CHAPTER 8

Energy and the Soviet Economy

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Energy and the Soviet Economy

The energy sector importantly influences and is influenced by the nature and health of the Soviet economy as a whole. Those who formulate energy policy do so in a context which is affected by the structures and performance of the national economy. Their decisions, in turn, help to set the parameters for economic performance. This chapter explores the role of energy in the Soviet economy. It seeks to highlight the economic impacts of alternative plausible levels of Soviet energy availability, and to point out major consequences of various economic eventualities for energy production.

The chapter begins with an overview of the Soviet economy, highlighting recent growth trends. This provides a basis for examining the role of the energy sector in that economy, for identifying some of the factors that influence Soviet energy policies, and for describing the recent direction of these policies. The chapter then presents a simplified description of the Soviet economy that can be used to better understand prospects for energy and economic growth in the present decade. It culminates in the development of "best" and "worst" case scenarios for Soviet economic growth and energy trade in 1985 and 1990.

SOVIET ECONOMIC PERFORMANCE

ECONOMIC GROWTH

The rate of Soviet economic growth over the past quarter century has generally declined. This slowdown is reflected in gross national product (GNP), investment, and consumption spending growth rates. According to Western estimates, Soviet GNP grew at close to 6 percent annually in the 1950's, but growth slowed to 5.0 to 5.5 percent in the 1960's, to 3.8 percent in 1971-75, and to 2.8 percent during the Tenth Five Year Plan (FYP), (1976-80)[1] (see table 53). Investment has traditionally grown faster than consumption in the Soviet economy. In the 1950's, new fixed investment grew at an average annual rate of 10 to 12 percent, contrasted with 5 to 6 percent annual growth for consumption. Since then, the absolute and relative gap in growth rates has alternately narrowed and widened. In the period 1976-79, annual growth was roughly 4 percent for investment v. 3.2 percent for consumption.[2] The average annual growth rate of per capita consumption, a major contributor to maintaining political stability for the Soviet regime, fell from 4.6 percent per annum in the 1950's, to 3.6 percent in the 1960's, and 2.5 percent for the period 1971-79.[3]

Soviet defense spending is commonly believed to have grown roughly in line with GNP for most of the postwar period. In the past several years, however, estimated defense spending has grown at a more rapid rate than GNP. According to the Central In-

[1] Rush V. Greenslade, "The Real Gross National Product of the U.S.S.R., 1950-1975," in Joint Economic Committee, U.S. Congress, *Soviet Economy in a New Perspective* (Washington, D.C.: U.S. Government Printing Office, 1976), pp. 269-300; Central Intelligence Agency, *The Soviet Economy in 1978-79 and Prospects for 1980*, ER 80-10328 (Washington, D.C.: CIA, June 1980).

[2] Greenslade, op. cit.; and Central Intelligence Agency, *Simulations of Soviet Growth Options to 1985*, ER 79-10111 (Washington, D.C.: CIA, March 1979).

[3] See Gertrude Schroeder-Greenslade, "Consumption and Income Distribution," paper presented at the Airlie House Conference, Oct. 23-25, 1980

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Table 53.—Average Annual Rates of Growth for Soviet GNP, Factor Inputs, Factor Productivity, and Consumption Per Capita
(percent)

	1951-55	1956-60	1961-65	1966-70	1971-75	1976-80
GNP	6.00/0	5.80/o	5.00/0	5.50/0	3.80/o	2.80/o
Labor[a]	1.9	0.6	1.6	2.0	1.7	1.2
Capital	9.0	9.8	8,7	7.5	7.9	6.8
Land	4.0	1.3	06	-0.3	0.8	–[c]
Combined factor productivity	1.4	1.8	0.9	1.5	-0,4	-0,7
Per capita consumption[b]	5.3%	4.2%	2.5%	4.7%	3.2%	1.6%[c]

[a] Marl-hours

[b] Total consumption

[c] Refers only to 1976-79

SOURCES Rows 1-5 (1951.70). Rush V Greenslade, "The Real Gross National Product of the U.S S R , 1950.1975, " in Joint Economic Committee, U S Congress, *Soviet Economy in a New Perspective* (Washington, D C U S Government Printing Off Ice, 1976); Rows 1-5 (1971.79) Central Intelligence Agency, *The Soviet Economy in 1978.79 and Prospects for 1980,* ER-80-10328 (Washington, D C June 1980), Row 6 (1 951 ·70), Gertrude E Schroeder and Barbara S Severln, "SO. viet Consumption and Income Policies in Perspective, " in Joint Economic Committee, op cit pp 620-660, Row 6 (1971 .79) Ger trude Schroeder. Green slade, "Consumption and Income Distribution, " paper presented at the Airlie House Conference, Oct 23-25, 1980, and Central Intelligence Agency S/rnu/at/errs *of Soviet Growth Options to 1985,* ER 79.10131 (Washington, D C March 1979) Preliminary 1980 estimates supplied by the Central Intelligence Agency

telligence Agency (CIA), the defense share rose to a level of 12 to 14 percent of Soviet GNP at the end of the Tenth FYP period, after having stabilized at roughly 11 to 13 percent of GNP between 1965 and 1978.[4]

Although there is debate in the West regarding the relative weight of different factors in explaining the Soviet economic slowdown, identification of the basic factors is not in dispute. A country's aggregate output typically depends on the size of its labor force, its accumulated capital stock, and the combined productivity of capital and labors (Land is a third factor of production when agricultural output is included in the summary output measure.) The more rapid the growth of capital and labor and of their combined productivity, the greater the rate of growth of output. Soviet growth rates for individual 5-year periods for each of these factors are shown in table 53,

Labor[6]

Growth in the Soviet labor force has fluctuated as a result of underlying demographic factors and changes in the labor force participation rate, i.e., the labor force as a percentage of the population of able-bodied ages. The dramatic slowdown in labor force growth in the late 1950's was caused primarily by the fall in the birthrate during World War II. The jump in the growth rate in the 1960's is attributable both to underlying demographic factors and to an increase in the labor force participation rate from 83 to 88 percent, reflecting in large part a significant increase in the number of women workers. The 1970's were characterized by a gradual decline in the labor force growth rate.

Capital

Although the overall rate of capital accumulation has slowed since the 1950's, Table 53 shows that it continues to be quite high, particularly in relation to GNP growth. Throughout this period, the capital stock has grown much faster than the labor force. This has resulted in a remarkably rapid rise in the Soviet capital-labor ratio. In industry, for example, the labor force increased about 140 percent between 1958 and 1978 (from 15 million to 36 million), while the industrial capital stock grew by 14.5 times over the same period. [7] This has led some observers to attribute part of the decline in Soviet growth

[4] Greenslade, op. cit.; CIA, *Simulations* , op. cit.: and CIA, *The Soviet Economy* ..., op. cit.

[5] There is now, moreover, a growing 3-factor production function literature based on capital, labor, and energy.

[6] All data on Soviet labor are from Murray Feshbach and Stephen Rapawy, "Soviet Population and Manpower Trends and Policies, " in Joint Economic Committee, U.S. Congress, *Soviet Economy in a New Perspective,* op. cit. , pp. 1 13-1 54; and Murray Feshbach, "Population and Labor Force, " paper presented at the Airlie House Conference, Oct. 23-25, 1980.

[7] Martin L. Weitzman, "Soviet Industrial Production, " paper presented at the Airlie House Conference, Oct. 23-25, 1980.

rates to strong diminishing returns to capital in industry.[8]

Slowing growth of inputs has been reinforced by falling productivity. Increased productivity of the factor inputs, made possible by the introduction of new technology, and perhaps in some cases by improvements in the planning and management systems, accounted on average for 1 to 2 percentage points of the annual GNP growth rate in the 1950's and 1960's, but in the 1970's turned negative.

PROSPECTS FOR ECONOMIC GROWTH

In 1979 Soviet GNP rose only 0.7 percent, and economic growth in 1980 has been estimated by the CIA at 1.5 percent. For the period 1978-80, GNP increased by an annual average of 1.9 percent, the lowest for any 3-year period since World War 11.9 It therefore appears that the U.S.S.R. has entered a period of more fundamental constraints on economic growth. As analysts in both East and West have long anticipated, the Soviets have exhausted the potential for rapid growth based on an *extensive* strategy, i.e., the rapid accumulation of factor inputs with relatively little emphasis placed on their quality or their efficient use.

Barring a significant change in the labor force participation rate and the death rate in the 1980's, the increase in the Soviet labor force over the next decade is preordained, i.e., all its potential members have already been born. Western experts have estimated that this rate of growth will be only 0.4 to 0,5 percent annually over the next decade, about one-fourth the rate of the 1970's. This dramatic projected slowdown in the annual growth of the population of able-bodied ages is due to a number of demographic factors, including progressive aging of the population, a fall in the birth rate since the 1950's, and a recent increase in mortality rates not entirely explained by the age structure of the population.

The slow growth of the labor force is expected to continue to the end of the century. While the labor force participation rate may be influenced through economic policy, it is unlikely that it can be raised much more in the absence of coercion. At 88 percent (v. 65 percent for the United States), the rate is already the highest in the industrialized world. These aggregate labor force trends will be aggravated by the shift in the population structure towards non-Russians in Central Asia. Unless there is considerable migration of Central Asians to labor-deficit areas of the U. S. S. R., Soviet industry could face labor constraints even greater than those suggested by the aggregate labor force projections.

Capital accumulation cannot continue to grow at the high rates of the past without severely curtailing the share of output going to consumption. In any event, the productivity of such additions to the capital stock is questionable.

To counter these declines in the growth of inputs, Soviet leaders are hoping for large increases in productivity. The Eleventh FYP calls for an increase in the productivity of "socialist labor" of between 17 and 20 percent over 5 years.[10] The growth of productivity is partly determined by economic policy but, perhaps more fundamentally, it is also conditioned by the economic system. In particular, the capability of the economy to generate ever larger output levels from given "inputs' of labor and capital—in other words, to shift from extensive to *intensive* growth-is critically dependent on the nature of the prevailing decisionmaking, information, and incentive systems. These elements of the economic system will have a fundamental impact on the efficiency with which existing resources are used, and on the

[8] This interpretation was first developed in Martin L. Weitzman, "Soviet Postwar Growth and Capital-Labor Substitution, *American Economic Review*, vol. 60, No. 4, September 19'70, pp. 676-692

[9] CIA, *The Soviet Economy in 1978-79*, op. cit.

[10] *Ekonomicheskaya gazeta*, No. 49, December 1980.

extent to which technological progress and industrial innovation are stimulated. A significant improvement in productivity performance, therefore, would seem to presuppose important changes in the way in which the economy operates.

Soviet leaders have understandably resisted the idea that the economic system requires fundamental change, but they have accepted modifications classified as "improvements in the economic 'mechanism.'" In contrast to the limited decentralization that has occurred in other socialist countries such as Hungary, Soviet "reform" efforts since the 1950's have largely been devoted to attempting to perfect the system of central planning and to modifying organizational structures and incentive systems so as to increase the likelihood that lower management levels will operate in accordance with plan directives.

The latest of these reforms, announced in a party-government decree in July, 1979, concerning the "improvement of planning and the strengthening of the influence of the economic mechanism in the promotion of production efficiency and the quality of work," called for several changes in the planning and management systems. These included emphasizing interenterprise contractual obligations, strengthening the bonus system, and adopting new major success indicators for industrial management.[12] In addition, there is to be a basic reform in the wholesale price structure at the beginning of 1982. The implications of price reform for energy are discussed in chapter 7.

U.S. experts on the Soviet economy have been virtually unanimous in concluding that these changes in the "mechanism" are not fundamental, and are therefore unlikely to significantly forestall a continued slowing in Soviet economic growth.[13] Indeed, the 1979 decree has been characterized as one of a series of fairly minor reforms which began in 1965. The reform process has been likened to "being on a treadmill, for most of them amounted to reforming previous reforms that failed to work."[14] It is difficult to evaluate these predictions, however, because it is almost impossible to empirically measure the impact of changes in economic system on aggregate economic performance.

[11] See Joseph S, Berliner, "Planning and Management," presented at the Airlie House Conference, Oct. 23-25, 1980.

[12] *Ekonomicheskaya gazeta*, No. 32, August 19'79. See also Berliner; op. cit., and Hans-} Iermann Hohmann and Gertraud Seidenstecher, "Anderungen irn Sowjetischen Planungssystem: Rezept gegen Wachstrumsruckschlag?" 11, Bericht Nr. 33 (Köln: Bundesinstitut fur Ostwissenschaftliche und Internationale Studien, 1979).

