

PROVIDING FOR DEFENSE

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The Soviet Union was a relatively poor country that punched above its weight for much of the twentieth century; that is, its military power considerably exceeded that of other countries at a similar level of development. It is true that the Soviet Union, though poor, was large, and size lends obvious advantages to military effort. However, size is a source of weakness as well as of strength to poor countries; their lack of economic integration and the costs of territorial defense offer an adversary the chance to infiltrate the population or dismember the territory with relative ease. In spite of its relative poverty, the Soviet Union was able to preserve its economic and political integrity in the face of threats from adversaries that were both wealthy and large. As a result it was able to sustain the mobilization of its considerable resources and supply its armed forces with mass-produced, modernized equipment in much worse conditions than those under which the richer economies of Italy, Japan, and even Germany fell apart.

The process of supplying the Soviet military effort with the necessary finance and materials in successive stages of historical development has deposited a rich sediment of documents that is now declassified to a considerable extent, but still incompletely,

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up to 1963. The documents themselves are dispersed among various archives only some of which are open to independent researchers; for example, the archives of the central government (GARF), the party (RGASPI), and the agencies of planning and supply (RGAE) are largely open, as is the military archive (RGVA) of records up to 1941, but the military archive of records after 1941 (TsAMO) and the KGB and presidential archives remain largely closed. Moreover, within each of the “open” archives many documents, files, and entire *fondy* remain classified; the extent of declassification is highly variable, declassification having been carried out relatively systematically, but still incompletely, up to 1963 only in the economic archive.

Still, the volume of documentation now available is immense, and the volume of archival research published so far, under conditions of fairly free access and uncensored publication, has done no more than sample it, with considerably more attention being paid to the Stalin period and within this to the 1930s.¹ Therefore

1. V. T. Aniskov and A.R. Khairov, *Istoriia voenno-promyshlennogo kompleksa Rossii v regional'nom aspekte: ot nachala pervoi do okonchaniia vtoroi mirovoi voiny. Na primere Verkhnevolzh'ia* (Iaroslavl': Iaroslavskii gosudarstvennyi universitet, 1996); John Barber and Mark Harrison, eds., *The Soviet Defence-Industry Complex from Stalin to Khrushchev* (London: Macmillan, 2000); Irina Bystrova, “The Formation of the Soviet Military-Industrial Complex,” Center for International Security and Arms Control: Stanford University, 1996; Irina Bystrova, “Sovetskii VPK. Teoriia, istoriia, real'nost',” *Svobodnaia mysl'*, no. 6 (1997): 30–44; R. W. Davies, “Soviet Military Expenditure and the Armaments Industry, 1929–33: A Reconsideration,” *Europe-Asia Studies* 45, (1993): 577–608; R. W. Davies and Mark Harrison, “The Soviet Military-Economic Effort Under the Second Five-Year Plan (1933–1937),” *Europe-Asia Studies* 49, (1997): 369–406; Mark Harrison, *Accounting for War: Soviet Production, Employment, and the Defence Burden, 1940–1945* (Cambridge: Cambridge University Press, 1996); G. V. Kostyrchenko, “Organizatsiia aviatsionnogo krupnoseriinnogo proizvodstva,” in G. S. Biushgens, ed., *Samoletostroenie v SSSR. 1917–1945 gg.*, vol. 1, 1917–1939 gg. (Moscow: TsAGI, 1992), pp. 413–36, and “Aviatsionnaia promyshlennost' nakanune i v gody Velikoi Otechestvennoi voiny (1939–1945 gg.),” in vol. 2, 1939–1945 gg. (Moscow: TsAGI, 1994), pp. 197–238; A. K. Kruglov, *Kak sozdavalas' atomnaia promyshlennost' v SSSR* (Moscow: TSNIIatominform, 1994); S. V. Kuvschinov and D. A. Sobolev, “Ob uchastii nemetskikh aviakonstruktorov v sozdanii reaktivnykh samoletov v SSSR,” *Voprosy istorii estestvovoznanii i tekhniki*, no. 1 (1995), pp. 103–15; Lennart Samuelson, *Soviet Defence Industry Planning: Tukha-*

I do not pretend to present a comprehensive survey of “what the archives show.” Rather, I shall give a few impressions of what has been added to our knowledge, concentrating on three main aspects of research:

—*Strategy and leadership*: the roles of the leaders of the armed forces and defense industry, their plans and perspectives, their collaboration and conflict, and their influence on high-level decision making

—*Numbers and rubles*: the more readily measurable dimensions of the expanding supply of defense: budgets and procurements in rubles and physical units, the number of establishments of different kinds and their outputs, their assets and personnel, and so on, including the means by which the authorities monitored this expansion

