are also other costs of "winning" which have not been explicitly discussed which quite possibly imposed an additional burden upon the Soviet population. Costs of occupation and costs of emerging from WWII as a major military power have necessitated disproportionately large annual expenditures for defense. In contrast to the US economy where defense spending ordinarily creates jobs, generating additional national income, the burden of a high level of defense expenditures in the Soviet economy is real in the sense that the size of the economy, or level of national income, is fixed and increasing the share of output for defense purposes causes a "crowding out" of the provision of consumer goods. In this sense, the economic consequences of WWII

Footnotes

1. I thank Larry Neal for suggesting this term to describe the postwar burden of WWII to the Soviet people.

2. Further discussion of evacuation and occupation loss is found in Istoriya, vol II, 1963, p. 148; Chaedaev, 1965, p. 65; Eshelony, 1960, pp. 108, 140; and Kravchenko, 1970, pp. 123-25.

3. A comparison of the share of wartime defense outlays with the 1940 level is somewhat misleading because the share of defense outlays had already begun to rise sharply by 1940 in anticipation of war. Defense outlays in 1937, for example, represented only 17% of all budget non-financial uses of funds. Yet by 1940 this category had reached some 34%. See Millar (p. 112).

4. The population of the Soviet Union was reduced by 7 million during the course of WWII, from 198 to 191 million. Taking into account the prewar population growth rate of 2.5 % per annum implies a total loss in population of some 20 million. A total "loss" of over 50 million people by 1959 (compared to the expected population at that time) is given in V.V. Pokshinshevskii, Geografiia naseleniia SSSR: ekonomiko-geograficheskie orcherki (Moscow, 1971), p. 34.

5. On January 1, 1961, the Soviet government revalued the ruble, ten rubles equalling one new one. Unless otherwise noted, ruble figures given in the remainder of this paper are in new rubles.

6. Lorimar (1946, p. 148) reports 20.1 million people in the newly acquired territory. Bergson and Heymann (1954, p. 6) put this figure at 23.6 million.

7. A complete discussion of this problem is found in Moorsteen and Powell, pp. 255-73.

8. Calculating potential output by projecting a prewar output trend into the postwar period cannot accurately represent an estimate of what the course of output would have been in the absence of WWII, but it does make clear the nature of the loss in output which the war, in all its consequences, entailed. For example, Soviet data indicate that had it been possible to maintain the output growth rate indicated by the prewar trend (6.1% annually 1928-1937, 5.9% 1936-1939, in 1937 prices), the absolute volume of output realized in each postwar year would have been attained 6 to 7 years earlier. Alternatively, the absolute value of output based on the prewar growth trend would have exceeded actual output from 1945 to 1950 by some 50%.

9. The origins of the Cold War have been the subject of controversy for over 2 decades. The traditional view assigns initiation of the Cold War to the Soviet Union, interpreting US actions as responses to Soviet policies in Poland and Eastern Europe. The literature abounds with the traditional viewpoint. See, for example, Mosley (1949), Schlesinger (1967), Feis (1970). Revisionists do not see US foreign policy after WWII as merely responding to Soviet initiatives. Rather, they see US leaders using diplomatic policy and

economic sanctions to try to shape the postwar world in accordance with US needs, standards, and conceptions. See especially Alperovitz (1965), Gardner (1970), Kuklick (1972). For a representative discussion of differences and attempts to classify writers into "schools" see Maier (1970), Graebner (1969), Morganthau (1967).

10. Calculations in terms of the 1945 workforce are higher than those based on 1940 figures because of the reduced size of the postwar workforce. For complete discussion see Linz (1983).

11. There is no question that Lend Lease food shipments alleviated serious Soviet shortages during the war. Shattered Red Army communication systems were rebuilt using Lend Lease equipment. Lend Lease supplied specialized steels and alloys, allowing Soviet efforts to concentrate on the production of basic types of steel. Moreover, Lend Lease aid was not entirely consumed by the war effort. Electric power machinery, a complete rubber tire factory, equipment for drilling and refining petroleum, and technical knowledge were all valuable in Soviet reconstruction efforts. It is clear, then, why the abrupt termination of Lend Lease cause the Soviets so much concern. For an excellent discussion of Lend Lease aid see Martel (1979).

12. The State Department argued that the food crisis was over (apparently disregarding the 1946 Soviet harvest), and that UNRRA aid was no longer necessary to war-ravaged countries since they were capable of importing necessary goods. In early 1947, however, the United Nations' Food and Agriculture Organization estimated a world grain shortage in that year of about 8 million tons. Furthermore, evidence indicates that Poland needed \$200 million for imports for 1947 to maintain a minimum individual daily subsistence of 1,800 calories, and relief deficits for Austria, Greece, Hungary, Italy and China totaled \$596 million for 1947 (Paterson p. 88). Perhaps a better explanation for UNRRA termination was the increasing awareness in Washington of the value of economic assistance as a diplomatic tool. The apolitical nature of UNRRA policy was not well-liked -- US officials wanted influence over the final distribution of UNRRA funds. This position is exemplified by US response to the Soviet request in 1945 for \$700 million for reconstruction in the Ukraine and Beylorussia, a request which required the appropriation of more funds to the UNRRA general fund. The US, however, was unwilling to make the appropriation, supplying instead only a fraction of the amount requested. To make up the difference, the US suggested that the Soviets apply for a loan, which the US then failed to grant.

13. Although Marshall invited European nations to undertake a joint economic reconstruction plan with US assistance, the "Marshall Plan" in a manner similar to the Truman Doctrine, equated economic recovery with political stability, anti-Communism, and security against Soviet expansion. In addition, the French and British feared that the inclusion of the USSR would foreclose Congressional support for a European recovery program, and therefore took a decidedly cool attitude toward the Soviets at the Paris conference of the

three foreign ministers. For a distribution of Marshall Plan aid and further discussion see Patterson and Polk (1947), Paterson (1978).

14. Prior to, and concurrent with the German invasion in June 1941, the Soviets transferred to the East all moveable capital stock, and deliberately sought to destroy everything which could not be removed. The Germans also succeeded in destroying a large portion of the remaining capital stock during their retreat in 1943. For descriptions of the military campaigns and general history of WWII, see Clark (1966), Hart (1971), and Seaton (1971).

15. The mean average percentage error (MAPE) is calculated by dividing the sum of the values by the sum of the errors, giving equal weights to all errors. The root mean squared error (RMSE) penalizes the large errors by weighting them more since it is calculated by summing the squared errors divided by the number of observations, then dividing by the sum of the values divided by n . The RMSE is a more conservative criterion because it is always larger than the MAPE.

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