[13] See, for example, Gertrude E. Schroeder, "The Soviet Economy on a Treadmill of 'Reforms,'" in Joint Economic Committee, U.S. Congress, *Soviet Economy in a Time of Change*, vol. 1 (Washington, D. C.: U.S. Government Printing office, 1979), pp. 312-340; Hohmann and Seidenstecher, op. cit.: and C IA, *The Soviet Economy in 1,978-79*, op. cit.

[14] Schroeder, op. cit,

ENERGY IN THE SOVIET ECONOMY

ENERGY AND ECONOMIC PERFORMANCE TO 1980

Economic Growth

Easily accessible energy played an important role in generating past high Soviet growth rates. Soviet "gross energy consumption" has increased roughly in line with Soviet GNP over the past 30 years. However, energy consumption grew more rapidly than GNP between 1950 and 1965, less rapidly in the 1965-75 period, and then again more rapidly over the past 5 years. Indeed, the elasticity of energy use with respect to GNP (the growth rate of the former divided by the growth rate of the latter) was higher between 1975 and 1980 than in any of the earlier subperiods, precisely at a time "when the government has pursued a vigorous cam-

paign to encourage energy saving and reduce waste.[15]

Table 54 shows how the investment requirements of the energy sector compete with other sectors of the economy. The investment share of agriculture, construction, and transport-communications increased from 25 percent in 1960 to over 35 percent by the late 1970's. Most of this increase came at the expense of investment in housing and to a lesser extent, consumer goods, trade, and services.

The investment share of the nonconsumer-goods industrial branches (mainly machinery, industrial raw materials, and intermediate products) and the energy sector have remained quite stable. The energy sector's share was about 10 percent throughout this period. Between 1970 and 1977 energy's share of increments to annual total fixed investment in the Soviet economy was only 9 percent. In December 1977, however, the energy sector was declared a "leading link" in the economy. Since then it has apparently enjoyed priority status. In 1978, almost 50 percent of the *increase* in fixed investment in industry was allocated to energy. In 1979, roughly one-half of the increment in *total* fixed investment was accounted for by increased investment in energy.

[15] Robert W. Campbell, "Energy in the U.S.S.R. to the Year 2000," paper presented at the Airlie House Conference, Oct. 23-25, 1980. It must be noted that energy conservation only recently began receiving serious attention in the U.S.S.R. Moreover, care should be taken in interpreting such relationships in the short-term. Energy/GNP ratios are most meaningful when observed over long periods.

Table 54.—Distribution of Soviet Gross Fixed Investment by Sector in Selected Years, and of Increments to Fixed Investment for 1970-77 (percent)

	1960	1965	1970	1975	1978	1970-77 (increment)
Fuels and power	10.4%	11.6%	10.0%	9.7%	10.3%	9.1 %
Agriculture	13.2	16.9	17.7	20.6	19.9	24.6
Construction	2.8	2.6	3.6	3.8	3.7	5.2
Housing	22.8	17.1	16.6	14.4	13.5	8.5
Trade and services	16.1	16.9	17.1	15.1	14.9	11.1
Transport and communications	9.3	9.6	9.4	10.8	12.5	14.6
Consumer goods	4.8	4.3	4.3	4.0	3.3	3.6
Other Industry [a]	20.8	20.9	212	21.6	21.8	233
Total [b]	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

[a] Includes machinery and Industrial raw materials and Intermediate products
[b] Columns may not exactly add to 100 percent due to rounding

SOURCES Calculations based on CI A Simulations..., op cit and CIA. The Soviet *Economy..., op. cit.*

Energy Trade

The U.S.S.R. is a leading energy exporter and the revenues generated by its energy sales have been critical to its economy. Tables 55 and 56 highlight the important role of energy exports both in relation to output and as a source of export revenues. As shown in table 55, roughly one-fourth of Soviet production of petroleum and petroleum products is exported, with about 40 percent of these exports (in terms of quantities) going to non-Communist countries. The U.S.S.R. also imports petroleum, principally from Iraq and Libya, but it is commonly believed that a large portion of this imported oil is reexported. In any case, these imports have not amounted to much more than 5 percent of its total petroleum exports.

About 13 percent of Soviet natural gas output was exported in 1980, and this percentage has been growing rapidly in the last few years. A little under half of Soviet natural gas exports now go to the West. Soviet imports of natural gas, principally from Iran and Afghanistan, were also significant in the late 1970's, but the 1evel of imports has fallen and their relative importance continues to fall. By 1980, when deliveries of gas from Iran had ceased, these imports were less than 5 percent of exports.

Less than 5 percent of Soviet coal output is exported. Over one-third of these exports

[16] *Narodnoye khozyaystvo SSSR*, 1978 and 1979

Table 55.—Estimated Soviet Energy Production and Foreign Trade, 1980a

Product group	Soviet production	Soviet exports	Exports as percent of production	Percent of exports to West[b]	Soviet Imports	I reports as percent of exports
Petroleum and petroleum products.	603 mmt	150 mmt	25%	39%	7 mmt	5%
Natural gas.	435 bcm	56 bcm	13%	*41%*	*2* bcm	4%
Coal	716 mmt	27 mmt	4%	39%	9 mmt	33%

[a]All of th, foreign trade figures are estimates, Since 1976, the U.S.S.R. has not published such data for energy commodities in natural units The estimates for coal trade, in particular are subject to considerable margin of error

[b]The West here corresponds to non-CMEA countries

SOURCES SSRT /ffdx *v1980* g (Moscow *1981*) C 1A *International Energy Statistical Review Mar* 31 1981 Wharton Econometric F orecasting Service Centrally Planned E conomies P roject and OTA estimates

Table 56.—The Importance of Soviet Energy Exports and Imports, 1972-79

	1972	1973	1974	1975	1976	1977	1978	1979
Share of energy exports as percent of ruble value of Soviet exports to:								
Socialist Countries	16.6'YO	17,60/o	18,50/o	26.00/o	27.30/o	29 80/0	31 *,80/0*	*36.00/o*
All other countries , ...	19.8	21.4	33.3	39.7	44.2	42.2	41,3	50.0
Share of all energy exports to Socialist Countries	65.1	57.7	53.5	60.7	58.7	57.4	60.0	55,7
All other countries	34.9	42.3	46.5	39.3	41.3	42,6	40,0	44,3
	1 00.0%	1 00.0%	1 00.0%	100.0%	1 00,00/0	1 00.00/0	1 00.00/0	1 00.0%
Share of Energy Imports as percent of ruble value of all Soviet imports from:								
Socialist Countries	2.4%	2.3%	1 .9%	3.0%	2.7%	2.4%	2.2%	2.4%
All other countries	4.1	5.0	5.4	4.9	4.6	5 2	5.6	5.9
Share of all energy imports from: Socialist Countries	64.0	59.3	54.7	52.4	52.6	57,1	60.0	56.6
All other countries.	36.0	40.7	45,3	47.6	47.4	42,9	40,0	43,4
	100.0%	1 00.0%	1 00.0%	1 00.0%	1 00.0%	1 00.0%	1 00.0%	1 00.0%

SOURCE Derived from Vneshnyaya torgovlya, various years

are directed to Western markets (see table 55). Imports of coal, largely from Poland, may have amounted to over one-third of the volume of Soviet coal exports in the late 1970's.

The growing importance of energy exports in total Soviet trade during the course of the 1970's is illustrated in table 56. In 1972, fuel and electric power exports accounted for 16.6 percent of the ruble value of Soviet exports to all "socialist" countries, and 19.8 percent of the value of exports to the "capitalist" world (the industrialized West and non-Communist developing countries). By 1979, the share of these energy exports had risen to 36.0 percent for exports to the socialist countries and 50.0 percent for exports to the capitalist world. Similarly, the quantities of oil and oil products exported

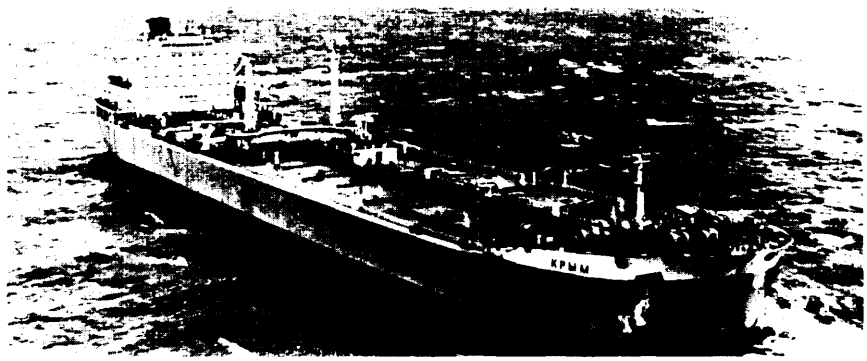


Photo credit TASS from SOVFOTO

First Soviet-made supertanker

grew by more than 50 percent and the quantity of natural gas exported more than sextupled (from a very low base) between 1972 and 1979.

The relative importance of energy as a source of export revenue has been further enhanced by the enormous increases in world energy prices. Indeed, it has been estimated that for the period 1970-77 alone, improvements in Soviet hard currency terms of trade permitted the U.S.S.R. to purchase $14.2 billion more in hard currency imports than otherwise would have been possible without resorting to some combination of expanded real exports, increased gold sales, or additional hard currency debt. This windfall gain amounted to 21 percent of the cumulative value of Soviet hard currency merchandise exports from 1971 through 1977.[17]

THE FORMULATION OF ENERGY POLICY

It is clear that the time of easy energy supplies is over for the U. S. S. R., and the easy answers to energy policy followed in the past two decades are unlikely to be fruitful in the future. A new strategy has become necessary, but its formulation is, and will continue to be, a complex process. There is evidence that debates have arisen over the relative priority to be accorded different energy industries and over the best way to improve the efficiency and productivity of energy production. While decisions naturally reflect the choices of the Communist Party and its Executive Committee (Politburo) and a number of state planning and administrative organizations, Soviet leaders are influenced by a variety of ministerial, regional, and scientific connections. These groups, which compete for resources and influence, play an identifiable role in the formation of economic policy and are critical to the outcome of policy once formulated. Thus, energy decisionmaking in the Soviet Union takes place in a political context. A brief description of the process by which energy policy is set, including identification of the actors involved, is helpful in understanding the apparent outcome and consequences of these debates.

Decisionmakers

There are two important steps in energy, as in all, decisionmaking in the U.S.S.R.[18] The first is the continuous determination of *basic* policy directions by the Politburo, which then directs the Council of Ministers and other state agencies to work out the details. The second is the formal elaboration of energy policy plans by Gosplan, the State

[17] Edward A. Hewett, "The Foreign Sector in the Soviet Economy: Developments Since 1960, and Possibilities to 2000," paper presented at the Airlie House Conference, Oct. 23-25, 1980.

[18] For further information on the structure of the Soviet Government and economy and on the economic planning system, see Office of Technology Assessment, *Technology and East-West Trade* (Washington, D. C.: U.S. Government Printing office, 19791, ch. X: and Joseph S. Berliner, *The innovation Decision in Soviet Industry* (Cambridge, Mass.: MIT Press, 1976).

Planning Agency, in cooperation with government ministries and planning and research institutes. Ministries involved in producing and supplying energy, together with those involved in supporting functions such as the construction of necessary infrastructure, assist in the formulation of plans for the branches of the industries for which they are responsible. The ministries also have a major role in implementing the plans.

Within the general guidelines set by the Politburo, Central Committee, and the Council of Ministers, Gosplan exerts a considerable degree of influence over the allocation of priorities between the energy sector and other sectors of the economy, and over the setting of priorities among the various energy industries. Various departments of Gosplan are responsible for general planning (which must take energy supply and demand into account), for working out the balances of inputs into the energy-producing industries and balances of supply and demand for various types of energy, and for energy production. Gosplan also makes decisions regarding energy-related imports and exports, although such decisions require the participation of a number of other ministries and government agencies.

Despite the comparative centralization of the Soviet system, there is a good deal of diffusion of responsibility among a number of energy ministries. Figure 22 demonstrates the plethora of organizations involved in the discovery, production, and delivery of Soviet energy resources. There are over 60 ministries in the Soviet Government. Of these, 11 have direct responsibility for energy production and energy resource management, and another 6 provide support (e.g., construction, transportation, infrastructure).