—*Value for money*: the management of defense production and innovation from day to day so as to achieve desired results from limited resources by controlling quality, effort, and value per unit of resource, revealed in decrees, plans, reports, minutes, and correspondence at every level from the minister to the workshop.

chevskii and Military-Industrial Mobilisation (Stockholm: Stockholm School of Economics, 1996); Lennart Samuelson, *Plans for Stalin's War Machine: Tukhachevskii and Military-Economic Planning, 1925-41* (London: Macmillan, 2000); N. S. Simonov, “Voenno-promyshlennyi kompleks SSSR v 20-50-e gody,” *Svobodnaia mysl'*, no. 2 (1996), pp. 96-114; N. S. Simonov, *Voenno-promyshlennyi kompleks SSSR v 1920-1950-e gody: tempy ekonomicheskogo rosta, struktura, organizatsiia proizvodstva i upravlenie* (Moscow: ROSSPEN, 1996); N. S. Simonov, “‘Strengthen the Defence of the Land of the Soviets’: The 1927 ‘War Alarm’ and Its Consequences,” *Europe-Asia Studies* 48 (1996): 1355-64; I. M. Savitskii, *Oboronnaia promyshlennost' Novosibirskii oblasti. Opyt poslevoennogo razvitiia (1946-1963 gg.)* (Novosibirsk: Olsib, 1996); A. N. Shcherba, *Voennaia promyshlennost' Leningrada v 20-30-e gody* (St. Petersburg: Nestor, 1999); D. A. Sobolev, *Nemetskii sled v istorii Sovetskoi aviatsii. Ob uchastii nemetskikh spetsialistov v razvitii aviastroeniia v SSSR* (Moscow: Aviantik, 1996); I. D. Spasskii, ed., *Istoriia otechestvennogo sudostroeniia*, vols. 1-5 (St. Petersburg: “Sudostroenie, 1994-96); *The Numbered Factories and Other Establishments of the Soviet Defence Industry, 1927-67: A Guide*, Part I, *Factories and Shipyards: Version 2.0* (by Julian Cooper, Keith Dexter, Mark Harrison, and Ivan Rodionov), and Part II, *Research and Design Establishments: Version 1.0* (by Keith Dexter), University of Warwick, Department of Economics [www.warwick.ac.uk/staff/Mark.Harrison/VPK/], 2000.

STRATEGY AND LEADERSHIP

The Burden of Defense

The archives confirm the seriousness with which the Soviet leadership considered and organized the supply of national defense. In the prewar years defense consumption grew rapidly to form a significant burden on national income. In broad terms this was understood already from Abram Bergson's computation of Soviet government and national accounts in benchmark years (1928, 1937, 1940, and so on).² However, the archives have significantly enlarged our knowledge of detail, including the patterns and trends across intervening periods. Most sensationallly, R. W. Davies showed that published military budgets were directly falsified and understated in the period from 1931 to 1933 in order to influence the Geneva disarmament negotiations; the deceit was carried on in 1934 and 1935 so as to smooth the transition back to relatively truthful accounts in 1936.³ A comparison of columns 1–3 of Table 1 shows the sharp increase in the share of defense outlays in Soviet national income in 1932 that this concealed; even so, in the early 1930s the defense burden remained below the level of 1913.

The same figures also show a second jump in the level of the defense burden in 1936. Davies and the present author showed that this upward shift was very difficult for industry; in particular, the leaders of industry and the armed forces jointly promoted mass production as a source of cost economies and standardization compared with existing craft methods, but had to face reluctance and resistance from craft interests in factories and prevarication at lower levels of the ministerial hierarchy. A third

2. Abram Bergson, *The Real National Income of Soviet Russia Since 1928* (Cambridge, Mass.: Harvard University Press, 1961).

3. Davies, "Soviet Military Expenditure"; Davies and Harrison, "The Soviet Military-Economic Effort"; R. W. Davies and Mark Harrison, "Defence Spending and Defence Industry in the 1930s," in Barber and Harrison, eds, *The Soviet Defence-Industry Complex*, pp. 70–72.

TABLE 1
THE SOVIET DEFENSE BURDEN, 1913 AND 1928–1944:
ALTERNATIVE MEASURES

Year	Defense outlays at prevailing prices			Defense outlays at factor costs of 1937			
	<i>Official figures, % of net material product</i> 1	<i>Gregory and Bergson, % of GNP</i> 2	<i>Davies and Harrison, % of labor incomes</i> 3	BERGSON % of GNP 4	% of total final demand 5	HARRISON % of GNP 6	% of total final demand 7
1913	5.9	4.8	—	—	—	—	—
1928	3.0	2.4	—	1.3	—	—	—
1929	3.1	—	2.5	—	—	—	—
1930	3.2	—	2.5	—	—	—	—
1931	—	—	3.0	—	—	—	—
1932	4.5–4.8	—	5.3	—	—	—	—
1933	—	—	5.1	—	—	—	—
1934	—	—	5.0	—	—	—	—
1935	—	—	5.7	—	—	—	—
1936	—	—	8.6	—	—	—	—
1937	7.2	6.2	8.7	7.9	—	—	—
1938	9.0	—	9.7	—	—	—	—
1939	11.9	—	—	—	—	—	—
1940	14.7	13.0	18.1	17.3	—	17	17
1941	20.5	—	—	—	—	28	28
1942	32.8	—	—	—	—	61	58
1943	29.9	—	—	—	—	61	55
1944	28.1	—	—	—	44	53	48

