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## **The Overambitious First Soviet Five-Year Plan**

Soviet economic growth since 1928, under nine five-year plans, attests to the power of Soviet economic planning. Yet the first plan, far from marking out the road then taken by the economy, proves on *ex post* analysis to have been unachievable. This essay describes a test of the plan's feasibility and sketches a few alternative feasible growth paths. Its analytic base rests on plan-testing methods that have developed out of work on problems that were initially confronted in the USSR almost half a century ago. It seems fitting, therefore, to apply these methods retroactively, forty-five years after the fact, to the First Soviet Five-Year Plan, formulated in the late 1920s to cover the period 1929–33. Though the testing methods are somewhat technical, their power deserves appreciation and evaluation by scholars in many disciplines. I am grateful for the opportunity to expose this approach to the critical scrutiny of informed students of Soviet history.

In thus using new tools to reopen some of the growth issues that were faced in the late 1920s, we are able to make quantitative comparisons between intentions and various hypothetical alternatives, and relate both to actual developments. This in turn provides a new basis for evaluating the factors that led to the plan's overambitiousness. But while an economist can offer evidence that the targets were too ambitious, he cannot answer the question, "Why were overambitious targets pressed for and accepted?" Political scientists and historians are needed to add breadth and depth to a narrow economic analysis. Ambitious targets, up to a point at least, may serve a useful function in galvanizing a dramatic campaign for rapid expansion of output. But up to what point? Statistical possibilities require evaluation in a setting that takes account of the political cross-currents of the time, the fears and tensions that shaped national policy. These issues of degree and extent require qualitative as well as quantitative judgment.

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Table 1. *First Soviet Five-Year Plan, Base-Period Flow Table, 1927/28* (in millions of rubles at 1926/27 prices)

Inputs from:	Output to:							Total inter-industry	Consumption	Government	Inventories	Fixed capital	Exports	Total final demand	Total domestic output
	Agriculture	Industry	Transport	Construction	Housing	Other sectors									
Agriculture	1,818	1,382					3,200	10,024	134	50			199	10,407	13,607
Industry	528	5,685	750	711	110	217	8,001	3,794	981	344			303	5,422	13,423
Transport and communications	47	714	184	64	11	19	1,039	824	178	32			33	1,067	2,106
Construction											3,888			3,888	3,888
Housing								1,694						1,694	1,694
Other sectors	431	937	148	140		43	1,699	4,882	297	107			213	5,499	7,198
Total intermediate	2,824	8,718	1,082	915	121	279	13,939								
Value added	10,783	4,705	1,024	2,973	1,573	6,919	27,977	21,218	1,590	533	3,888	748	27,977		
Total inputs	13,607	13,423	2,106	3,888	1,694	7,198									41,916

Source: Derived by the author from Gosplan SSSR, *Piatiletanii plan narodno-khoziaistvennogo stroitel'stva SSSR*, 3rd ed., 3 vols. in 4 (Moscow, 1930).

Examination of alternatives tempts one to reflect on the consequences for the USSR of imposing overambitious targets on a strained economy. Brief observations in this vein, while necessarily tentative, are cautiously offered at the end of the essay. Economists and others engaged in formulating national plans today may find this review of early Soviet experience instructive. It may also be generally useful to be reminded of the consequences of overambitiousness and related contributions of Stalinism to Soviet experience.

This analysis is focused on the First Five-Year Plan as approved (in its "optimal version") in May 1929. We find that its targets, taken together, simply could not be achieved, nor were they all achieved during the five years after 1928. But the actual shortfalls were due in part to serious economic difficulties not foreseen when the plan was formulated. The test reported on below does not examine the plan's feasibility under the unanticipated blows in agriculture and foreign trade that shook the Soviet economy in the early 1930s. Rather, it confines itself to the question whether the targets for 1933 could have been achieved under the optimistic parameters embodied in the plan. It is also confined to the official targets ratified in the spring of 1929, ignoring the wild target increases issued in 1930 and 1931. We place ourselves at the beginning of 1929 and search for the upper limits of the achievable.

### *The Main Features of the Plan in an Input-Output Framework*

Tables 1 and 2 summarize the 1928 preplan situation of the Soviet economy and the dimensions that were to be achieved by 1933. In these flow tables, the rows show the amounts of domestic production that six major sectors of the economy actually delivered to major users of their output in 1928 and were expected to deliver in 1933.<sup>1</sup> The receiving sectors are in part the same producing sectors and in part the major users of final output: households, government, inventories, fixed capital, and exports. A number serves twice in this compact format. A sector's column shows the source of its inputs, and a sector's row shows the destination of its output. Hence the name, input-output table. The columns on the left of the double line show the composition of each sector's input requirements, and the columns on the right show the internal composition of each category of final demand. It will be seen that the 1933 numbers are much larger than the 1928 numbers. The extent of intended growth differs widely, however, from one cell to another, as is brought out in table 3.

The two panels of table 3 show the plan's intentions with respect to the growth of each sector's total output, and also with respect to the growth of each category of final demand. All outputs were to grow, but one is tempted to para-

1. For a lucid introduction to input-output analysis see Hollis B. Chenery and Paul G. Clark, *Interindustry Economics* (New York, 1959).