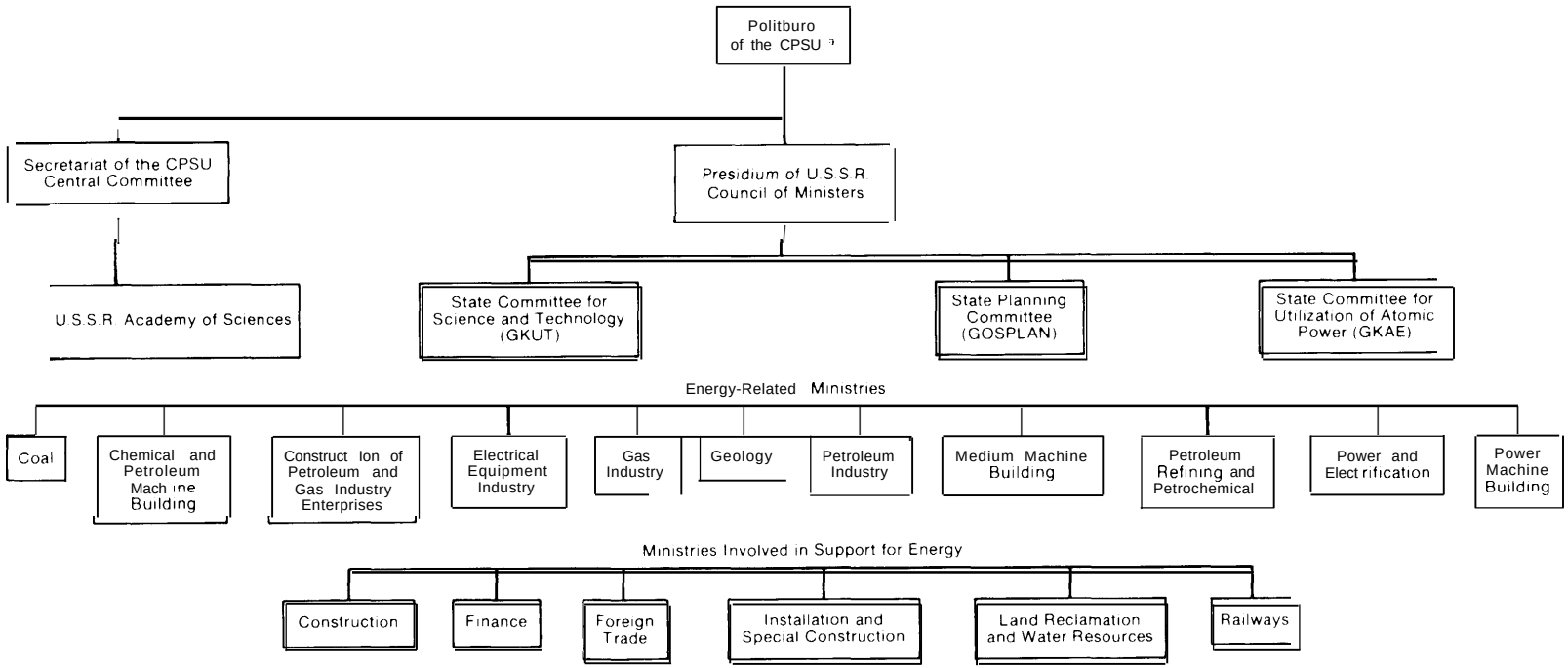
The involvement of some 17 ministries results in considerable overlap in jurisdiction and intense competition for resources. Deciding what Western energy technology should be imported and what energy should be exported, and implementing these decisions, are processes that involve complex interactions among a variety of individuals and organizations. A ministry may be responsible for producing commodities for export (such as oil) and various institutions can request Western imports (such as turnkey plants, large diameter pipe, or mining equipment), but it is Gosplan that makes the critical choices, the monetary aspects of which must be approved and executed by Gosbank, the State Bank. The Ministry of Foreign Trade carries out approved export and import plans through its various trade associations. In addition, the State Committee for Science and Technology (SCST) coordinates policy on technology imports. The decisions and actions of all of these parties are subject to approval by high Party and government organs such as the Politburo and the Council of Ministers.

Energy Policy Debates

Problems in measuring the performance of Soviet energy industries and in appropriately allocating resources recur in a fairly routine manner, as a part of energy planning and policy implementation. But at a higher level, Soviet planners have been engaged in debates over the general direction of energy policy. Disagreements over policy are seldom pursued openly, but a careful reading of the Soviet press and scientific journals reveals a variety of opinions on energy priorities among key leaders. A fundamental question here concerns which energy sector should be awarded priority in capital investments.

Energy industries usually require large-scale investments with long-term payoff periods. This makes decisions about energy-related investments particularly difficult, as increasing allocations to one sector may necessitate reductions in growth of investments in other sectors. Soviet policymakers have been faced with setting priorities among the following: investments for expanded oil and gas production in Siberia; investments designed to increase

Figure 22.—Energy Decisionmaking in the Soviet Union



[a]CPSU - Communist Party of the Soviet Union

NOTE: The Ministries appearing here represent about one-third of total U.S.S.R. ministries.

SOURCE: Derived from Central Intelligence Agency, "Energy Decision Making in the Soviet Union," CR 80-10623, August 1980.

coal production, particularly through the development of surface mining in Siberia; investments in nuclear power stations; and commitments of resources for energy conservation, especially on a regional basis. Among the key policy debates of recent years has been controversy over the question of whether primary emphasis should be placed on the development of petroleum, i.e., oil and gas, or coal, particularly lignite.[19] This issue has been an important one in the Politburo during the last decade.

Those who have publicly emphasized the importance of oil and gas development in Western Siberia include Party President and General Secretary Brezhnev; representatives from Moscow, Western Siberia, Upper Volga, and Azerbaijan; the Chairman of Gosplan; and spokesmen from oil- and gas-related ministries and ministries concerned with automobiles, agriculture, aviation, and defense. Those who have gone on record supporting increased coal production include the late Premier Kosygin, the President of the Soviet Academy of Sciences, and others who perceive a limited future for hydrocarbon development. While Soviet controversies over energy planning are complex, normally carried out in secret, and not easily capsulized in simple dichotomies, public statements of key leaders about these issues have received widespread attention in the Soviet press.

Controversies over whether coal or oil and gas should be made the centerpiece of Soviet energy policy now appear to be resolved. In the current FYP, investment in the gas industry, mostly in West Siberia, will double, and it would seem that increased gas production is now considered the answer to meeting both growing domestic needs and export commitments.[20] But the debate itself merits examination to the extent that it illustrates the institutional conflicts which tend to arise in Soviet energy planning. These debates can be analyzed in terms of individuals—their background, preferences, and personalities, as well as the regional or institutional interests which they legitimately represent. For example, the preference of one Politburo member, V. V. Grishin, for gas and oil might be explained in part by the fact that, as the First Secretary of the Communist Party in Moscow, he has a vested interest in assuring large and reliable supplies of motor fuel as well as heat, power, and gas for its residents. Experience with shipments of poor quality coal which caused frequent shutdowns of power-generating units in the area evidently convinced Grishin that the conversion of coal-burning plants to natural gas is necessary.[21]

It is not surprising that individuals exhibit preferences for energy policy options which promote their own regional or organizational interests. More important for long-term policy trends, however, are recurring conflicts among institutions. At the 25th Party Congress in March 1976, then Premier Kosygin championed a program for large increases in coal production. According to this proposal, during the Tenth FYP the importance of coal would increase in the total energy balance. This was to be achieved through the expansion of surface mining of lignite in the remote Kansk-Achinsk, Ekibastuz and Kuznetsk regions, and the construction of lignite-fired power stations near the mines. Extra-high-voltage powerlines would carry electricity from these stations to the European U. S. S. R., more than 2,500 km away (see ch. 5).

Both the coal advocates and the petroleum advocates had persuasive arguments to support their positions. Kosygin emphasized the fact that development of coal could facilitate savings in natural gas and oil, fuels that could be used most efficiently

[19] Leslie Dienes and Theodore Shabad, *The Soviet Energy System. Resource Use and Policies* (Washington, D.C.: V. H. Winston & Sons, 19791, p. 268.

[20] See Theodore Shabad, "Siberian Gas Field Delayed by Soviet," *New York Times*, Aug. 20, 1981.

[21] V. V. Grishin, "All Energy for the Fulfillment of the Decisions of the 25th Congress of the Communist Party of the Soviet Union, and for the Successful Completion of the Tenth Five-Year Plan," in *Selected Speeches and Articles of V. V. Grishin* (Moscow: Izd. politicheskoi literature, 1979), p. 562.

as exports and chemical feedstocks. Coal advocates also argued that, because of the high labor productivity of surface mining, coal developed in the Kansk-Achinsk region is among the cheapest fuels available. Those who placed first priority on an oil and gas strategy asserted that, because overall coal output has not expanded rapidly and because of the low quality of much of the coal produced in Siberia, the coal industry is not a reliable energy supplier. Indeed, demand for coal from Kansk-Achinsk and Ekibastuz has consistently fallen below quota. While coal advocates expected that the European U.S.S.R. would be a great market for coal, consumers there and in Siberia have tended to prefer more reliable natural gas supplies.

Strong institutional resistance to a coal strategy evidently came from Gosplan, whose research reported unfavorably on the idea of using lignite as a major source of electricity for population and industrial centers in the European U.S.S.R. Furthermore, Gosplan has placed priority on an oil and gas strategy in its allocation and administrative functions, obstructing the construction of the long-distance powerlines. These powerlines area critical element in the coal strategy which is oriented toward increasing supply of "coal by wire" electricity to consumers in the European U.S.S.R. Despite the fact that construction of the lines was approved by the Ministry of Power and Electrification, Gosplan delayed and reduced allocations for the project.[22] Without this crucial powerline link, the lignite strategy foundered.

Gosplan's reluctance to rapidly develop the long-distance powerlines can be explained by a number of factors. First, Gosplan experts calculated that capital investment in the transportation of natural gas was more efficient than investment in the development of coal production. This is an important point. The "coal v. gas" decision also entails basic choices affecting the transportation sector, i.e., whether investment should be directed toward the construction of gas pipelines or additional rail capacity for coal. At a seminar held in Washington, D. C., in March 1980, a Gosplan official stated that his research institute favored postponement of Kansk-Achinsk lignite development, because capital investments could be more effectively directed toward the purchase of French gas industry equipment.[23] Gosplan's electricity cost projections were also important. It was calculated that nuclear and gas-burning power stations located in central Russia could provide cheaper electricity to consumers in that area than electricity transported from the Kansk-Achinsk and Ekibastuz mine-mouth stations.[24] In short, Gosplan's research on investment and energy costs worked against a lignite strategy and tended to favor development of the more "progressive and efficient gas industry.

The coal and power and electrification ministries also opposed the lignite strategy, but for different reasons. Where Gosplan officials stressed investment and energy cost considerations, the ministries charged with implementing plans for coal development were concerned with the past performance of the coal industry. Surprisingly, even the Ministry of Coal has been ambivalent toward the development of lignite complexes. While it is naturally anxious to increase coal production, its officials have been slow to commit resources to the construction and equipment of new mines, evidently preferring to direct investments to older mines in areas where regional ties to the ministry are long-standing. Moreover, since the earnings of coal enterprises depend primarily on the quantity of coal shipped, the quality of

[22] V. M. Tuchkevich, "Speech at the Session of the General Meeting of the Academy of Sciences of the U .S. S. R., *Vestnikan SSSR*, No. 5, May 1980. pp. 98-99.

"Interview with Albina Tretiakova, Demographic Division, Department of Commerce, Washington, D. C., Dec. 17, 1980, concerning R. V. Orlov's comments at the "Seminar on Energy Modelling Studies and Their Conclusions on Energy Conservation and Its Impact on the Economy," held in Washington, D. C., May 24-28, 1980.

[24] *Elek tricheskiye s tan tsii*, No. 12 (1978), *pp.* 11-14, translated in ".News Notes," *Soviet Geography*, Mar. *20, 1979,* pp. 188-190.

the coal mined is a secondary consideration. Electricity producers are consequently vulnerable to being forced to rely on poor-quality Kansk-Achinsk and Ekibastuz coal. It is no wonder that reliable and cheap hydropower is much more popular among the electricity producers in Siberia. As the coal and power ministries each attempt to maximize their profits and performance, the result is systemic suboptimization (delays in expansion of overall coal-fired power production).

The Ministry of Power and Electrification (Minenergo) has neglected construction of lignite or coal-fired powerplants not only because hydroelectric plants are cheaper to operate, but also because of the poor quality of delivered coal. High in ash, and often certified above its actual calorific content, the coal tends to cause power equipment breakdowns and consequent loss in production time. Since Minenergo's performance is measured in terms of total output and by grams of standard fuel consumed per kilowatt-hour of electricity produced, the ministry's record is jeopardized by coal-fired power production. Although Minenergo was directed to construct coal-fired power stations in the Tenth FYP, the system of performance indicators actually embodies strong disincentives to carry out such orders. As long as the ministry maintains a good overall record in production of electricity, it is unlikely that it will be punished for failing to speed up construction of coal-fired plants.