NOTE. Figures that rely on archival documents made available since 1990 are shown in italic boldface. Defense outlays are measured on a budget basis. Net material product is GNP at factor cost, *plus* net indirect taxes, *less* capital consumption, *less* the value of final services. Labor incomes are approximated as total employment times public sector average earnings. Total final demand is GNP at factor cost *plus* net imports.

SOURCES: Col. 1: net material product in 1913 and 1937–1944 from RGAE (Rossiiskii Gosudarstvennyi Arkhiv Ekonomiki, Moscow), f. 4372, op. 95, d. 168, ll. 79–80, and in 1928–1930 from S. G. Wheatcroft and R. W. Davies, eds., *Materials for a Balance of the Soviet National Economy, 1928–1930* (Cambridge: Cambridge University Press, 1985), p. 127; defense outlays in 1913 from R. W. Davies, *The Development of the Soviet Budgetary System* (Cambridge: Cambridge University Press, 1958), p. 65, and in 1937–1944 from K. N. Plotnikov, *Ocherki istorii biudzheta sovetskogo gosudarstva* (2d ed., Moscow: Gosfinizdat; 1955) *passim*, adjusted where necessary to calendar year. Net material product and defense outlays in 1932 from R. W. Davies, *The Industrialization of Soviet Russia*, vol. 4, *Crisis and Progress in the Soviet Economy, 1931–1933* (London: Macmillan, 1996), p. 505.

Cols. 2, 4, and 5: 1913 calculated from Paul R. Gregory, *Russian National Income, 1885–1913* (Cambridge: Cambridge University Press, 1980), pp. 59, 252; other years from Abram Bergson, *The Real National Income of Soviet Russia Since 1928* (Cambridge, Mass.: Harvard University Press, 1961), pp. 46, 128.

Col. 3: R. W. Davies and Mark Harrison, “The Soviet Military-Economic Effort Under the Second Five-Year Plan (1933–1937),” *Europe-Asia Studies* (1997): 395.

Cols. 6 and 7: Mark Harrison, *Accounting for War: Soviet Production, Employment, and the Defence Burden, 1940–1945* (Cambridge: Cambridge University Press, 1996), p. 110.

leap was accomplished between 1938 and 1940. As a result, the achievements of the decade in terms of outcomes were very great: In 1940 there were seven times as many regular soldiers and twenty times as many items of military equipment (in units of 1937) being produced as ten years previously.

Beyond the reported scale of defense consumption, the archives have revealed the scale of resources committed annually to investment in the economy's specialized defense industries. Further, both Nikolai Simonov and Lennart Samuelson have researched the process of investment in mobilization preparedness.⁴ From their work it must be supposed that by the end of the 1930s more or less every establishment and locality in the country, regardless of its peacetime role and subordination, had been given specific mobilization assignments. But it is not clear that the means were on hand to implement them, or that the particular assignments were coordinated in such a way as to contribute usefully to overall objectives.

Defense Motivations

The archives have cast new light on the motivations underlying the first plans for Soviet rearmament in the 1920s. According to Samuelson's archival study of Marshal M. N. Tukhachevsky (later chief of Red Army armament), Soviet plans to build a military-industrial complex were laid down before the so-called war scare of 1927 and in spite of the absence of any immediate military threat; at this time Tukhachevsky was already designing a "military-planning complex" in which the Red Army would participate directly in the overall allocation of resources.⁵ These par-

4. Simonov, *Voenno-promyshlennyi kompleks SSSR v 1920–1950–e gody*, pp. 115–25; Simonov, "Mobpodgotovka: Mobilisation Planning in Interwar Industry," in Barber and Harrison, eds., *The Soviet Defence–Industry Complex*, pp. 205–22; Samuelson, *Plans for Stalin's War Machine*.

5. Samuelson, *Soviet Defence Industry Planning*; Samuelson, *Plans for Stalin's War Machine*; Lennart Samuelson, "The Red Army's Economic Objectives and Involvement in Economic Planning, 1925–1940," in Barber and Harrison, eds., *The Soviet Defence–Industry Complex*, pp. 47–69.

ticular designs were frustrated, but what is also important is that they were associated with other plans for huge investments in heavy and defense industry and in the economy's general mobilization capacity. These plans, with the long-range objective of augmenting capacity for the future production of weapons rather than immediate rearmament, were carried out.