Table 2. *First Soviet Five-Year Plan, Terminal-Year Flow Table, 1932/33, "Optimal" Targets*  
(in millions of rubles at 1926/27 prices)

Inputs from:								Output to:						
	Agri- cul- ture	Indus- try	Trans- port	Con- struc- tion	Hous- ing	Other sec- tors	Total inter- in- dustry	Con- sump- tion	Gov- ern- ment	In- ven- to- ries	Fixed capi- tal	Ex- ports	Total final demand	Total do- mestic output
Agriculture	2,487	2,914					5,401	14,033	777	777		727	16,314	21,715
Industry	1,484	18,815	1,810	5,245	166	365	27,885	6,111	1,925	1,451		888	10,375	38,260
Transport and communications	137	1,248	388	480	17	34	2,304	1,263	329	154		101	1,847	4,151
Construction											13,726		13,726	13,726
Housing								2,561					2,561	2,561
Other sectors	916	1,368	300	863		60	3,507	6,282	603	524		413	7,822	11,329
Total inter- mediate	5,024	24,345	2,498	6,588	183	459	39,097							
Value added	16,691	13,915	1,653	7,138	2,378	10,870	52,645	30,250	3,634	2,906	13,726	2,129	52,645	
Total inputs	21,715	38,260	4,151	13,726	2,561	11,329								91,742

Source: Derived by the author from Gosplan SSSR, *Piatiletanii plan* (see table 1).

phrase the pigs' slogan on equality in Orwell's *Animal Farm*: "All outputs will grow, but some will grow much more than others." The industry and construction sectors were to be expanded far more rapidly than the agriculture and housing sectors. The plan called for *disproportional* growth in sectoral outputs. Subsequent five-year plans have continued this stress on disproportional growth, though the usual Soviet phrase is "planned proportional growth." The first panel of table 3 also displays markedly disproportional growth in the various categories of delivery to final demand. Household consumption was slated to rise by 43 percent, comparing 1933 to 1928, but the rise in deliveries to fixed capital formation was to be 3.5-fold, and other deliveries to nonconsumption were expected to be three times as large in 1933 as they were in 1928.

The foundation for this output growth was to be primarily a very rapid expansion in the economy's stocks of fixed capital, along with an increase in the size of the labor force, especially outside of agriculture. Table 4 shows 1928 base-period data for the amount of fixed capital in each sector, together with the plan's 1933 terminal year targets for the stocks that each sector would have after all the investment carried out during the plan period. Again one sees sharply disproportional growth, with marked stress on industry and construction. Their capital stocks were to rise 2.4 and 3.5 times, while housing capital was slated to rise by 19 percent and agricultural capital by 29 percent.

In 1928 the value of Soviet urban and rural housing accounted for 36 percent of all Soviet fixed capital. The capital stock in agriculture, including

Table 3. *Principal Dimensions of the First Soviet Five-Year Plan, "Optimal Variant"*

	1927/28 (million rubles)	1932/33 (million rubles)	Abso- lute incre- ment	1932/33 as per- cent- age of 1927/28	1927/28 percent share	1932/33 percent share
<i>Annual Deliveries to Final Demand</i>						
Consumption	21,218	30,250	9,032	143	76	57
Government	1,590	3,634	2,044	229	6	7
Inventories	533	2,906	2,373	545	2	6
Fixed capital	3,888	13,726	9,838	353	14	26
Exports	748	2,129	1,381	285	2	4
Total	27,977	52,645	24,668	188	100	100
<i>Annual Gross Output of Each Sector</i>						
Agriculture	13,607	21,715	8,108	160	33	24
Industry	13,423	38,260	24,837	285	32	42
Transport	2,106	4,151	2,045	197	5	4
Construction	3,888	13,726	9,838	353	9	15
Housing	1,694	2,561	867	151	4	3
Other and margin	7,198	11,329	4,131	157	17	12
Whole economy	41,916	91,742	49,826	219	100	100

Source: Derived by the author from Gosplan SSSR, *Piatiletanii plan* (see table 1).

Table 4. *Fixed Capital Capacity in 1928 and Planned for 1933, at the Beginning of the Year* (in millions of 1925/26 rubles)

Sector	1927/28	1932/33	Absolute increment	1932/33 as percentage of 1927/28	1927/28 percent share	1932/33 percent share
Agriculture	15,162	19,503	4,341	129	25	22
Industry	6,489	15,640	9,151	241	11	18
Transport	10,724	15,308	4,584	143	18	17
Construction	595	2,100	1,505	353	1	2
Housing	21,729	25,863	4,134	119	36	29
Other sectors	5,808	10,054	4,246	173	9	12
Whole economy	60,507	88,468	27,961	146	100	100

Source: Derived by the author from Gosplan SSSR, *Piatiletanii plan* (see table 1).

livestock herds, accounted for 25 percent of the economy's total. These two sectors together made up 61 percent of all fixed capital, a proportion not unlike that of the United States toward the end of the nineteenth century. The transport sector, too, accounted for a significant share of all fixed capital, larger than that of industry, reflecting the long history of Russian railroad building. These inherited stocks were welcome, but the emphasis had now shifted. The plan's intention was to reduce the share of housing and agriculture to 51 percent of all fixed capital, while raising industry's share from 11 percent to 18 percent.

### *What Actually Happened?*

Soviet growth since 1928 has been rapid and very substantial, but for the first few years it was erratic and fell far short of these targets.<sup>2</sup> Agricultural output not only failed to grow but declined in absolute terms, as indicated in the first panel of table 5 and chart 1. The corrected official Soviet agricultural output index that has been cited since 1958 shows a fall from 100 in 1928 to 81.5 in 1933, as compared with an intended rise from 100 to 155 set forth in the first plan. The livestock products part of the index fell from 100 to 44. "Liquidation of the kulaks as a class," not foreseen in the plan, was the cause of this agricultural setback.