As chapter 3 has described, efforts to increase coal production and consumption during the Tenth FYP clearly fell behind expectations. Where former Premier Kosygin had forecast a growth in coal output from 701 million metric tons (mmt) in 1975 to 790 to 800 mmt by 1980, actual output for 1980 was only 716 mmt. Stated in calorific terms, these statistics reveal an actual decrease in coal output during the plan period due to the increasing share of low calorie lignite in coal production. Furthermore, labor productivity in the coal industry has been declining since 1978. Recently published guidelines for the Eleventh FYP now reflect diminished expectations for coal. Targets for 1985 coal production have been set at 770 to 800 mmt, equivalent to the original goals for 1980, and the coal's calorific value will continue to decline as most of this growth will come from increased production of lignite. The new FYP guidelines can therefore be interpreted as a resolution of the coal v. petroleum controversy in favor of the latter.

A second and equally important consideration is the relative priority which has been accorded oil and gas. These are handled by different ministries which compete for investment, drilling capacity, and pipeline priority. The most widespread interpretation of the current FYP—in which oil production is set to rise 7 percent and gas production 47 percent–is that the U.S.S.R. is now placing its emphasis on gas.

This view is supported by the fact that in his speech before the Party Congress on February 23, 1981, Brezhnev emphasized the importance of Siberian gas development:

> As a task of paramount economic and political importance I consider it necessary to single out the rapid expansion of output of Siberian gas.
>
> The deposits of the Western Siberian region are unique . . . . The extraction of gas and petroleum in Western Siberia and their transportation to the European part of the country are becoming a predominant link of the energy program of the 11th and even of the 12th Five-Year Plan. This is the line of the Central Committee of the Party, and I hope it will be supported by the Congress. [25]

Summary and Conclusions

Controversy among Soviet energy planners and among various energy-related institutions suggests that in order to be successful, a Soviet energy strategy needs more

[25] "Report of the Central Committee of the CPSU to the 26th Congress of the CPSU on the Immediate Tasks of the Party in the Sphere of Domestic and Foreign Policy: The Report of the General Secretary of the Central Committee of the C PSU, Comrade 1,.1. Brezhnev," *Pravda*, Feb.24,1981, p. 5.

than the formal support of the leadership. In addition to the backing of members of the Politburo and the Council of Ministers, it requires the cooperation of Gosplan, other agencies, and the several ministries directly involved in its implementation. The personalities and preferences of top leaders can be important. The decline of the coal strategy, for instance, was surely affected by the demise of a prime advocate, the late Premier Kosygin; the present emphasis on gas has been underscored by Brezhnev. The actions of many institutions and ministries, however, have also been important. This fact takes on added significance in light of the advanced age of much of the present Soviet leadership.

On the evidence of the new FYP, advocates of gas development and of nuclear power have had the most influential voice in energy planning. Current policy guidelines indicate a strong commitment to the development of these fuels. But the energy debates of the last few years suggest that competition for resources may well reappear among ministries involved in the development of oil, gas, and nuclear power—particularly when the impending change in Soviet leadership takes place. Both international and domestic developments may affect priorities placed on various types of energy development. The gas industry, because of its reliance on Western equipment imports, is likely to be more committed to pursuing a strategy of interdependence with the West than the nuclear power industry, which prides itself on the development of indigenous technology. Whatever the strategy chosen at the top, however, successful implementation will depend on the cooperation of a variety of organizations and regions.

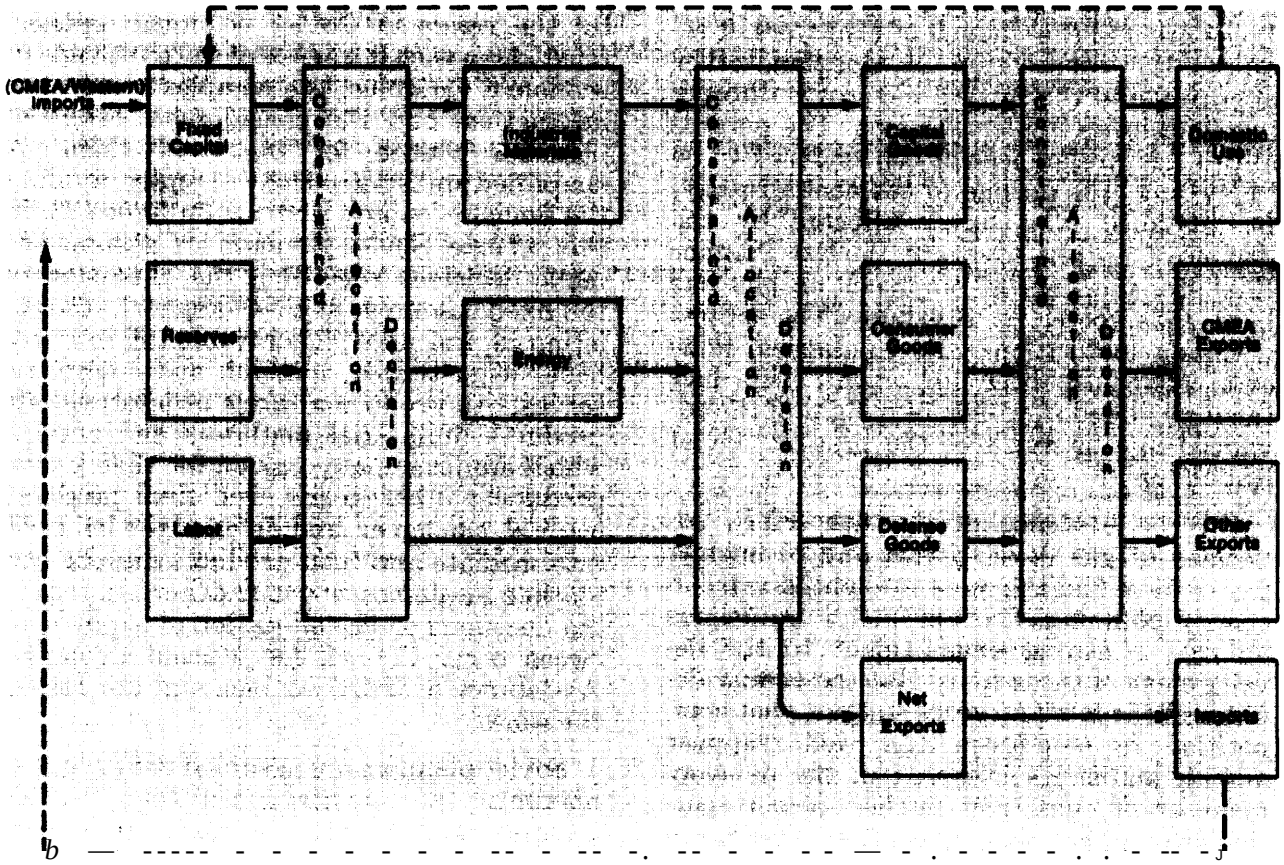
ENERGY AND FUTURE ECONOMIC PERFORMANCE

Whatever the energy policy pursued, it will affect and be affected by Soviet economic performance in the present decade. Any understanding of the ways in which energy availability is related to and affected by the range of Soviet economic options must carry with it a sense of the multitude of economic variables, the complexity of their interaction, and the considerable range of plausible values for many of them. A simplified and stylized way of understanding the Soviet economy is shown in figure 23. In this scheme, Soviet planners are assumed to make decisions regarding the allocation of the fixed resources at their disposal—the existing capital stock, labor force, and resource bases (e.g., timber, mineral, and energy reserves)—to produce a range of intermediate products (industrial materials and energy) which are principally valued for their use in producing other goods, and final products (capital, consumer, and defense goods). Both intermediate and final products may be earmarked for domestic use or exported, requiring decisions on the allocation of exports between other Council for Mutual Economic Assistance (CMEA) nations and the rest of the world.

Soviet planners are assumed to attempt to maximize the contribution of foreign trade to domestic growth, subject to foreign market conditions, regional balance of payments constraints, and possible "noneconomic constraints on trade with each region. In theory, and noneconomic constraints permitting, the planners would want to expand trade with a region as long as the terms of trade (the weighted price of exports relative to that of imports) exceeded the *relative* marginal productivity of the exports to domestic growth. This is the principle behind actual "foreign trade effectiveness" indices developed by Soviet and East European economists and designed to guide decisions on the structure of foreign trade.

An example of the kind of decisions facing planners can be found in Soviet oil trade with the West. Assuming for simplicity that this trade consisted solely of the export of Soviet oil in return for oil industry technology and equipment and that the main economic goal were to maximize the amount of oil available

Figure 23.—The Soviet Economy



SOURCE Off Ice of Technology Assessment

to domestic industry, political considerations aside, the Soviets would find it economically advantageous to expand this trade as long as their terms of trade (the export price of oil relative to the price of imported machinery and technology) were greater than the relative marginal productivity of the exportable oil in making oil available domestically. In other words, it would only make sense in this case to export oil to the West if the the proceeds could be used to buy sufficient technology to yield (on a present value basis) more oil than was exported.[26]

[26] 1'hotnas A. Wolf, "Soviet Petroleum Trade and Western Technology in a General Equilibrium Context: Some Preliminary Notes, " paper presented at the Twelfth National Convention of the American Association for the Advancement of Slavic Studies, Philadelphia, Nov. 6,1980.

The actual calculations are not nearly so simple, and even in this highly stylized framework, the process of deciding whether and where oil should be exported would entail consideration of numerous tradeoffs. Obviously, Soviet planners could not make all possible calculations and comparisons given the tremendous informational requirements and the lack of a price system which efficiently generates such information. But presumably, to the extent that the planners exhibit economic rationality, these types of calculations implicitly enter into the medium and longrun planning of Soviet foreign trade. Complicating the calculus are various "noneconomic" constraints or goals. For example, the proportion of domestic oil output exported to Eastern Europe may be higher than that suggested solely on the basis of economic criteria alone.

The remainder of this section seeks to elucidate some of the complex relationships and the nature of the costs and benefits associated with different Soviet policy options as they concern energy. For purposes of illustration, it hypothesizes a fall in oil output at existing levels of use of capital, labor, and intermediate products in the oil industry. Faced with this disturbance, Soviet policy makers can follow one or both of two basic courses of action. They can attempt to regain the previous level of oil output, or they can attempt to "make do" with a lower level of domestic oil production.

In order to boost oil output, the planners could increase the proportion of total labor and capital available to the oil industry. Wage rates could be raised in the hope of attracting workers, but such material incentives might have to be very large to overcome the disadvantages of working in West Siberia and the East. Assuming that other money wage rates were not reduced, such a measure would increase aggregate money income in the U.S.S.R. If increased real output of consumer goods were not forthcoming, this would be inflationary and could in turn negatively affect labor productivity.

The diversion of labor and current investment from other sectors would reduce the rate of growth of output in those industries. To the extent this diversion were at the expense of investment in the machine building and heavy industry branches, the potential for future growth in *all* other sectors, including oil, would be reduced. Diversion of investment spending from the consumer goods sector would reduce the future rate of growth of real consumption, which could in turn adversely affect the rate of productivity growth throughout the economy, as dissatisfied workers work less hard and spend more time away from the job queuing for consumer goods. A decline in productivity growth would cause a further slowing in overall Soviet economic growth. In short, the diversion of resources would not only have direct adverse consequences for output in various sectors. There would also be second, third, and higher order "multiplier" effects throughout the economy.

One way to try to reduce the adverse effects on economic growth in other sectors would be to raise the labor force participation rate. This is already very high, however, and the impact on overall economic growth of any conceivable changes would be negligible. Moreover, in order to induce additional people to enter the work force, it might be necessary to raise the output of consumer goods, at the expense of investment and future growth.

Another option would be to improve the decisionmaking, information, and incentive systems of the economy enough to raise the rate of growth of combined factor productivity. This could both raise the rate of growth of output in the oil sector itself, and stimulate higher output growth in other sectors. This approach might not involve significant economic costs, except insofar as changed indicators and norms might create considerable uncertainty among managers and workers during the transition period. Further, it would avoid the type of direct and indirect economic costs involved in any policy of resource reallocation. But such system change invokes other potential costs. The conventional wisdom among most Western observers is that any changes in planning and management systems profound enough to significantly affect productivity may well carry unacceptably high ideological and political costs for the Soviet leadership.