Long-range rearmament was not aimed at countering any particular military threat, since at the time none existed, so in Samuelson's view its precise motivation remains unclear. This is not the view of Simonov, who has placed the turn to long-range rearmament in the context of the Soviet leadership's documented awareness of two things: the growing shortages and discontent associated with implementing the first plans for ambitious public-sector capital construction, and their retrospective analysis of Russian experience of World War I when the industrial mobilization of a poorly integrated agrarian economy resulted in economic collapse and civil war. Simonov concludes that, although the 1927 war scare was just a scare, with no real threat of immediate war, it was also a trigger for change. It reminded Soviet leaders that the government of an economically and militarily backward country could be undermined by international events at any moment; external difficulties would immediately give rise to internal tensions, especially between the government and the peasantry as both suppliers of food and the main source of military recruits. The possibility of such an outcome could only be eliminated by countering internal and external threats simultaneously, in other words by executing the whole Stalin package of industrialization and farm collectivization as preconditions for sustained rearmament.⁶

Both Samuelson and Simonov confirm that in the mid-1930s Soviet military-economic planning was reoriented away from abstract threats to real ones emanating from Germany and Japan.

6. Simonov, *Voenno-promyshlennyi kompleks SSSR v 1920–1950–e gody*; Simonov, "Strengthen the Defence of the Land of the Soviets"; N. S. Simonov, "The 'War Scare' of 1927 and the Birth of the Soviet Defence-Industry Complex," in Barber and Harrison, eds., *The Soviet Defence-Industry Complex*, pp. 33–46.

As a result, the pace of war production was accelerated far beyond that envisaged earlier in the decade. Samuelson has disentangled the role of Marshal Tukhachevsky in this complex process. Pressing the case for long-range rearmament in 1930, when the fate of collective agriculture and the whole industrialization program stood on a knife-edge, Tukhachevsky went too far and alienated defense minister K. E. Voroshilov, who presented him to Stalin as trying to bankrupt the country with the costs of "red militarism." Tukhachevsky lost credibility with Stalin and had to retreat to survive, but subsequently he regained Stalin's confidence and was able to continue his advance more circumspectly. For Tukhachevsky personally it finished badly: In 1937 he fell foul of an intrigue probably engineered by Voroshilov, and was arrested and executed (at the same time the whole General Staff and officer corps were savagely purged). However, the cause that he had championed prospered. In the late 1930s the pace of war production was accelerated far beyond that envisaged in the earlier 1930s and military-industrial mobilization became all-encompassing, while contingency plans for the future became more and more ambitious.

In Samuelson's view the military archives leave open the question of whether these plans were designed to support an aggressive war against Germany in the future, rather than to counter a German attack. However, the documentation assembled by Gabriel Gorodetsky in the central political, diplomatic, and military archives has surely settled this issue: Stalin was trying to head off Hitler's colonial ambitions and had no plans to conquer Europe, even though his generals sometimes entertained the idea of a preemptive strike, and attack as the best means of defense was the official military doctrine of the time.⁷

The present author's investigations confirm the huge costs of

7. Gabriel Gorodetsky, *Grand Delusion: Stalin and the German Invasion of Russia* (New Haven, Conn.: Yale University Press, 1999).

the Soviet war effort.⁸ Table 1 (col. 6) shows that in 1942 and 1943, when Soviet productive capacities were most seriously affected by territorial losses and the war was at its most intense, defense outlays accounted for more than 60 percent of Soviet GNP compared with only 17 percent in 1940 at prewar prices. (The burden on the net material product at prevailing prices, col. 1, was much lower because of a huge inflation in the price of civilian goods, especially food products, at the same time as dramatic economies were achieved in the cost of weaponry.) In a comparative context the Soviet economy achieved a degree of mobilization comparable or superior to that of the other powers, including those with much wealthier economies.⁹

Why, in spite of such extensive prewar preparations, did it cost the Soviet Union so much to fight World War II? On Samuelson's assessment the military-technical preparedness of the Red Army and defense industry in 1941 was generally better than has sometimes been portrayed: no excuses there for the disastrous showing of 1941–42. Samuelson lays the blame at the door of Stalin's strategic leadership. Had there not been such secrecy in the pursuit of rearmament, the Germans might have been better informed of the Soviet Union's military-economic potential and more reluctant to launch their June 1941 invasion; Stalin's appalling decision making undid the Red Army's initial equipment and supply advantages and explains how the Germans nearly brought their invasion off.