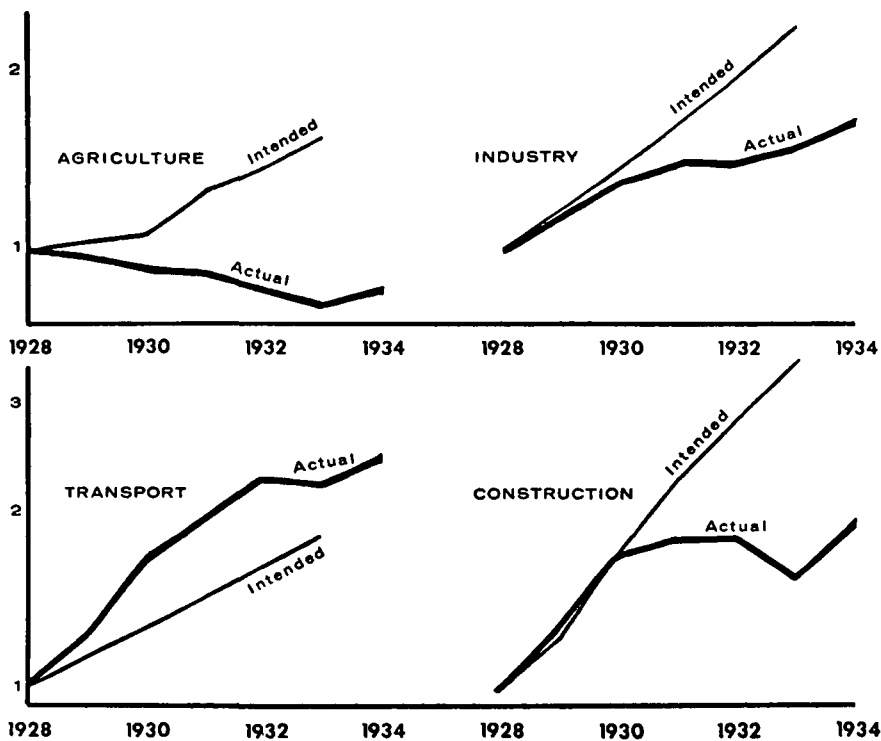
Industrial output expanded markedly, though the extent of the rise cannot be measured unambiguously. The content of manufactured output changed quite sharply, with many new products entering the list, and alternative valuations used in weighting these components lead to alternative estimates of the

2. For a detailed review of the period see Naum Jasny, *Soviet Industrialization, 1928-1952* (Chicago, 1961), and Alec Nove, *An Economic History of the U.S.S.R.* (London and Baltimore, 1969).

rate of growth in industrial output. The official Soviet index claims a rise from 100 in 1928 to 213 in 1933. Nutter's careful assembly of individual output series for Soviet industry, multiplied by base-period price weights, yields an index that rises from 100 in 1928 to 140 in 1931, stays at the same level for 1932, and rises to 149 for 1933. Other sets of legitimate price weights would yield higher rates of growth, though no Western investigator has yet been able to assemble and weight component series in such a way as to equal the official Soviet series reproduced in the second panel of table 5. Even if one rejects the official Soviet series as reflecting improper price weights, it remains clear that industrial output expanded markedly, by at least 50 percent over five years and 80 percent over six years, though the aggregate target for 1933 was far from met.

In the transportation and communications sector, output expanded too much! The First Five-Year Plan called for an 83 percent rise in freight and passenger transportation (together with telephone and telegraph services), with the expectation that no more than this volume of activity would be generated by the targeted levels of activity in industry and agriculture. Unfortu-

Chart 1. *Intended and Actual Output Trends in Agriculture, Industry, Transport, and Construction in the USSR, 1928-34*



nately the turbulent events of the early 1930s led to massive short-run increases in passenger traffic along with a growth in freight traffic that ran far beyond plan intentions.<sup>3</sup> The series shown in table 5 indicates that transport activity quickly rose above plan levels and reached 227 percent of 1928 by 1932. It fell off somewhat in 1933, but rose again in 1934. Great backlogs of unshipped freight clogged the railroads for three or four years, and passenger travel conditions were chaotic. The overfulfillment of plan targets in this sphere hampered the rest of the economy.

The fourth panel of table 5 compares the actual volume of fixed capital construction activity over the period 1928–34 with the intentions embodied in the First Five-Year Plan. Again it appears that output rose rapidly to a level 80 percent above 1928 by 1931 but that no increase was registered for 1932. In 1933 the index fell to 155, evidently reflecting the difficulties of that crisis year. In 1934 a sustained advance began. Though impressive, the performance in this sector fell short of plan intentions. Shortfalls in capital construction undercut the expansion of capacity and therefore limited the growth of output.

In the housing sector, fragmentary evidence indicates that the urban housing stock was increased by perhaps 12 percent but that the urban population grew more rapidly than the plan anticipated. Square meters of floor space available per urban resident fell from 5.4 to 4.7.<sup>4</sup> There is no indication that rural housing improved, though poor peasants moving into the quarters of those displaced by collectivization may have bettered their living arrangements. Finally, for the miscellaneous residual of activities in the sixth sector, I lack any summary measure of quantitative trends.

These comparisons of actual developments with plan intentions show clearly how badly achievements fell short of plan targets. We should recall that the years 1929–33 were difficult ones. After 1929 serious crises developed in the agricultural sector, in retail trade, and in Soviet foreign trade, but instead of slowing the plan, the party responded by demanding emergency efforts for still more drastic quick results. A sharp fall in available animal draft power led to an emergency increase in the target for tractor production. Turmoil in agriculture cut food, cotton, flax, and leather supplies. The shortage of raw materials for textiles created a demand for emergency imports. Shortages of food and other consumer goods, combined with a drive on private retail trade, forced the introduction of rationing and stimulated a rise in money wage rates that played havoc with planned production costs. Delays in the completion of new

3. The record is analyzed in Holland Hunter, *Soviet Transportation Policy* (Cambridge, Mass., 1957).

4. See my "Priorities and Shortfalls in Prewar Soviet Planning," in Jane Degras and Alec Nove, eds., *Soviet Planning: Essays in Honour of Naum Jasny* (Oxford, 1964), pp. 1–31.