Finally, Soviet planners could attempt to increase and accelerate imports of Western oil equipment and technology. This strategy would presumably be based on the perception that the opportunity cost of such imports was relatively low. The calculation, however, is not so simple as might appear. Increased imports of technology for hard currency would have to be paid for with some combination of the following: increased exports of energy or industrial materials, reduced hard currency imports of other goods, greater exports of gold, and an increase in hard currency debt.

The latter two choices would carry the cost of reducing future external financial flexibility. Increased real exports of energy or industrial materials would reduce the supplies available to domestic industries, thereby slowing output growth in these sectors. A decline in hard currency imports of industrial materials or nonenergy capital goods and technology would likewise slow domestic output growth. A reduction in imports of grain or other consumer goods would reduce domestic consumption growth and indirectly adversely affect productivity growth. World market price trends for all these products, for gold, and for Western export credits, would influence the final choice. At the same time, the planners would be comparing the costs and benefits of expanded technology imports with the costs and benefits associated with other major policies, such as intersectoral reallocation of labor and capital.

In effect, each option has its economic and political opportunity costs. The economic cost of a given policy lies in the direct or indirect negative effect it has on output growth in one or more sectors, and the impact it has on future external financial flexibility. The benefit of a given policy could be measured in terms of its direct or indirect positive effect on output growth in one or more sectors. The planners' intersectoral priorities would determine the implicit weight attached to the induced change in output in each sector.

In addition to pursuing policies aimed at reviving petroleum output, the planners could seek to make a new lower level of oil production go farther, thus minimizing its negative impact on economic growth. Such an approach would involve some combination of reallocation of available energy supplies, direct energy conservation, interfuel substitution, and expansion of energy imports.

One possibility is that Soviet planners might seek to absorb any fall in oil output by cutting back on oil allocations to the capital goods and industrial material sectors.[27] This would have an especially profound effect on the overall rate of economic growth. Consumption would only be affected indirectly, through the slowdown of investment spending in that sector, but eventually production in the consumption sector would slow, and thus there might also be a decline in the rate of growth of productivity.

As output declined in certain sectors as a result of reduced energy availability (combined with unchanged energy-use coefficients), either domestic consumption of these products or exports would have to fall. In the former case, the impact on future growth would be direct; if exports are reduced, the impact would be less immediate. In that case the multiplier effect would come through an eventual fall in real imports induced by the deteriorating trade balance.

Output declines stemming from factor reallocation, energy reallocation, or other policies, could in principle be avoided through fuel conservation and substitution. But a conservation-substitution policy is not without cost. Significant retrofitting and other conversion measures would claim some new investment which otherwise would be used to expand productive capacity. On the other hand, as chapter 7 points out, much of the Soviet conservation effort is aimed at urging industry to use less energy and motivating management to reduce the materials intensity of production, which in turn indirectly reduces energy consumption.

Another way of "conserving" oil would be to export less of it. The costs of pursuing this policy are similar to those attached to increased imports of oil technology. Reduced exports of oil or other energy products to CMEA and/or the West would indirectly involve some combination of a fall in domestic output of some sectors and reduced future

[27] This is the basic policy assumption built into the econometric model of the Soviet economy used by the CIA. See C 1A, *SOVSIM: A Model of the Soviet Economy*, E R 79-10001" (Washington, D. C.: CIA, February 1979); and CIA, *Simulations*, op. cit.

external financial flexibility. In the case of CMEA there are also the "political" costs of reducing oil exports.

Alternatively, the U.S.S.R. could step-up its imports from selected oil-producing less developed countries (LDCs) in return for exports of Soviet capital goods and arms. But this "soft currency solution" would not be costless to the Soviet economy. Expanded exports of Soviet capital goods would slow Soviet domestic output growth. Increased arms exports, unless from inflated inventories, might also come either at the expense of the Soviet military or at the cost of diverting investment from one or more "civilian" sectors into defense. Successful pursuit of this policy would also be predicated on the existence of sufficient demand by oil-producing LDCs for Soviet capital goods and arms. If demand is weak relative to Soviet export offers, Soviet terms of trade with this region would decline, eliminating much of the economic advantage of such trade. In other words, the relative price of LDC oil would no longer be below its relative marginal productivity to the Soviet economy.

Finally, the effect of a partial or total Western embargo of energy technology and equipment exports must be considered. An embargo policy that stopped or interrupted economically beneficial trade would mean that Soviet demand for this technology at existing prices would be frustrated. This would increase the relative attractiveness of all other policy options. It would also mean generally lower rates of growth for Soviet investment, consumption and defense than otherwise.

In sum, virtually any policy that the leadership pursues carries with it both economic costs and benefits. The task is to select that combination of policies which together yield the highest benefit-cost ratio. The remainder of this chapter attempts to suggest a plausible range of parameters within which these policies will have to be made. It seeks to shed light on the ways in which energy availability in the present decade will affect Soviet economic growth, and on the ways in which energy availability could affect Soviet hard currency trade prospects. To accomplish this, OTA has posited high and low levels of output for 1985 and 1990 in the various Soviet energy sectors and used these to generate "best" and "worst' case scenarios for Soviet economic growth and hard currency trade.

ENERGY AND THE SOVIET ECONOMY: BEST AND WORST CASE SCENARIOS

While Soviet leaders have already made and publicized their energy policy preferences for the Eleventh FYP period, their (or their successors') options for the late 1980's seem for the most part to remain open. The scenarios constructed for both 1985 and 1990 suggest some parameters and a few of the policy choices facing Soviet policy makers during the 1980's. *These are not predictions.* The intention here is simply to provide the reader with a sense, not only of the number and complexity of factors which together determine the outcomes of policy choices, but also of the sensitivities of the Soviet economy to various energy-related developments. Because OTA has not relied on formal econometric modeling, all estimates are in highly aggregative terms.[28]

One basic assumption entailed in these scenarios is that Western exports of energy equipment and technology to the U.S.S.R. in coming years will have a greater effect on the Soviet energy sector after 1985 than during the Eleventh FYP. This assumption is based on the length of time usually required

[28]Readers wishing to consult such formal models should see CIA, *SOVSIM*, op. cit.; and Daniel L. Bond and Herbert S. Levine, "The Soviet Economy to the Year 2000: An Overview," paper presented to the Airlie House Conference, Oct. 23-25, 1980.

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to consummate deals with Western firms, the lags generally encountered in utilizing Western technology and equipment, and the long lead times involved in most large energy projects. Even the West Siberian export pipeline project, discussed below and in chapter 12, is not scheduled to begin gas deliveries until the latter part of the decade. Thus, in the 1990 scenarios an attempt is made to address the question of the difference alternative "extreme" Western trade policies might have on Soviet economic growth, fuel balances, and East-West trade in the late 1980's and beyond. The extremes considered are "maximal" and "minimal" Western energy-related trade, technology, and credit assistance to the U.S.S.R. in the 1980's. It should be noted, however, that OTA does not assume that Western assistance to Soviet energy industries will have only a negligible effect before 1985. There is evidence, for example, that the U.S.S.R. is in part relying on imported pipe and possibly compressors to further expand its internal gas distribution system during the Eleventh FYP.

ALTERNATIVE SOVIET ECONOMIC GROWTH AND HARD CURRENCY TRADE SCENARIOS, 1981-85

OTA's "best" and "worst" case scenarios for the Soviet economy for the period 1980-85 are based on assumptions for Soviet economic growth, domestic energy supply and demand trends, and basic foreign trade conditions. The scenario "outcomes" are estimates of the Soviet net fuel balance after meeting domestic needs and commitments to other CMEA countries, as well as an implied maximum rate of growth for Soviet nonenergy imports from the non-CMEA region. It must be emphasized that most of the assumptions employed here are informed guesses and as such subject to question. The scenario outcomes can be visualized as order-of-magnitude indicators of the range of the plausible. But while each of the assumptions made is in itself plausible, it is far less likely that *all* these conditions would ever be *simultaneously* either "best" or "worst." Consequently, while these cases define a reasonable universe of possible developments, the most extreme outcomes are unlikely.

As noted above, the rate of Soviet economic growth both influences and is influenced by the size as well as the composition of the Soviet energy balance. All other things being equal, the greater the supply of domestic energy supply relative to domestic energy demand, the higher the expected rate of economic growth. At the same time, the more rapidly the economy is growing, the greater will be the growth in demand for energy.

This chapter assumes that the rate of growth of Soviet GNP is basically determined by the rates of growth of the fixed capital stock, the labor force, and combined factor productivity, respectively. But changing levels of domestic energy output have an indirect influence on Soviet economic growth. The growth rate in the capital stock is influenced by current investment decisions; the size of the labor force is affected by labor market policies; and productivity growth is influenced by both economic policy and "reforms" in the system. All of these policies are affected in turn by domestic energy conditions.

Plausible growth rates for the Eleventh FYP period seem to be bracketed by "low" and "high" annual averages of 1.6 and 3.2 percent respectively. The low rate suggests a perhaps politically unacceptable growth rate for per capita consumption, well below 1.0 percent per annum, but given that estimated GNP growth for the U.S.S.R. was only 0.8 percent in 1979 and 1.4 percent in 1980, the lower bound is clearly not impossible.

The methodology used in developing these "extreme" GNP growth rates is as follows:

1. The labor force is alternatively assumed to grow at 0.4 and 0.5 percent per annum. The higher rate assumes various policy measures designed to raise the

labor force participation rate above 88 percent.

2. The growth rate for the Soviet fixed capital stock is projected on the basis of published CIA estimates of fixed capital investment and the net fixed capital stock for individual years in the late 1970's; and Soviet figures for 1980 investment and planned investment in 1981 and for the Eleventh FYP as a whole.[29] By making reasonable assumptions about the distribution of this investment over the Eleventh FYP, it can be estimated that, if plans are met, the net fixed capital stock would increase about 5.4 percent annually.
3. Combined factor productivity is alternatively assumed to decline by 0.5 percent and to rise by 1.0 percent annually. While the former prospect would be very unwelcome, it is not out of the question. As indicated in table 53, combined factor productivity in the U.S.S.R. fell at an annual average rate of 0.7 percent between 1976 and 1980. The higher growth rate assumes that the various announced measures for raising productivity in the Eleventh FYP would be enormously successful. OTA makes the conventional assumptions of 0.66 and 0.34 for the imputed shares of national product accruing to labor and capital respectively.

The Eleventh FYP projects the rate of growth of "national income utilized" to decline by about one-fifth from the average rate for 1976-1980.[30] Applying this same proportionate decline to the rate shown in table 53 above for Soviet GNP growth for 1976-80, yields a rate of 2.2 percent per annum for 1981-85, which is close to the midpoint of the "plausible" range posited here.

For each of the GNP growth rates, an estimate is made of the net energy trade balance that would result from best-worst alternatives for domestic and foreign trade conditions with the non-CMEA world. The principal assumptions underlying both cases are listed in table 57. The worst case assumes an income elasticity of energy demand of unity (i. e., a l-percent increase in GNP leads to a l-percent rise in the demand for energy). This corresponds roughly to the relationship existing in the U.S.S.R. between 1965 and 1975. (For the Tenth FYP period this elasticity apparently significantly exceeded unity.) In the "best" case the energy demand elasticity is assumed to fall to 0.8. This would probably be considered highly optimistic by most experts, particularly in the near future. For example, some estimates assume that the Soviet energy elasticity will remain at about 1.00 for the next 20 years, or possibly fall to 0.9.[31]

The worst and best case assumptions for domestic output of oil, natural gas, coal, nuclear, and hydroelectric power are listed in table 57, and are based on the analyses in chapters 2 to 5 of this report. With the exceptions of gas and hydropower, these projections somewhat discount official Soviet plan targets. The worst case assumption for oil, 550 mmt, is the upper bound of the revised range estimated by the CIA.

Table 58 presents the estimated Soviet fuel balances, both aggregated and by major energy category, for 1980 and for each of the four 1985 scenarios (worst energy: high and low GNP growth; best energy: high and low GNP growth). Lacking sufficient information regarding fuel-specific conservation and interfuel substitution possibilities, OTA has refrained from disaggregating domestic consumption by energy source. In table 58, estimated domestic energy demand (calculated using the appropriate energy demand elasticities from table 57) is subtracted from the total available domestic energy supply, leaving an estimated *net* fuel export balance. To this is added an assumed level of Soviet 1985 energy imports from non-CMEA sources, leaving a gross fuel balance available for export outside CM EA. For sim-

[29] *Handbook of Economic Statistics*, ER 80-10452 (Washington, D.C.: CIA, October 1980); *Ekonomicheskaya gazeta*, No. 5 (1981).