A comparative perspective on World War II suggests, however, that the advantages of prewar rearmament tended to be

8. Harrison, *Accounting for War*. This early use of the archives to support macroeconomic research may be seen in future more as a coda to the large-scale Western quantitative assessment projects carried out in the Soviet period than as a pointer to the way in which the archives will be exploited in future. As is clear from the present survey, current research has an increasingly microeconomic orientation.

9. Mark Harrison, "The Economics of World War II: An Overview," in Mark Harrison, ed., *The Economics of World War II: Six Great Powers in International Comparison* (Cambridge: Cambridge University Press, 1998), pp. 22–25.

short-lived. There was no way of significantly smoothing the real costs of the war into the prewar or postwar periods, and the heavy wartime costs of Soviet victory are not very surprising. The only surprise is that the Soviet economy did not disintegrate completely. Based on the experience of World War I, Hitler's expectation was that, regardless of the initial size and equipment of its armed forces, a poor country like the Soviet Union would be unable to offer more than momentary resistance or supply a sustained military effort. Although Hitler's knowledge of history and economics was otherwise lamentable, in this at least he had both on his side. Those who now claim that the Soviet Union was always unstable should return to the experience of World War II and study it carefully, because in this war the Soviet Union was the *only* country to undergo a serious invasion without collapsing promptly.

Was There a Military-Industrial Complex?

Like some Russian writers, Samuelson freely uses the term "military-industrial complex."¹⁰ Do the archives reveal a military-industrial complex in the Western sense of active collusion between military and industrial leaders to swell the national resources available to both? It is obvious without any archives that the armed forces and defense industry shared a common interest in increasing resources for military as opposed to civilian final uses. Both knew that bigger military budgets would add to defense industry resources, and more defense industry capacity would eventually enhance Soviet military power. The archives confirm that the army and heavy industry each separately pressed for additional resources at various times. But did they pursue their

10. The Russian term *voenno-promyshlennyi kompleks*, often abbreviated to VPK, is similar but not equivalent; this point is not always appreciated by writers in either English or Russian. For discussion, see John Barber, Mark Harrison, N. S. Simonov, and B. S. Starkov, "The Structure and Development of the Defence-Industry Complex," in Barber and Harrison, eds., *The Soviet Defence-Industry Complex*, pp. 23–28.

interests jointly? Evidence of collusion—for example, that military leaders were prompted or induced to press for increased allocations by industrialists—has not been found. Irina Bystrova has shown that at key moments the voice of even the armed forces was conspicuously absent.¹¹ When minister for the chemical industry M. G. Pervukhin fought the planning chief N. A. Voznesensky for more resources for the uranium industry after World War II, it was within a bureaucratic framework that excluded the military (the Special Committee appointed by Stalin to take charge of atomic weapons development had no armed forces representatives); when in the same period minister for armament D. F. Ustinov struggled to get more factory space for jet and rocket armament from the Moscow city administration, the dispute was settled by Stalin, not by pressure from the armed forces.

In general, the daily correspondence among industrial and defense officials, illustrated below, suggests that mutual tensions, frustrations, suspicions, and conflicts between the army and industry were endemic. The absence of collusion may be explained in terms of a prisoners' dilemma. The structure of individual incentives was such that the private gains to collusion were typically less than the gains from acting in rivalry. Once budgetary allocations were given, defense producers could win more resources and an easier life by inflating costs and relaxing standards at the expense of resources for the military, while the military could secure cheaper, better weapons by bringing direct pressure to bear on the producers. Thus, for all their complementary interests, relations between the two sides were actually characterized by irreducible conflict.

It appears that industry and army had little opportunity to act in concert, and even the influence that each could exert separately was strictly constrained by the political system in which they operated. The interests of Soviet society were already overtly identi-

11. Bystrova, "The Formation of the Soviet Military-Industrial Complex," pp. 5, 6, 10.

fied with military and defense-industry interests, but the concentration of decision making in the central party organs and the ubiquitous role of the party-state apparatus meant that military and defense-industry interests had little or no freedom of independent action. Civilian leaders from Stalin onward retained complete authority through prewar rearmament, World War II, and postwar military confrontations. The political influence of outstanding soldiers was always tenuous, from chief of Red Army armament Tukhachevsky (executed by Stalin in 1937) to air force Marshal A. A. Novikov (imprisoned by Stalin in 1946) and Marshal G. K. Zhukov (sacked first by Stalin in 1946, then by Khrushchev in 1957). If any branch of government developed an organic relationship with the defense industry at this time, it was the security organs under the leadership of the civilian minister for internal affairs and deputy prime minister L. P. Beria. Beria, like Stalin's postwar commander of ground forces N. A. Bulganin, held the military rank of marshal, but neither was a professional military man. Boris Starkov has shown from the archives that Beria shared Stalin's distrust of the professional soldiers to the point where, in the early 1950s, he even opposed handing over his newly developed nuclear weapons to the armed forces.¹²

NUMBERS AND RUBLES

Secret Figures: How Accurate Was Defense Accounting?