Table 5. *Intended and Actual Output in the Agricultural, Industrial, Transport and Communications, and Construction Sectors, USSR, 1928–34 (1928 = 100)*

Sector	1929	1930	1931	1932	1933	1934
<i>Agriculture</i>						
Intended <sup>a</sup>	104	107	125	138	155	
Actual <sup>b</sup>	98	94	92	86	82	86
<i>Industry</i>						
Intended <sup>c</sup>	116	137	162	194	236	
Actual (1) <sup>d</sup>	120	146	176	202	213	254
Actual (2) <sup>e</sup>	114	130	140	140	149	178
<i>Transport and Communications</i>						
Intended <sup>f</sup>	113	127	144	162	183	
Actual <sup>g</sup>	122	164	191	227	222	244
<i>Construction</i>						
Intended <sup>h</sup>	123	171	226	285	353	
Actual <sup>i</sup>	125	166	180	180	155	189

Sources: (a) Gosplan SSSR, *Piatiletii plan*, 1:165. (b) TsSU, *Narodnoe khoziaistvo SSSR v 1958 g.* (Moscow, 1959), p. 350. (c) *Piatiletii plan*, 1:165. (d) *Nar. khoz.*, 1958, p. 136. (e) G. Warren Nutter, *Growth of Industrial Production in the Soviet Union* (Princeton, 1962), p. 525. (f) Narodnyi komissariat putei soobshcheniia, *Piatiletii plan transporta* (Moscow, 1929), by derivation. (g) Norman M. Kaplan, *Soviet Transport and Communications Output Indexes, 1928–1962* (RAND RM 4264-PR, 1964), p. 55. (h) *Piatiletii plan*, 2 (pt. 1): 440–41. (i) Richard Moorsteen and Raymond P. Powell, *The Soviet Capital Stock, 1928–1962* (Homewood, Ill., 1966), p. 392.

capital capacity led for a while to emergency imports of steel, copper, and a wide range of machinery and equipment. Living standards plummeted, and parts of the country suffered famine in 1933. At the end of the first plan period, most large capital construction projects remained uncompleted. With the economy in the throes of a near breakdown, the plan was declared “completed” at the end of 1932 and a new five-year plan was not issued until early 1934.

It is obvious that the first plan did not “succeed,” but perhaps this was not the planners’ fault. Some of these difficulties reflected a series of unfavorable events not foreseen in the plan. The plan itself, for example, even in its third edition issued in the summer of 1930, did not recognize the drastic losses caused by the policy of “liquidating the kulaks as a class.” Nor did the plan foresee the export and import crisis brought on by world depression. Emergency responses to these catastrophes could hardly prevent shortfalls in relation to the original targets of the plan’s optimal variant. We can, however, ask whether the original targets would have been achievable in the absence of these heavy blows. That is the task of the following sections. We begin with a brief exposition of the concepts and methods required to make the test.

*Input-Output Consistency and Intertemporal Feasibility*

Reflection on the flows summarized in the input-output tables for 1928 and 1933 suggests a straightforward meaning for economic consistency. Each sector needs to produce an annual gross output large enough to cover final demands for its form of production and also to cover the intermediate needs of all producing sectors. If all sectors provide mutual support for each other in this way, the flows will be consistent. Unsatisfied demand and underutilized sources may mar the apparent beauty of the scene; inventory changes will absorb small imbalances. Consistency among the intersectoral flows of a single year is not, however, a very searching test of plan feasibility.

The base-period flows of 1928 were realized in fact. The 1933 terminal-year table incorporates plausible changes in input structure and generous allocations to inventory (for reserves), so intersectoral consistency in the 1933 table is not an obvious problem. The major question is a dynamic one: could the whole set of higher 1933 levels be reached in five years, starting from the 1928 foundation? Perhaps one or two of the targets could be reached, but could *all* of them? Stated differently, no doubt all could be reached over a longer period of time, but how much longer would it take? Clearly, we need to test intertemporal feasibility. Each sector's output in each year is limited by its capital capacity at the beginning of that year. Labor, raw materials, and imports are also potential limitations, but Soviet planners rightly took capital capacities to be the binding constraints they faced at this time. Our test therefore concentrates on limitations imposed by capital capacity.

Additions to capital capacity take time, up to seven years for very large projects. Current output goes into capital formation during a gestation period; in due course the sector gaining new capital capacity can produce more output. Meanwhile, however, current output is deflected into capital formation which will only lead to more output after a waiting period. Soviet planners were aware of these practical considerations, and a lengthy project list appended to volume 3 of the First Five-Year Plan recorded for over twelve hundred specific projects in the industrial sector the year they were to be launched, the year they were to be completed, their expected ruble construction cost, and some indication of the time pattern of outlays that was anticipated. Some were already under way as the plan period began, and some were not due for completion until after the First Five-Year Plan period was to end. Some quick projects could begin yielding output within a year. Two-year and three-year projects were more typical. Some very large and expensive projects would only begin yielding output after four years, and would not be fully completed for several years thereafter.

A composite weighted average of Gosplan expectations indicates a standard gestation-period pattern under which, if a sector's output was to increase

in 1932 over 1931, for example, 8 percent of the value of the necessary capital increment for 1932 would have to be built in 1928, 16 percent in 1929, 41 percent in 1930, and 35 percent in 1931. This meant that three-quarters of the expense would be incurred over the two years preceding completion of the new capacity, but that the other quarter would have had to be launched earlier. Factories and other forms of productive capital cannot be built overnight; the growth and structural shifts called for in the First Five-Year Plan faced sharp physical limitations on this score.