[30] *Ekonomicheskaya gazeta*, No. 9, February 1981.

[31] See Campbell, op. cit., table 1.

Table 57.—Major Assumptions Underlying 1980-85 Scenarios

	Worst case	Best case
Income elasticity of energy demand	1.0	0.8
Petroleum output (mmt)	550	645
Natural gas output (bcm)	600	640
Coal output (mmt)	750	800
Nuclear power (bkwh)	170	227
Hydroelectric power (bkwh)	237	237
Average annual growth rates for real exports to non-CMEA area of (1979 share of total exports in brackets):		
Timber products (7,5%)	0%	*2 .5%*
Platinum group metals (2.1%)	2.2	*4,4*
Raw cotton (2.0%)	0	*2.5*
Chemicals (6.5%)	12,3	17.7
Automobiles (1.4%)	5.0	10.0
Diamonds (1.7%)	0	5.0
Other products (23.7%)	0	5.0
Maximum permissible normalized trade balance[a]	-0.50	-0.50
Average annual growth rates for Soviet foreign trade prices with non-CMEA area:		
Export prices	10.0%	*12.5%*
Import prices	10.0	*7.5*

[a]Merchandise trade balance divided by the value of exports, see P 270

SOURCE Off Ice of Technology Assessment

plicity OTA assumes that these imports remain at their estimated 1979 level (roughly 7 mmt of crude oil, and 2 billion cubic meters (bcm) of natural gas from Afghanistan.)[32] This is not a forecast (indeed, gas shipments from Iran may have only temporarily ceased) but an assumption made to facilitate the computations underlying the alternative scenarios.

The figures in table 58 raise some important issues. For example, the worst energy/low growth scenario (column 3) suggests a net fuel export balance of nearly 61 million tons of oil equivalent (mtoe) (1.22 mbd), with coal consumption declining from 1980 levels, and oil consumption virtually stagnating. Thus, unless significant substitution of gas for oil in domestic consumption occurred fairly quickly, most or all energy exports would have to be composed of natural gas shipments. An export level of 61 mtoe is imposing by 1979 or 1980 Soviet gas export standards, however. OTA has estimated that present pipeline capacity might support 27 to 29 mtoe of natural gas exports to Western Europe.[33] For the "best" case scenarios, which yield even larger net fuel balances but also larger implied natural gas deliveries, the possible pipeline capacity constraint could be even more serious.

Assessment of the foreign trade implications of these net fuel balances also involves assumptions regarding the possibilities for expanding Soviet nonenergy exports to non-CMEA countries and Soviet terms of trade with these nations. It is assumed here that all non-CMEA trade roughly reflects patterns of trade with the Soviet Union's hard crrency partners. Given the difficulty of separating hard currency from non-CMEA soft currency trade, and the very aggregative level of this analysis, it was not thought worthwhile to strive for a greater degree of accuracy. In any event, the focus here is on the net Soviet energy balance available for export to the non-CMEA region, and most of these exports are undoubtedly made for hard currency.

Western trade statistics show that Soviet energy exports accounted for an estimated 55.1 percent of the total value of Soviet exports to 17 "Industrialized West" (IW) countries in 1979. [34] Six nonenergy export product

[32]Campbell, op. cit.; and Jan Various, "Eastern European and Soviet Fuel Trade, 1970-1985, discussion paper No. 80- 10 (Vancouver: [department of Economics, University of Brit ish Columbia, April 1980).

[33] 1980 Soviet gas deli\'cries to Western Europe totaled roughly 23 bcm. The excess capacity of the Orenburg gas pipeline (i.e., after meeting annual commitments of 15.5 bcm to I'; astern Europe) available for export to Western Europe is about 1'2 to 13 bcm. Present pipeline capacity could, therefore, support possibly 23 + 13 = 36 bcm x 0.8 123 = 29 mtoe of nat ura 1 gas exports. See Campbell, op. cit.: and Goldman, op. cit.

[34]These estimates are based on adjustments to unpublished data made available by the Department of Commerce. According to *Vneshnyayatorgovlya SSSR, 1979*, energy accounted for 50 percent of total 1979 exports to nonsocialist countries. A study by Jan Various ("So\'iet and Eastern European Foreign Trade in the 1970's: AQuantitative Assessment, discussion paper No. 80-11 (Vancouver: Department of I-; conomics, University of British Columbia, April 1980) suggests that 1979 Soviet energy exports

Table 58.—Fuel Balances by Category, 1985 Scenarios and 1980 Base Year (millions tons of oil equivalent)

	1980 base year[a]	1985 (worst energy, high GNP growth)	1985 (worst energy, low GNP growth)	1985 (best energy, high GNP growth)	1985 (best energy, low GNP growth)
Hydro, Nuclear Power and "other"	1075	138	134	150	146
Coal	319.3	300	300	320	320
011 and products	3541	362	364	444	446
Natural gas	2496	368	370	396	399
Total	1,030.5[b]	1,168	1,168	1,310	1,311
Domestic and CMEA energy demand[c]		(1206)	(1 116)	(1169)	(1099)
Net fuel balance	83[d]	(38)	52	141	212
1979 energy Imports from non-CM EA	g[d]	9	9	9	9
Gross fuel balance (available for export to non-CMEA)	92	(29)	61	150	221

[a] From Campbell op cit table 2
[b] Net of all exports and Imports of energy
[c] The methodology for deriving the amount of energy available for domestic consumption and hard currency export relies heavily on Campbell OP cit and may be summarized as follows
[a] Assume a level of domestic energy output (011 gas coal hy dro and nuclear generated electricit y and other e g peat firewood shale 011) Output for the latter is assumed (per Campbell ito decl ine from about 5 percent of energy demand n 1980 10 3 percent in the year 2000 at a rate of O 5 percent every 5 years
[b] Subtract net losses and internal consumption and net intrasector outflow per Campbell
[c] Subtract assumed level of net ex ports to the CM EA F or simplicity it is assumed t hat a ll electricity ex ported to E astern E u rope w ill be generated by nuclear power (Ch 9 estimates 16 bkWh per year in 1981 85)Other estimates are coal (net of coal [reports from Poland) 8 mmt 011 80 mmt annually in 1981-85 to Eastern Europe and 11 mmt annual ly to non-European CMEA gas 30 bc m per year O TA ass umes that these are fixed commitments that the S oviets will honor regardless of their own internal energy situati On
[d] Mu ltiply the resu lt (C) by conversion factor to obtain amount av ailable for distrbuti On
[e] Subtract nonfuel uses for 011 and gas assuming the following per annum growth rates

GNP	Oil	Natural gas
32%	2 5%	4 0%
2 4	15	30
16	10	20

[d] Based on C I A Internationall Energy Statistical Review March 31 1981 Wharton Econometric Forecasting Associates Inc Centrally Planned Economics Project unpublis hed data

groups, listed in table 57 and together accounting for an additional 21.2 percent of Soviet exports to the IW in 1979, were analyzed and assigned individual best and worst case growth rates, in terms of real export growth. In each of these markets real export growth is determined by both supply and demand. Detailed analyses taking into account such conditions for each product group were beyond the scope of this study.

a mounted to about 61 percent of total Soviet nonarms ex - port s to non-CMEA countries. (iiven the rough equivalence o f a ll these proportions, it seemed reasonat)le to use the more detailed I W st a t istics as a basis for calculating the weights of energy a nd selected major n on energy exports in total Soviet nona rm s ex pOr t s for h ard currency.

Past real export and domestic output performance was investigated for some products, however, in an attempt to generate plausible worst and best case estimates for real export growth in the 1980's. Some of these considerations are briefly set forth in appendix A.

Attempting to estimate price developments for each of these product groups is an even more speculative exercise than making real export growth projections. This is equally true for the prices of Soviet imports from non-CMEA sources. Consequently, OTA has simply assumed a uniform rate of inflation for all exportable, and a uniform rate of

price increase for all importable. Indeed, assuming an unchanged relative price structure within each category of goods is more reasonable than attempting to estimate rates of inflation for separate product groups. By distinguishing clearly between exports and imports, one can still assume that Soviet terms of trade change.

Price indices developed on the basis of official Soviet trade statistics suggest that Soviet export and import prices in trade with non-Socialist countries increased at annual rates of 4.5 and 3.1 percent respectively between 1970 and 1978.[35] This implies an average annual improvement in terms of trade of about 1.3 percent. However, a possible upward bias in the export quantity index employed here may understate the rate of export price increase. It has been estimated, for instance, that between 1971 and 1977 Soviet export and import prices in "hard currency trade" (a subset of trade with nonsocialist countries) increased at average annual rates of 20, 21, and 12 percent respectively. This suggests an average annual terms-of-trade improvement of about 7 percent.[36]

As a "best" case, OTA assumes that Soviet export prices in trade with the non-CMEA area increase by 12.5 percent annually, whereas import prices rise by 7.5 percent. The implied annual terms-of-trade improvement is about 4.7 percent. For the worst case it is assumed that all foreign trade prices rise at 10 percent a year, leaving Soviet terms of trade with the non-CMEA region unchanged.

Soviet import capacity is not determined solely by the growth of Soviet real exports of energy and nonenergy products and the terms of trade. Revenues from gold sales, services, and military sales to various developing countries have often accounted for more than enough hard currency to offset hard currency merchandise trade deficits. Furthermore, the U.S.S.R. has financed much of its trade deficit in recent years with Western credits.

Data on gold sales and arms shipments are notoriously poor, and erratic movements in gold prices increase the difficulty of projecting hard currency revenues from this source. Moreover, any attempt to estimate Soviet credit drawdowns would be an extremely complicated and speculative undertaking. OTA has therefore assumed that, regardless of Western credit availability and supply-demand conditions on world gold and arms markets, Soviet policy makers would avoid allowing the hard currency merchandise trade deficit to exceed, at least for any extended period of time, some reasonably conservative proportion of current Soviet exports. This analysis therefore utilizes the concept of a "normalized" trade balance, which is the merchandise trade balance divided by the value of the exports.[37]

The U.S.S.R. normalized balance varied between – 0.11 and – 0.82 in the 1970's. It reached its most negative value in 1975, due to a rapid increase in Soviet imports and a weakening of Soviet exports to the West because of recession. The U.S.S.R. was able to bring the normalized deficit to below – 0.30 by 1977. Changes in the value of the normalized deficit have also typically (though not inevitably) been associated with more gradual changes in the Soviet debt service ratio, because varying degrees of the merchandise trade deficit can be financed by gold and arms sales.

For both the "worst" and "best" cases OTA has assumed that maximum permissible normalized trade deficit for 1985 is – 0.5.

[35] Hewett, "The Foreign Sector," op. cit.

[36] Paul Ericson and Ronald S. Miller, "Soviet Foreign Economic Behavior: A Balance of Payments Perspective, in Joint Economic Committee, U.S. Congress, *Soviet Economy in a Time of Change*, vol. 2 (Washington, D.C.: U.S. Government Printing office, 1979), pp. 208-243.

[37] This concept was first used by Edward A. Hewett in, "Soviet Primary Product Exports to CMEA and the West," paper presented to the Association of American Geographers Project on National Resources in the World Economy, May 1979; and has also been used by Thomas A. Wolf, "Alternative Soviet Hard Currency Scenarios: A Back of the Envelope Analysis," app. III in Phillip D. Stewart, *Soviet Energy Options and United States Interests* (Columbus, Ohio: Mershon Center, April 1980), pp. 37-56.

In other words, the hard currency deficit is allowed to equal one-half the value of Soviet exports (or imports could be 1.5 times as great as exports). The exact manner in which this deficit is financed remains unspecified. Possibly under the "best'" conditions more Western credit would be available, and the U.S.S.R. would be more willing to take on debt obligations, whereas in the "worst case" scenario credit sources might dry up and the U.S.S.R. would have to more rapidly increase gold and arms sales.

Table 59 presents the different hard currency trade outcomes implied by alternative assumptions regarding: 1) GNP growth, 2) domestic energy supply and demand conditions, and 3) foreign trade conditions. Soviet hard currency import capacity has been singled out for the following reasons: 1) The Soviets view hard currency imports–whether grain, machinery and equipment, or technology-as an important stimulus to domestic productivity growth and to general economic development. 2) The U.S.S.R. cannot afford to run indefinitely a hard currency deficit above some "prudent" level, a fact which will constrain Soviet ability to import both fuels and nonenergy items, and under certain circumstances, may seriously constrain Soviet economic growth. 3) The degree to which the U.S.S.R. can increase its *real* hard currency imports will have a bearing on its foreign economic and political policies.