In February 1935 defense commissar Voroshilov complained to Ordzhonikidze, commissar for heavy industry, that the defense industry had underfulfilled the 1934 plan for military procurements.¹³ The evidence supplied by his deputies responsible for artillery, aircraft, and the military budget showed that heavy industry had failed to fulfill its targets for both ruble values and

12. B. S. Starkov, "The Security Organs and the Defence-Industry Complex," in Barber and Harrison, eds., *The Soviet Defence-Industry Complex*, p. 265.

13. RGVA (Rossiiskii Gosudarstvennyi Voennyi Arkhiv, Moscow), f. 4, op. 14, d. 1315, ll. 144-85.

physical units of guns, shells, aircraft, and engineering and chemical equipment that should have been delivered; Voroshilov alleged heavy industry had favored allocations to civilian consumers over the needs of the army and navy. Voroshilov's deputy and chief of the artillery administration Efimov commented, "Industry, as always, is adding its orders for the NKVD, Osoaviakhim [the mass organization for civil defense], and [its own] test-firing ranges on to the figures for systems supplied to the army."

Within a few days, however, Ordzhonikidze replied that Voroshilov was simply wrong: there was no underfulfillment. Voroshilov launched an investigation into Ordzhonikidze's figures. Ordzhonikidze was vindicated in virtually all respects. The defense commissariat's financial section had wrongly counted its own orders to other suppliers as orders unfulfilled by heavy industry. Its artillery and shell administrations had failed to credit heavy industry with naval guns and ordnance received. The defense commissariat's figures for units of engineering and chemical equipment received were likewise understated. Only with aircraft procurement were Voroshilov's figures shown to be correct; industry's higher delivery figures included some aircraft delivered to Osoaviakhim and some delivered to the army in arrears from the previous year.¹⁴

The lessons of this episode are thus not at all what a Western reader might have imagined at the beginning of the correspondence. When it came down to it, there was no inflation of figures by industry, only a minor sleight of hand, maybe no more than a misunderstanding. When forced, the suppliers and users could

14. Humiliated and angry, Voroshilov prepared various Soviet rituals of apology and blame; oddly enough, he failed to carry any of them out. He drafted an apology to Ordzhonikidze, but on the last page he added in manuscript: "Wait. K.V[oroshilov]." His deputy chief of staff Levichev accepted prime responsibility for misleading him, although he sought to divert some blame to army chief of armament Tukhachevsky, from whose "initiative" the whole affair had sprung. Voroshilov drafted a reprimand for his chiefs of staff and of chief administrations, but again added in his own hand: "Still wait. K.V." At the end of the file, dated May 17, the formal reprimand lies today, handwritten in the top corner the words: "Give to me after holiday. K.V." RGVA, f. 4, op. 14, d. 1315, ll. 149–52, 155, 174–76, 184–85.

reconcile their accounts to the point that everyone knew precisely how many aircraft, tanks, guns, and shells had actually been produced and procured. At the same time the reconciliation was not achieved without cost: it took special effort and strong motivation to achieve. Moreover, the atmosphere was one of habitual suspicion and mutual resentment.

More generally, the archives suggest that this was a system that was relatively successful in accounting for numbers when they really mattered. Defense was one area where numbers mattered, so in the defense sector we find a variety of systems of accounting for numbers of rubles assigned and spent; numbered establishments for production and research; numbers of personnel by rank, qualification, experience, salary grade, and if necessary by name; numbers and value of weapons produced; numbers and value of research and development contracts; and so on. These systems appear to have operated with relative rigor in both peace and war. Thus the archives have conclusively refuted the conjecture that published figures for the wartime production of armament were greatly inflated by unjustified reports arising from the desire of industrial leaders to claim 100 percent plan fulfillment.¹⁵ In the main, the published figures were based on procurements, and the army knew exactly how many weapons it was getting. When the published procurement figures for the 1930s are compared with production series now available from the archives only minor discrepancies appear, and these are typically no more serious than those disputed by Voroshilov and Ordzhonikidze in 1935.¹⁶

This minor dispute illustrates one weakness in the control of numbers. Numbers were not always known or held at the level

15. This was originally proposed by B. V. Sokolov, "O sootnoshenii poter' v liudiakh i voennoi tekhniki na Sovetsko-Germanskome fronte v khode Velikoi Otechestvennoi voiny," *Voprosy istorii*, no. 9 (1988), pp. 116–27. See further, Harrison, *Accounting for War*, pp. 183–84, 318n.