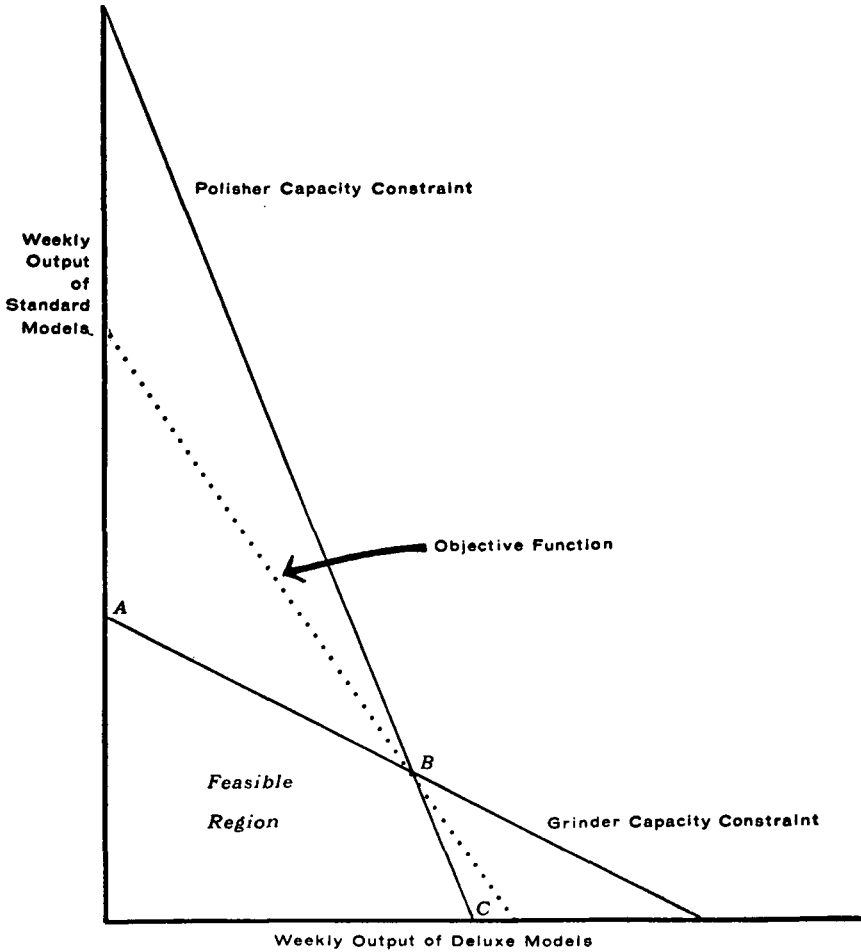
Additions to capital stocks also are limited by the difficulty of diverting current output away from other uses, especially household consumption. The party was very conscious of this problem. It underlay the debate over terms of trade between the peasantry and the regime. The optimism and ambitiousness embedded in the First Five-Year Plan are epitomized by the fact that the plan assumed no belt-tightening at all! Household consumption was to grow throughout the plan period. Buried within detailed plan tables are indications that some categories of urban residents and some categories of the rural population were to be squeezed, but apart from these small minorities, all Soviet citizens were to improve their lot under the First Five-Year Plan. We shall shortly find that this optimism was unfounded.

In order to test whether the Soviet economy could have been brought forward from its 1928 state to the intended 1933 levels, year by year and sector by sector, we need the strict quantitative framework that can be imposed by linear programming. It will be a mechanism of many parts, but its underlying rationale can be understood quite readily through a simple illustration taken from an IBM pamphlet.<sup>5</sup> Suppose we have a machine shop producing two models of a product, one standard and the other deluxe. Suppose the equipment necessary for fabrication consists of two kinds of machine tool—grinders and polishers. Suppose that the amounts of grinding and polishing time required for each grade of product are known, and the weekly capacity of the grinders and polishers on hand is also set forth. The situation then can be put on a graph as in chart 2.

The grinders can divide their time between standard and deluxe models and turn out each week various amounts of both, up to the limits marked by the straight line labeled grinder capacity constraint. Another straight line shows the polisher capacity constraint. The two lines, together with the axis for zero production of one or the other product, mark off a feasible area which encloses all the combinations of output that the machine shop at the moment is capable

5. International Business Machines, *Introduction to Linear Programming* (White Plains, N.Y., 1964). For a definitive treatise see George B. Dantzig, *Linear Programming and Extensions* (Princeton, 1963).

Chart 2. *Production of Standard and Deluxe Models Using Grinders and Polishers (A Linear Programming Illustration)*



of producing. The area above and to the right of the constraints is *infeasible* (i.e., cannot be reached), because the machine capacity required to produce such output combinations exceeds what is available.

This feasible region can be swept by a straight line (the dotted line in chart 2) whose slope reflects the relative importance of (in this case the profit earned on) standard and deluxe models. The points on such a line show alternative combinations of standard and deluxe model production that yield a specified total profit. One can see intuitively that as the line moves northeastward away from the origin, the numerical values representing points on this line will increase. It is a very convenient property of well-behaved linear problems that an optimal solution which maximizes the value of this objective

function will be located at one or another of the vertices where constraints intersect.

Chart 2 shows how a vertex clearly presents itself as the best combination. Higher profits on deluxe models would make the dotted line steeper and eventually shift the optimal solution to point C. Adding to grinder capacity would keep the optimal solution at B, but shift production from deluxe to standard models. This illustration, with two activities and two constraints, can be extended to very large problems with dozens of activities and hundreds of constraints.<sup>6</sup> Computers can conduct the search for feasible and optimal solutions. Feasibility means that a combination of activity levels fits within all the constraints (i.e., that it lies inside the feasible space). Optimality means that the weighted sum of the objectives that are given numerical expression in an objective function has been pushed to a limit. Solutions that are feasible but less than optimal will combine activities in such a way that the objective function is not maximized. Though graphical illustrations must be left behind, we can still think of searching for the best vertex in an n-dimensional space. We first try to get inside the boundaries set by all the constraints, and then try to push out to the frontier at the "best" point.

Numerical estimates for the constraints that limited Soviet expansion under the First Five-Year Plan can be extracted from plan documents, as summarized by the preceding tables. They include: (1) 1928 stocks of fixed capital in each sector, (2) capital/output ratios for each sector for each year over the plan period, (3) input-output coefficients for each sector for each year over the plan period, (4) inventory-requirement ratios for each sector for each year over the plan period, (5) required-import ratios, annually for each sector that can import, (6) amounts to be delivered by each sector in each year to the government and to exports, as specified in the plan, (7) amounts of export earnings assigned each year to repayment of trade debts and accumulation of a credit reserve, and (8) targeted 1933 gross output levels for each sector (specified as floors rather than ceilings).