Most observers of the Soviet energy situation now dismiss—if indeed they ever entertained–the possibility that the U.S.S.R. itself might become a net importer of energy by 1985. This judgment is easily supported by the outcome in table 59 for the high GNP growth/worst case scenario in which the U.S.S.R. would have to import 38 mtoe (763,000 barrels per day) of energy in order to meet domestic demands *and fixed commitments to other CMEA countries.* Even if the normalized trade deficit quintuples to – 0.5 by 1985, Soviet *real* imports of nonenergy products from the non-CMEA region would in this case still have to *decline* by an average of 9.2 percent a year. By 1985 real nonenergy imports would be only 56 percent as great as they were in 1979. While such a circumstance is not impossible, it would send East-West trade into sharp decline and could put enormous pressure on the Soviet Union to solve its energy problems in other ways.

Table 59.—Alternative Scenarios for 1980-85[a]

GNP growth	Worst case		Midrange[b]	Best case	
(Average annual rate)	Net fuel balance (MTOE)	Maximum growth of non energy imports from non-CMEA (average annual rate)	Net fuel balance (MTOE)	Net fuel balance (MTOE)	Maximum growth of nonenergy imports from non-CMEA (average annual rate)
3.2%	(38)	-9.2%		141	1 9.3%
		12.7%	92		15.2%
1,6%	52	3,3%		212	24.2%

[a] Al l growth rates are actually calculated for the period 1979-85, because base year value and export weight figures are includedin the appendix expressions and 1979 is the most recent year for which disaggregated value data on Sovietforeign trade is presently available The actual value for the normalized trade deficitin 1979 was -O t 1 The Soviet net fuel balance (as defined in table 58) for 1979 was estimated as 83 mtoe(60 8 mmt of petroleum and petroleum products, 207 bcm of natural gas, and roughly 102 mmt of coal exported to non-CMEA destinations) Adding to this estimated Soviet energy Imports from non -CMEA sources of 9 mtoe gives a *gross* fuel balance (i e available for export) in 1979 of 92 mtoe The total percentage growth of energy exports between 1979 and 1985 is then calculated by relating the estimated gross fuel balan ce for 1985 (e g 61 mtoe for the worst case/low growth scenario) to the base year balance for 92 m toe

[b] In this Scenario, middle range values for GNP growth and domestic energy supply and demand conditions are assumed for *both* cases Worst and best cases here therefore refer only to rates of real nonenergy export growth The terms of trade are assumed to Increase by the same amount in both cases

SOURCE Off Ice of Technology Assessment

While military and political solutions to the "worst case" energy situation are possible, a less drastic and perhaps more likely response would be to permit the energy constraint to slow the rate of economic growth. Maintaining some level of hard currency energy exports would lead to growing domestic energy shortages. These shortages could stimulate redoubled conservation and substitution efforts, but the near-term impact might largely be in terms of reduced economic growth. As growth slowed, energy demand would fall, and the U.S.S.R. would move toward the low growth-worst case outcome in the lower left corner of table 58.

When GNP growth slows to 1.6 percent, the ability of the U.S.S.R. to expand its real nonenergy imports from the non-CMEA region is respectable, albeit limited. A yearly 3.3-percent growth of real imports would mean a dramatic slowdown in the enormous growth of the past two decades, financed in the second half of the 1970's by windfall gains caused by exploding energy prices. (Soviet real imports from nonsocialist countries grew at annual rates of 9.3 percent in the 1960's and 12.7 percent between 1970 and 1978.[38]) Such a low GNP growth rate might be politically intolerable. Even with investment growing at only 2.5 percent a year, and with a slowdown in the growth of defense spending, annual GNP growth of 1.6 percent could easily reduce annual per capita consumption growth below 0.5 percent. This compares with an annual average growth rate of 2.5 percent in the period 1971-79.[39]

If the low extreme of the new CIA oil output estimate for 1985 (500 mmt) were used for the "worst case" analysis, the outlook for Soviet hard currency trade and economic growth would worsen. Specifically, the maximum growth rate for Soviet nonenergy hard currency imports would fall to minus 16 percent and minus 3.1 percent for the high and low growth scenarios respectively. The corresponding net fuel balances would be (83) and 16 mtoe (1.67 million and 321,000 barrels per day respectively).

The "best case" scenarios yield much higher net fuel balances and permit annual growth of real nonenergy imports from the non-CMEA region of between 19.3 and 24.2 percent. Even in the event of rapid GNP growth, the U.S.S.R. would emerge with a net fuel balance larger than it has today. Both these instances, however, raise the question of how this much energy would be physically exported, particularly if considerable substitution of gas for oil in domestic uses were not achieved. Energy exports to Eastern Europe could be raised above planned levels, but again, if most of the increase were to be in the form of natural gas, the logistical feasibility of transporting the gas is uncertain.

It is highly unlikely that the U.S.S.R. will be faced with either the worst or best cases. Assuming that the most probable outcome falls between, OTA has also calculated the implied maximum growth of nonenergy imports from the non-CMEA region under mid-range economic growth and domestic energy conditions that yield a net fuel balance of 92 mtoe (1.85 mbd). Depending on the rate of growth of nonenergy exports to the non-CMEA area, real non-energy import capacity would grow in this case by 12.7 to 15.2 percent annually, consistent with Soviet performance in the 1970's. This result is essentially due to the assumed improvement of roughly 5-percent- per-annum in Soviet terms of trade under conditions of net energy exports. Indeed, this analysis shows the very important role that the terms of trade play in determining the growth of Soviet real import capacity. For the best case scenarios, for example, a l-percent-per-annum improvement in the terms of trade has the same impact on Soviet import capacity as an increase of 17.8 mtoe (357,000 bpd) in the Soviet net fuel balance.

[38] Hewett, "The Foreign Sector," op. cit.
[39] Schroeder-Greenslade, op. cit.

ALTERNATIVE SOVIET HARD CURRENCY TRADE SCENARIOS, 1990

The effects of different levels of Western assistance will be reflected much more strongly in Soviet energy output by 1990 than will be the case by 1985. An interesting issue here is the difference Western assistance might make in the Soviet Union's capacity in 1990 to import nonenergy products (grain, machinery and equipment, technology, consumer goods, intermediate industrial products) from outside the CM EA.

OTA has considered two cases: maximal Western trade, technology, and credit availability for Soviet energy projects; and minimal Western energy assistance. The former case assumes development and completion of the West Siberian gas export pipeline (see ch. 12) by 1985 or 1986, as well as other large-scale projects possibly directly involving the United States and Japan. The minimalist case assumes a virtual embargo or at best a very low level of Western energy-related technology transfer, pipe deliveries and energy credits to the Soviet Union. No attempt is made in this analysis to examine the feasibility of the maximalist case on the supply side.[40]

Rather than deal with a number of combinations of Western trade policy, Soviet energy conditions and economic growth rates, a single plausible Soviet energy situation is assumed, and a single constant rate of Soviet economic growth for the entire period is posited. The growth of nonenergy exports, the terms of trade and the maximum allowable "normalized' trade deficit are also assumed to be the same regardless of the state of Western trade policy.[41] Specifically, OTA assumes that the Soviet economy grows at an average annual rate of 2.4 percent, which is the midpoint of the extreme growth rates considered for 1980-85. An income elasticity of energy demand of 0.9 is assumed, again half way between the high and low elasticities considered for the earlier period. Nonenergy exports are assumed to increase at rates that are for the most part intermediate between the 1985 worst and best case assumptions. Soviet terms of trade are assumed to increase at 2.3 percent annually, and the normalized deficit is permitted to rise to – 0.5. Planned levels of Soviet energy exports to CMEA are retained at 1985 levels. Again, worst and best cases for energy production are based on chapters 2 to 5 in this study. These assumptions are summarized in table 60.

The discussion in the foregoing chapters leads to the conclusion that Western energy technology and equipment would have a relatively greater quantitative impact on the Soviet gas industry than on the oil industry. Translating such a judgment into numerical production levels is a highly speculative exercise. The figures in table 60 should, therefore, be seen as merely illustrative of the possible impact of Western assistance on these industries.

For oil, OTA assumes that Western assistance would make no more than a 10 percent difference in output levels. Given a policy of maximal assistance, OTA estimates that Soviet natural gas production in 1990 could be 100 bcm (or 15 percent) higher than otherwise. This assumes that the new export pipeline to Western Europe would lead to an an-

[40]Because of the dearth of hard data and because the focus here is on the Soviet side of the East-West relationship, the analysis proceeds not from estimates of the scale of Western exports and credit availability, but rather from aggregative but plausible assumptions regarding the impact of such assistance on 1990 Soviet output levels for different energy sources. Such issues as whether or at what terms sufficient Western financing for such ventures could be arranged are not considered.

[41]For simplicity, the normalized trade deficit is assumed not to apply to credits related to new energy projects. As contemplated, those projects would involve a very rapid buildup in credits to about 1985-86 and then equally fast repayment by about 1990.

Table 60.—Major Assumptions Underlying 1990 Scenarios

	Worst case (minimal Western energy assistance)	Common to both cases	Best case (maximal Western energy assistance)
Income elasticity of energy demand. . . .		0.9	
Petroleum output (mmt)	500		550
Natural gas output (bcm)	665		765
Coal output (mmt) . . .	850		875
Nuclear power (bkwh)	411		470
Hydroelectric power (bkwh)[a]	271		271
Average annual growth rates for real exports to non-CMEA area:			
Timber products. . .		1.0%	
Platinum group Metals		3.0	
Raw cotton		1.0	
Chemicals.		10.0	
Automobiles.		5 0	
Diamonds		2.0	
Other products		2.0	
Maximum permissible normalized trade balance.		-0.50	
Average annual growth rates for Soviet foreign trade prices with non-CMEA area:			
Export prices		**10.0%**	
Import prices		*7.5%*	

[a] Based on Campbell OP cit.

SOURCE Off Ice of Technology Assessment

nual output increase of from 40 to 70 bcm, that joint U.S.-Japanese-aided projects could yield an additional 20 bcm, and other smaller scale efforts could augment Soviet gas output (but not necessarily Soviet exports) by 10 to 40 bcm.

The assumed production levels are, of course, key to the quantitative outcomes of each scenario. For oil in particular, the range of existing 1990 production estimates is tremendous. These are from 350 to 450 mmt (CIA) to 750 mmt (The Economist Intelligence Unit). (see ch. 2). The assumed range of 500 to 550 mmt in table 60 falls roughly halfway between these two extremes.

The outcomes for the worst-best case scenarios are reported in table 61. Without Western assistance, the Soviet net fuel balance (i.e., net fuel available for export to the non-CMEA region) declines from 83 mtoe (1.67 mbd) in 1979 to a deficit of 12 mtoe by 1990. With maximal Western help, on the other hand, the net fuel balance increases by over one-third to 126 mtoe (2.53 mbd) in 1990. As with the scenarios for 1985, however, one would want to examine in some detail the technical capacity of the Soviets actually to export such large volumes of fuels, particularly natural gas.[42]

[42] For the best case scenario, 1990 Soviet energy demand is estimated as 1,276 mtoe. 1990 estimated Soviet "available energy" (i.e., after assumed exports to CMEA), balances for each fuel category (Campbell, op. cit., estimates of 1980 domestic energy consumption by category are in parentheses) are: hydro, nuclear, and "other"= 209 mtoe (108); coal= 350 mtoe (319); oil= 404 mtoe (354); and gas= 480 mtoe (250).

Table 61 .—Alternative Scenarios for 1990 (percent)

	Worst case (minimal Western energy assistance)	Best case (maximal Western energy assistance)
1990 net fuel balance	(12) mtoe	126 mtoe
Percentage change in net fuel balance (1979-90) . . .	-100%	51%
Percentage change in capacity to import non-energy products from non-CMEA area (1979-90)	14%	163%
Implied average annual growth rate for real import capacity.	1.2%	10.2%

[a] This would be the average annual rate of growth of nonenergy Imports from the non-C MEA region Implied by the level of real nonenergy related Imports that the U S S R could purchase in 1990 after repayment of energy project-related debt The actual average annual rate of growth of such Imports prior to debt repayment would be considerably smaller

SOURCE Off Ice of Technology Assessment

Given the foreign trade conditions posited above, the Soviet Union's capacity to import nonenergy products from the West grows in *real* terms between 1979 and 1990 by 14 percent in the worst case and by 163 percent in the best case. These changes translate into per annum growth rates of 1.2 and 10.2 percent respectively. The latter figure, however, must be interpreted with great care. The significant increase in energy exports implied in the best case outcome would only occur in the second half of the decade, after completion of the massive natural gas pipeline projects and after technology transfer in the coal, nuclear, and oil sectors had had an appreciable effect. Furthermore, a good portion of these incremental energy exports would have to be used to pay off project-related debts in the 1986-90 period. Consequently, under the assumed conditions Soviet real imports of nonenergy and nonenergy-project products would actually grow at a rate somewhere between 1.2 and 10.2 percent. Nevertheless, assuming that the bulk of these large Western credits had been retired by 1990, Soviet real import *capacity* at that time would have increased by 163 percent, having grown at an average annual rate of 10.2 percent since 1979. In the worst case scenario Soviet real import capacity increases at a negligible rate. In the best case, the growth in import capacity almost matches the growth rate of the 1960's.