16. Davies and Harrison, "The Soviet Military–Economic Effort," pp. 402–6.

where they mattered. In this case the subordinates of Voroshilov's deputies knew the numbers involved precisely, but had not transmitted them upward, with the result that Voroshilov's deputies unwittingly misled him. This may exemplify a general difficulty in the control of aggregates. For example, it would have been difficult for Soviet leaders to be sure how much they were really spending on defense, although every ruble was accounted for somewhere, if only those down below had accurate knowledge as to how many rubles were being used up in defense and how many left available for civilian purposes.

The blurring of boundaries between civilian resources used for military purposes and military resources used for civilian production was a pervasive feature of the system, for three reasons. First, the specialized assembly of weapons was only the tip of the defense iceberg; defense also consumed a huge volume of "dual-purpose" final and intermediate products and services. Second, the economy's capacity for wartime mobilization was designed to be far in excess of peacetime military requirements, so that wide swaths of the civilian economy were continually engaged in mobilization plans and exercises; in order to offset the peacetime costs of maintaining this large safety factor, the reserve capacities of the specialized defense industry were also typically used to meet civilian orders. Third, the rapidity of technical change in weaponry, often unanticipated, meant that the specialized capacities designated in advance for military production were never precisely adapted to new military projects which therefore drew continually on civilian science and production facilities and personnel. At lower levels, therefore, the borderline between the civilian and military economies was both mobile and intrinsically fuzzy.

In spite of the fuzziness, the government's accounting system appears to have been capable of segregating defense rubles from civilian rubles. Within each agency flows of defense-related information were channeled separately and secretly through its "first

department” or office for liaison with the security organs.¹⁷ In the early years the problem was not so much to keep defense matters secret as to ensure that those who needed it had access to them. This was because managers and officials were too ready to use secrecy rules to turn defense-related data into private information in order to extract additional rents; for example, industrial managers tried to keep production cost statistics secret in order to retain discretion over prices and profits and prevent defense purchasers from verifying them.¹⁸ In January 1935 deputy commissar for heavy industry G. M. Piatakov proposed to prime minister V. M. Molotov on grounds of national security that defense industry should no longer have to report its progress to the finance ministry or Gosplan’s statistical administration.¹⁹ In order to counter this tendency, the central government enacted rules to enforce the upward flow of defense information. For example, a Politburo resolution of January 1932 required that defense industry production *should* be included in the calculated totals for industry as a whole. And in March 1935, following Piatakov’s proposal and a counterclaim from Gosplan’s statistics branch that it was being starved of defense-industry data, Sovnarkom made limited concessions to Piatakov but still required defense industry to report both real outcomes and ruble aggregates to Gosplan in Moscow, real outcomes for civilian products only to local statistical agencies, and ruble aggregates to the Ministry of Finance.²⁰

17. Simonov, *Voenno-promyshlennyi kompleks SSSR v 1920–1950-e gody*, p. 44.

18. Mark Harrison and N. S. Simonov, “Voenpriemka: Prices, Costs, and Quality Assurance in Defence Industry,” in Barber and Harrison, eds., *The Soviet Defence-Industry Complex*, pp. 233–35; see further, Barber, Harrison, Simonov, and Starkov, “The Structure and Development of the Defence-Industry Complex,” pp. 19–23.

19. Andrei M. Markevich, “Otraslevye narkomaty i glavki v sovetskoi ekonomike 30-ykh gg. (na primere NKTP i GUMPa),” Institute of Russian History, Russian Academy of Sciences, Moscow, 2000. Thanks to the author for permission to cite this unpublished paper.

20. Simonov, *Voenno-promyshlennyi kompleks SSSR v 1920–1950-e gody*, p. 44; Simonov, “Strengthen the Defence of the Land of the Soviets,” pp. 1362, 1364n; Markevich, “Otraslevye narkomaty i glavki.”

Published Figures: Distortion versus Concealment.

Between the rise and fall of the Soviet Union much was written in the West about the Soviet practices of statistical distortion and concealment. On the whole, the defense archives have tended to vindicate two scholars, Abram Bergson and Peter Wiles. Bergson argued that distortion was typically involuntary; it resulted from the “methodological deficiencies” to be found everywhere in Soviet statistics, not “free invention,” which he believed to be rare. “In the case of free invention,” he wrote, “research on the Soviet economy clearly is practically ruled out at once. In the case of methodological deficiencies, there is at least a core of fact from which to start and one may hope to detect and even correct the deficiencies.”²¹ The methodological deficiencies of which Bergson wrote, although acknowledged rarely in public discourse and then only for a narrow expert audience, are routinely accepted and discussed in archival documents. On the other hand, the archives also suggest that once clear rules were established and lower levels forced to comply, the accounting for defense numbers and defense rubles was probably not significantly deficient.