For an objective function, one can take the maximization of household consumption over the plan period, drawn from the various producing sectors in proportions indicated by the two flow tables. A great tug of war over resource use is involved in the expansion process. Consumption at the end of the plan period could be enlarged if consumption at the beginning were squeezed so that resources could be concentrated on building new capital capacity. The consumer's belt can be tightened only so much, however. As we saw, the First Five-Year Plan optimistically assumed that household consumption could rise

6. The pioneering model for testing an economy-wide development plan was formulated and applied to India by Richard S. Eckaus and Kirit S. Parikh; see their *Planning for Growth* (Cambridge, Mass., 1968).

continuously from 1928 levels throughout the plan period. We should therefore specify an objective function with a "slope" and position reflecting intended consumption levels and see if it lies within the feasible space. If not, we can start from well inside the frontiers and sweep the feasible space in order to estimate the total amount of household consumption that could have been delivered.

Alternatively, one can restate the problem, making deliveries to households each year part of the mandatory constraints that must be fulfilled, and letting terminal-year capital stocks be the variables to be made as large as possible. The two approaches are not in fact so very different, since it is additions to capital capacity that enable the economy to deliver increasing amounts to household consumption.

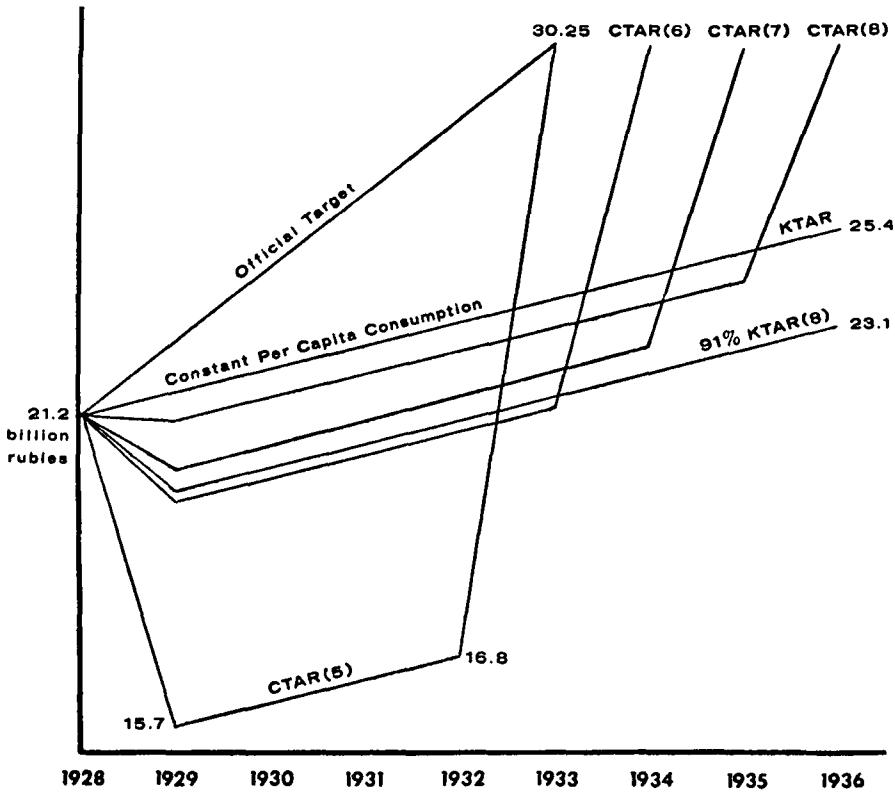
The process of adding to capital capacity spreads out over several years and several sectors. As a result, an economy's structure cannot be quickly changed. The capital increments required for use in 1932, for example, will begin to draw slightly on output channeled into fixed capital construction in 1928. All during 1929, 1930, and 1931, additional output must be assigned to capital formation as part of the increment being made ready to come into operation at the beginning of 1932. The same gestation period was involved for earlier years and continues on into the postplan period. One can easily imagine a shorter gestation period, but the one employed here is the one that appears to have been anticipated by the project-makers themselves.

New capital in the form of buildings and structures comes from the construction sector. New capital in the form of equipment comes from the industrial sector. Each in turn draws some inputs from other sectors, thus indirectly involving the whole economy. The claims of capital formation thus reach backward through preceding years and outward through the economy's intersectoral structure. Ambitious leaders may call for overnight expansion of particular parts of the economy, but a framework that is quite rigid in the short run will sharply limit the degree to which drastic shifts can be accomplished.

### *Test Results and Alternative Expansion Paths*

In light of the circumstances under which the First Five-Year Plan was issued, it is not surprising to learn that its targets, taken together, were infeasible both algebraically and politically. With the original targets for consumption, and using all the other constraints and targets, no initial feasible solution to the linear programming problem can be found. We cannot get within the feasible space. The levels of household consumption called for by the plan, when combined with all the intended capital formation, lie outside the boundaries of the achievable, whether we try to maximize consumption or capital formation. Too much was called for, simultaneously, both in output increases

Chart 3. *Intended and Alternative Household Consumption Expansion Paths in the USSR, 1928-36*



and in transformation of the economy's structure. No allocation of resources among the six sectors and over the several plan years would enable the terminal-year levels of capital and output to be reached, along with the intended levels of household consumption and other final uses. Even with the plan period extended to six, seven, or eight years, the full set of official targets is unachievable.

If we ask instead how much could be delivered to households over the plan period, on the assumption that terminal-year capital stock requirements are met, we find that there is a feasible and optimal solution in five years. It is displayed in chart 3, along with a number of alternative expansion paths. The five-year solution here incorporates a mild requirement that year-to-year increases in household consumption, after the first plan year, at least match the rate at which total population was expected to grow—namely, 2.26 percent per year. The trouble with this solution, of course, is that it would have reduced household consumption from its 1928 level of 21.2 billion rubles to about 15.7 billion rubles in 1929; the level would have risen to 16.8 billion by 1932, and only in the last year would it have risen to the target level of 30.3 billion rubles.



Though this path is algebraically optimal, it would not have been politically feasible. One thinks of the surgical operation that was technically successful although the patient died.