SUMMARY AND CONCLUSIONS

Soviet economic growth has gradually slowed in recent years, and even without an energy "problem, it is likely that growth would continue to decelerate in the 1980's. The basic causes of this slowdown are falling rates of growth of the Soviet capital stock and labor force. Recently their impact has been reinforced by stagnating or declining productivity, only in part the result of adverse weather conditions. Even in the absence of a serious decline in Soviet oil output, the Soviet economy in this decade will probably not be able to attain the growth rates of the 1970 unless significant gains in productivity can be achieved.

It is generally agreed in the West that significant productivity increases are unlikely to occur in the absence of more profound changes in the Soviet planning and management systems than are presently contemplated. Superimposed on these fundamental trends and challenges to the Soviet planners is now the possibility of a plateauing or even decline in oil output. A decline would certainly cause Soviet growth to slow even more, although the magnitude of such a slowdown is not at all obvious. The impact of falling domestic energy supplies will depend on a system of complex relationships in the economy, and on Soviet priorities and actual policies regarding the composition of the future energy balance and foreign trade patterns. The formulation of Soviet energy policy takes place in a political context and involves a number of different interests and actors. It now appears that this policy broadly favors gas and nuclear development, partly at the expense of the oil and coal sectors.

The foregoing discussion has attempted to suggest the major direct and indirect economic ramifications of basic Soviet economic policy options. There is nothing to keep Soviet planners from pursuing some or all of these policies simultaneously. They probably will pursue most of them in some measure. But every policy carries with it costs and benefits to the Soviet economy. In an effort to give some rough order-of-magnitude sense of how the Soviet economy might be affected by the energy situation, OTA has developed several alternative scenarios for Soviet energy and aggregate economic conditions in the 1980's. The "worst" and "best" case scenarios are meant to bracket plausible outcomes for Soviet eco-

nomic growth, energy balances, and growth in hard currency import capacity. These scenarios should not be viewed as predictions. They are simply attempts to set forth plausible ranges for the parameters under which Soviet economic policy makers will have to operate over the next decade. Each scenario is based on a long list of simplifying assumptions.

The scenario outcomes for the period 1981-85 suggest that if most or all of the ''worst case assumptions materialize, Soviet economic growth could slow considerably during the Eleventh FYP. Annual rates of GNP growth would probably be much lower than the 2.8-percent-per-annum average recorded for 1976-80, and could result in small and perhaps politically unacceptable increases in real per capita consumption for the Soviet population. Under such conditions the ability of the U.S.S.R. to increase its real nonenergy imports from the West would also be seriously impaired. This would negatively affect the overall growth prospects for East-West trade and would in turn place further strains on the Soviet economy.

Under a series of "best" case conditions, the Soviet Union would be able to continue to grow at a rate approximating overall Soviet performance for the Tenth FYP. At the same time, its net fuel balance available for export to the West would increase over 1979-80 levels. This, combined with continued improvements in Soviet terms of trade under "best" conditions, would permit the U.S.S.R. to expand real hard currency imports at historic rates and possibly to divert more energy than presently contemplated to Eastern Europe.

Actual conditions will likely fall somewhere between these extremes. If the U.S.S.R. encountered economic growth, energy, and foreign trade conditions midrange between those assumed for the worst and best cases, the Soviet Union might be able to maintain energy exports to the West at about 1979-80 levels and continue to increase its real hard currency imports at rates established over the past 15 to 20 years. This would make possible annual per capita consumption growth well above 1 percent.

OTA assumed that Western assistance in the development of Soviet energy resources would have its greatest quantitative impact after 1985. The 1990 scenarios therefore consider the possibility of minimal Western energy assistance (the "worst" case) and maximal Western cooperation (the "best" case). Such help, in the form of exports of energy-related equipment, materials and technology, and extensive export credits, would be forthcoming principally in the 1981-85 period. The credits are assumed to be more or less fully repaid by 1990. Most of the assumptions regarding energy and foreign trade conditions are essentially "midrange' estimates.

In the worst case scenario, Soviet fuel exports would disappear by 1990. Soviet capacity for hard currency imports (in real terms) would grow at a little more than 1 percent per annum in the 1980's, contrasted to annual growth of over 12 percent in the 1970's. With massive Western assistance in energy development, on the other hand, once these project debts were repaid, Soviet import capacity would more than double. This would mean that the Soviet *capacity* to purchase real imports from the non-CMEA area would have increased at an effective annual rate of over 10 percent a year. Real nonenergy-related imports in the interim would not have grown so rapidly because most of the increase in the net fuel balance would occur only after 1985, and debt repayment would eat into energy export revenues up to 1990. In both cases, real GNP was assumed to grow at a ''midrange" value of 2.4 percent, a rate that would be compatible with real per capita consumption growth in excess of 1 percent a year.

Sizable increases in the Soviet fuel balance available for export to the West raise the question of whether all of the implied balance could really be exported. The issue arises because the big gains in domestic energy production are likely to come in natural gas. In most cases sizable oil exports

could only be maintained if very significant substitution of gas (not coal) for oil were possible. If gas is to replace rather than augment oil exports, a much-expanded natural gas pipeline network, perhaps even beyond the scale of ongoing and contemplated projects, is needed. More precise judgments about these constraints, however, would only be possible after examining much more closely the degree to and rate at which gas can really be substituted for oil in domestic consumption.

Assuming that the worst-best case scenarios for 1990 are at all close to the range of plausible outcomes, they suggest that the simultaneous maintenance of a politically feasible rate of economic growth in the U. S. S. R., the further expansion of real energy exports to Eastern Europe after 1985, and a reasonably high rate of growth of East-West trade (in real terms), will hinge importantly on whether or not the West plays a significant part in developing Soviet energy sources, and particularly gas, in the 1980's.

Appendix A. – Export and Domestic Output Performance for Selected Nonenergy Products

TIMBER

Although subject to considerable cyclical fluctuations, Soviet real exports to the West of timber products (mainly sawn lumber to Western Europe, sawlogs to Japan, and pulpwood) tended to stagnate in the 1970's. Real exports of sawlogs increased only about 4 percent in the course of the 1970's and declined between 1975 and 1979. Lumber exports declined by 20 percent between 1970 and 1975 and then increased to slightly more than their 1970 levels by the end of the decade. Timber export prices tended to grow at 10 to 12 percent per annum in the first half of the decade and at about 10 percent annually after 1975. According to Soviet statistics the volume of timber-cutting in the U.S.S.R. actually declined between 1975 and 1979.[1] The Eleventh Five-Year Plan (FYP), however, calls for a 17- to 19-percent increase in output in the wood products sector over the next 5 years.[2] On the basis of this information, OTA assumed a plausible range of zero to 2.5 percent annual growth in Soviet real timber product exports to the non-Council for Mutual Economic Assistance (CMEA) region. The upper limit is based on an optimistic Western assessment of Soviet timber production by 1990.[3]

PLATINUM

Soviet platinum group exports, primarily directed to Japan, West Germany, and the United States, have fluctuated considerably over the past decade, presumably because of rapidly changing demand conditions and the possible tendency to utilize platinum exports as a residual financing mechanism, much the way gold appears to be used.[4] Estimated Soviet production of these metals increased at an average annual rate of 4.1 percent between 1970 and 1979, although growth slowed to 2.2 percent per annum after 1975.[5] OTA has taken this latter rate as a basis for the lower bound of real export growth up to 1985, with the upper bound assumed to be twice this rate (4.4 percent).

COTTON

Soviet production of cotton grew considerably in the 1970's, with output rising at an average 2.7 percent annually from 1970 to 1975 and 3.8 percent between 1975 and 1979.[6] From a fairly low base, Soviet exports of raw cotton to the West (principally Western Europe and Japan) rose by an average 30 percent a year in the first half of the decade, slowing to about 2.5 percent per annum after 1975.[7] In his 26th Party Congress speech, Soviet Prime Minister Tikhonov indicated a goal of 9.2 million to 9.3 million tons average annual cotton production between 1981 and 1985, which suggests essentially no growth over 1979 output.[8] OTA's range for export growth was therefore set at an annual rate of zero to 2.5 percent, the worst case figure assuming a constant ratio of hard currency exports to output, the latter assuming that the export growth rate of the late 1970's could be maintained.

CHEMICALS

About three-quarters of Soviet chemical exports to the West in 1979 were accounted for by "radioactive chemical elements' shipped primarily to France and West Germany. No data are available on these exports in real terms, but real growth has obviously been dramatic, as the total value of shipments to the IW rose from only $60 million in 1975 to $922 million in 1979.[9] OTA has fairly arbitrarily assumed that these exports would increase by another $250 million to $500 million by 1985, in 1979 prices.

The Organization for Economic Cooperation and Development (OECD) has estimated that annual CMEA deliveries to the West of chemicals on the basis of recent compensation agreements will total some $1.0 billion to $1.5 billion in the

[1] *Narodnoye khozyaystvo SSSR, 1979.*

[2] *Ekonomicheskaya gazeta,* No. 49, December 1980.

[3] Brenton M. Barr, "Domestic and International Implications of Regional Change in the Soviet Timber and Wood· Processing Industries, Association of American Geographers Project on Soviet Natural Resources in the World Economy, June 1978, manuscript.

[4] See Ronald G Oechsler and Hedija H Kravalis, "Complementarity in US. I report Needs and Soviet Export Capabilities: Platinum," unpublished study, Feb. 15, 1979; and Thomas A. W'elf, "Soviet Primary Product Exports to the West: An Empirical Analysis of Market Power and Price Sensitivity," study prepared for- the ( )ffice of External Research, U S Department of State, September 1980

[5] ('al lculated from ('1A, *Handbook of Economic Statistics,* op. cit.

[6] *,I"(Iro(ino}{" khozyaystvo SSSR, 1979*

Vneshnyaya torgovlya SSSR, various issues.

[7] *Ekonomicheskaya gazeta,* No. 10, March 1981.

[8] Hedija f Kravalis, et al., "Soviet Exports to the I ndustrialized West: Performance and l'respects," in U S. Congress Joint Economic Committee, *Soviet Economy in a Time of Change,* vol 2 (Washington, D.C : U S (Government Printing office, 1979), pp. -t 1 4-46 1; and U.S. Depart ment of Commerce data

early mid-1980's, presumably in constant (i.e., 1979 or 1980) prices. Roughly 90 percent of these deliveries are to come from the Soviet Union. OTA has, therefore, taken $1.0 billion to $1.5 billion as a plausible range for the increase by 1985 in Soviet chemical exports to the West in 1979 prices. (As OECD points out, however, whether *all* of these compensation deliveries will augment rather than replace current deliveries is not known.) Combining the very rough estimates for enriched uranium and compensation deliveries yields a range for average annual growth of real Soviet chemical exports to 1985 of 12.3 and 17.7 percent.

AUTOMOBILES

Soviet exports of automobiles to the IW countries increased from 8,000 units in 1970 to 60,000 in 1975 and 110,000 by 1979.[10] The average annual growth rate for 1975-79 was about 16 percent. Assuming a continued strong Soviet push in this area, OTA set a 5- to 10-percent-per-annum plausible growth rate range for automobile exports in the 1980-85 period.

DIAMONDS

Soviet diamond exports are in many respects more of a mystery than platinum group metals. It has been estimated, however, that real diamond exports fluctuated relatively little and without trend between 1971 and 1977.[11] Rather arbitrarily, real diamond exports are estimated to increase at an average annual rate of zero to 5 percent to 1985.

All other Soviet exports to the West, (no one of which, at the SITC 4- to 5-digit level of aggregation, exceeded more than one percent of Soviet exports to the IW in 1979), are also arbitrarily assumed to grow within the range of O to 5 percent to 1985.

[10] *Vneshnyaya torgovlya SSSR*, various issues.

[11] Ericson and Miller, op. cit.