Chart 3 shows how belt-tightening could have been reduced by extending the plan period to six, seven, or eight years. With eight years in which to achieve the capital stocks and output levels that were called for in the plan, some 21.1 billion rubles of consumption could have been delivered to households in 1929, and per capita consumption levels would have been very nearly maintained throughout the plan period. These alternatives retain the original targets, merely extending the plan period and lowering the required mid-plan consumption growth rate. It is instructive to examine a sterner approach, one that would require household consumption only to keep pace with the expected growth of total population, so that per capita consumption, though not permitted to fall, would not be allowed to rise during the plan period. To let the composition of household consumption undergo structural change as the plan intended, while constraining its expansion with this kind of floor, amounts to requiring the consumption growth path marked KTAR (for capital target).

This growth path is obtained by restating the whole problem, placing the deliveries to household consumption among the boundary conditions that have to be met, and shifting the focus to fixed capital construction as the activity to be maximized. Under this approach, the objective function contains terminal-year capital stocks in each of the six sectors, in proportions laid down by the original plan. We seek to push this function out as far as possible. If we set a consumption floor that requires constant per capita household consumption, there is no feasible solution, even over an eight-year plan period. The Soviet economy was tightly constrained at the end of the 1920s, and there was no easy way to build an altered structure. Experiment indicates that roughly a 9 percent cut in household consumption would have freed enough resources to set the growth model in motion, and the line marked 91 percent KTAR(8) records an algebraically optimal path under these specifications. It would have kept household consumption standards at a mid-1920s level during the extended plan period from 1929 through 1936, while resources were channeled into capital formation. As shown in table 4, the First Five-Year Plan called for raising total completed capital stocks from 60.5 to 88.5 billion rubles by the beginning of 1933. The solution computed here would have brought capital stocks up to 83 billion rubles by the beginning of 1934 and about 150 billion rubles by the beginning of 1936. The precise details need not be taken literally, but it is clear that a very substantial expansion of fixed capital stocks could have been obtained under such a policy.

These alternative expansion paths are deceptively easy. They greatly overstate the actual achievability of these activity levels. The reason is that, in linear



programming, resources within a single sector are treated as though they are completely homogeneous. Intrasectoral flows are completely unconstrained. With only six large, highly aggregated sectors in this model, target achievement and structural transformation are artificially easy, and a great deal easier than if these large sectors were disaggregated into finer detail. Disaggregation would increase the number of constraints and restrict the feasible space within which solutions would have to be sought. Even the present simple model assures us not only that the official targets lay outside the feasible space but also that a more realistically detailed formulation would push computed solutions toward the origin. That is, if the First Five-Year Plan were reconstructed in fine detail, the computed feasible growth of consumption and/or capital stocks would not be as high as chart 3 implies.

The grim fact is—to repeat—that there was no easy way to pursue the first plan's objectives. The economy was already strained at the beginning of the plan period. Quick structural changes were impossible because of the gestation process required to build the desired new fixed capital, drawing directly and indirectly on every part of the economy. The intended sectoral growth rates were extraordinarily high by contemporary standards; and within the perspective of a quarter-century's development experience of dozens of countries, these rates appear even more obviously unrealistic today.

Our initial experiments with altered plan parameters have stayed very close to the plan's objectives. One hesitates to rewrite history, not least because it is hard to make nonarbitrary selections from among innumerable hypothetical alternatives. In due course some of the reasonable choices that were available in 1928, some of the alternative policies that might have been followed, can be embodied in a modified structure of plan targets and usefully tested for results. Such work, however, lies in the future. Meanwhile, it should be stressed that the focus here has been on feasibility, not optimality in the economist's sense. Lacking any statistical basis for estimating consumers' preferences, or planners' preferences, or any other criterion of optimality, we have no yardstick against which to evaluate the plan's output targets. And given these targets, to juggle the constraints in search of improved growth paths does not constitute a systematic search for genuine "optimality."

Nevertheless, these paths suggest that the purposes embodied in the plan could have been sought through consistent and plausible programs, without any alteration in the structure of the terminal-year targets in the First Five-Year Plan or change in their level except to introduce a stern no-growth, no-fall policy toward per capita consumption standards. Lower growth rates and slower structural shifts might have brought the Soviet economy out of its strained situation by the middle 1930s, and might have done so fairly smoothly. A milder set of targets would still, of course, have required some difficult

changes. The regime would have had to coax more off-farm output from the peasants, raising the level of 1928 procurements by perhaps 4 percent per year. It would also have been necessary to divert a larger share of the national income away from consumer goods and into capital formation. In the face of difficulties arising from the world depression, poor harvests, or construction delays, the plan period might have had to be stretched out. The likelihood of these developments cannot, however, be tested by the model used here, which merely accepts the parameters embedded in the 1928 flow table and its intended evolution.

### *Why Were Targets Set Too High?*

These quantitative estimates demonstrate clearly that the targets in the “optimal” version of the plan accepted in the spring of 1929 were far too high to be achieved.<sup>7</sup> Individual targets, especially those relating to industry and construction, had been sharply raised in successive versions of the plan over the preceding two or three years. Though linear programming tests in an intersectoral framework were not then available, it was generally appreciated that, taken together, the targets would require an enormous effort. What pushed them so high?

For one thing, recent experience seemed to justify optimism. In recovering from near chaos at the beginning of the 1920s, the industrial sector and the economy generally had shown extremely rapid rates of growth for several years. It was widely feared that when prewar levels were reached, growth would slow down. But after 1913 output levels were reached, there evidently still remained underutilized capacity, and rapid industrial growth continued during 1927 and 1928. Russian industry produced more in 1916 than in 1913, and despite territorial losses the capacity inherited by the new regime proved capable of being pushed above 1913 output levels. Party optimists could thus use recent experience to rebut the “extinguishing curve” school of thought.

A second important factor appears to have been fear of military intervention. In his November 19, 1928, speech to the plenum of the Central Committee, Stalin argued that rapid industrial development was necessary because the USSR was backward. In what was to become a familiar argument (vividly stated for the Soviet public over two years later, in February 1931), he argued

7. This section rests largely on the analysis presented by Eugène Zaleski in his *Planification de la croissance et fluctuations économiques en U.R.S.S.*, vol. 1: 1918–1932 (Paris, 1962), and its English translation, *Planning for Economic Growth in the Soviet Union, 1918–1932* (Chapel Hill, N.C., 1971); by Moshe Lewin in his *La paysannerie et le pouvoir soviétique* (Paris, 1966), and its English translation, *Russian Peasants and Soviet Power* (Evanston, Ill., 1968); and by Edward Hallett Carr and Robert William Davies in their *Foundations of a Planned Economy, 1926–29* (London, 1969).

before an intraparty audience that capitalist encirclement was a serious danger ; he specifically mentioned Germany with its highly developed industry and technology.<sup>8</sup>

An impending showdown with the peasantry was a third major factor appearing to require extremely rapid expansion of industry. In the same November 1928 speech Stalin argued that a crash program to produce more tractors and synthetic fertilizer would be required in order to modernize the agricultural sector promptly. A year later, with the plan targets approved and the first year apparently coming to a successful conclusion, Stalin launched his great assault on the peasantry, arguing that prompt and drastic change in both agriculture and industry would be mutually reinforcing.

A fourth major factor was social-psychological. S. G. Strumilin voiced the attitude of some party activists in the summer of 1927 when he paraphrased Marx to argue, "Our task is not to study the economy but to change it."<sup>9</sup> He denounced Professor Kondratiev's cautious projections from the past and stressed the possibilities for imposing plan intentions on the existing situation. This view spread and by early 1931 was epitomized in Stalin's phrase, "There are no fortresses Bolsheviks cannot capture!" A large group of cautious engineers and economists, skeptical of the increasingly ambitious targets emerging in successive drafts of a five-year plan, were pilloried as bourgeois wreckers and removed from office. Even Strumilin, an intelligent and competent economist, was swept aside. One can understand the rationale for a broad campaign to fire everyone with enthusiasm, enlist dedicated effort, "uncover hidden reserves," shake people out of stodgy habits, and provide encouragement to sustain people in a difficult period. In this context, ambitious targets would have some objective functional usefulness—at least up to a point. Clearly, the tragedy of 1928–29 was that this approach got completely out of hand. Perhaps if linear programming and input-output economics had been available to the plan-makers, they would have been better able to stand up against the pressures for target increases.

A final factor that some have seen at work here, however, suggests that quantitative feasibility tests might have made no difference. Stalin's struggle for personal power introduced noneconomic considerations of decisive importance. He was prepared to push policy positions to an extreme degree in whatever direction would advance his drive against his opponents. Availability of the results reported in the present essay might not have added much to the arguments of those calling for reasonable targets. As Eugène Zaleski suggests, "Stalin was a man of action, and industrialization meant for him the intensified

8. I. V. Stalin, *Sochineniia*, 13 vols. (Moscow, 1947–53), 11:251.

9. Stanislav Gustavovich Strumilin, "Industrialization of the USSR and the Epigones of Populism," *Planovoe khoziaistvo*, 1927, no. 7, p. 10.

construction of factories, the development of new branches of industry and new regions, the improvement of labor skills, and the reduction of economic dependence on the outside world. His vision of industrial development was of a vast program of large works, but works carried out under the impetus of a drive imbued with ideological fanaticism. Under these conditions, what would it matter whether these immense works were completed in three, four, or ten years?"<sup>10</sup>

### *Conclusions and Implications*

Some years ago, Alec Nove raised the crucially important question "Was Stalin really necessary?" and argued that, in order to accomplish Bolshevik objectives, he was.<sup>11</sup> The present exercise in ex post planning provides some crude quantitative estimates indicating a modified reply. Stalin certainly was "necessary" for the drive to achieve the impossible targets of the First Five-Year Plan. But if Bolshevik targets are reinterpreted as calling for a very substantial increase in the economy's capacity (especially in industry and construction), put in place as quickly as conditions permitted, then the estimates presented above suggest that these Bolshevik objectives might have been achieved without the Draconian methods that Stalin used. A number of alternative paths were available, evolving out of the situation existing at the end of the 1920s, and leading to levels of capacity and output that could have been as good as those achieved by, say, 1936, yet with far less turbulence, waste, destruction, and sacrifice.

The "necessary" steps that Stalin took left behind them a permanently weakened agricultural sector, an embittered population, and a terrorized party. The policy of "liquidating the kulaks as a class" gave the regime control over the grain supply, but the agricultural sector after 1929 clearly supplied less output to the economy than it could have under fully plausible assumptions about its terms of trade with the regime. If economic expansion during the first plan period had proceeded along the kind of gradual path computed in illustrative solutions above, both the fixed capital base of the economy and the morale of its people would have permitted sustained expansion during the second plan period and thereafter. The serious external difficulties imposed on the Soviet economy by world depression would have been easier to handle.

Despite the disarray in the economy by the end of 1933, the practice of hortatory overtautness was continued in the Second Five-Year Plan and became standard operating procedure for the Soviet economy. The expansion

10. Zaleski, *Planification*, p. 69.

11. Alec Nove, *Economic Rationality and Soviet Politics* (New York, 1964), pp. 17-39.

rates embodied in Second Five-Year Plan targets were not as high as those bandied about during the “Bacchanalian planning” of 1930–31, but preliminary inspection suggests that, subjected to a feasibility test such as the one employed here, the 1937 targets would also prove overambitious. It is also clear that the practice of enforcing overfulfillment for targets related to construction and heavy industry, while permitting substantial shortfalls in targets related to living standards, carried over from the first plan period into subsequent standard Soviet operating practice. The regime mastered the art of “overfulfilling infeasible plans,” in the felicitous phrase of Herbert S. Levine.

The overambitious First Five-Year Plan has thus had very long-run historical consequences. It started the USSR on the road to massive economic power, but the analytic model employed here to examine the plan’s workability raises serious questions about the plan’s impact on Soviet society. Soviet history cannot be revised after the fact, but perhaps other countries can draw useful conclusions from this way of reviewing Soviet experience.