Distortion and concealment are related because what the Soviets wished to conceal they made secret, and rarely fabricated; on the other hand, they often wished to conceal the act of concealment itself, and this could lead to new kinds of distortion. Suppression was the usual substitute for invention; Bergson described the withholding of information, which was general in the years 1938–1956, as itself “something of a testimonial to the reliability of what actually is published.”²² However, selective suppression was sometimes ineffective because partial transparency made the

21. Abram Bergson, *Soviet National Income and Product in 1937* (New York: Columbia University Press, 1953), pp. 7–9n.

22. Bergson was encouraged in the belief that official data were not freely invented by a number of factors including a much earlier revelation from the archives—the 1941 Soviet national economic plan, captured in wartime first by the Germans, then the Americans. See Sovnarkom SSSR, Tsentral’nyi komitet VKP(b), *Gosudarstvennyi plan razvitiia narodnogo khoziaistva SSSR na 1941 god* (Baltimore: American Council of Learned Societies, 1947).

“blank spaces” more obvious and easier to fill in by guesswork or extrapolation. For example, in the spring of 1937 the heavy industry commissariat published figures for the gross output of its civilian products alone, while almost simultaneously Gosplan published the overall gross output of heavy industry, permitting anyone to compute the value of defense output as the residual. There was an alarmed reaction from within Gosplan demanding strict punishment of the responsible officials in industry.²³ A clampdown on statistical publication began from about this time and continued until the post-Stalin thaw.

The shift to selective revelation after Stalin brought new kinds of distortion directed to concealing acts of concealment. Peter Wiles described it as a policy of “minimal untruthfulness,” based on the aim “to obfuscate us while serving a useful purpose to those in the know, not to lie”; he conjectured that beneath this lay the statistical authorities’ “extreme reluctance to falsify totals, and strong preference for redistributing the item they wish to conceal all over the place in penny packets, under misleading sub-headings.”²⁴ The Stalin-era archives suggest that Wiles had identified this preference correctly. The authorities were usually truthful about aggregates. Bergson was right too: When selective suppression became hard to sustain, they preferred wholesale suppression to lying.

However, the archives also reveal that on rare occasions, when it served his purpose, Stalin invented freely, as in the case of the

23. Barber, Harrison, Simonov, and Starkov, “The Structure and Development of the Defence-Industry Complex,” p. 21. The fears aroused were entirely justified, for an entire cohort of Western scholars made its way in the postwar period by analyzing exactly such indiscretions, whether noticed or unnoticed by the Soviet regime itself.

24. P. J. D. Wiles, “Soviet Military Finance: Especially the Weapons Write-Off, the State Reserves, the Budgetary Defence Allocation, and Defence as a Productive Service,” in P. J. D. Wiles and Moshe Efrat, *The Economics of Soviet Arms (Some Probable Magnitudes)*, London School of Economics (London: STICERD, 1985), p. 6; P. J. D. Wiles, “How Soviet Defence Expenditures Fit into the National Income Accounts,” in Carl G. Jacobsen, ed., *The Soviet Defence Enigma: Estimating Costs and Burden* (Oxford: Oxford University Press, 1997), pp. 59–60.

fictional defense budgets reported in 1930 to 1935 (uncovered by R. W. Davies and mentioned above). On this occasion there were for several years two sets of defense accounts, one for consumption by both the public and the broad mass of less privileged officials, and another for the Politburo alone that showed the true state of affairs. On the basis of the documents revealed so far, this episode remains exceptional.

The defense sector may have been unusual within the Soviet economy in its degree of control over numbers and rubles. Unlike users of civilian products, the army was able to subject the process of producing and acquiring weapons to intense scrutiny, and it had powerful motives for exposing falsified output claims. In the civilian economy industrial and household consumers had little or no chance to monitor production, and producers could sometimes provide incentives for purchasers to collude with exaggerated output claims. Control over defense numbers and rubles was not secured without cost, however, and the archives also show that the army had great difficulty in controlling quality, effort, and value for money in general.

VALUE FOR MONEY

The Importance of Cash Limits

The wartime archives illustrate Soviet concern about value for defense rubles.²⁵ The authorities continually monitored the unit costs of munitions, which fell rapidly with mass production, and pushed down weapon prices in proportion. How to charge the army for weapons imported under the United States Lend-Lease program was a special preoccupation; at the official exchange rate imported weapons were too cheap in comparison with the price level for domestically produced weapons, so the authorities levied a tariff on them to bring their prices up to the domestic level before transferring them to the army. All this was purely a matter

25. Harrison, *Accounting for War*, pp. 173–74.

of bookkeeping; it had nothing to do with the allocation of real resources, which at the time was regulated by a limited number of nonmonetary controls and was motivated solely by the impulse to record what the war was costing, even when the war was going very badly and the economy itself was in a state of meltdown.

If we turn to the defense allocations of peacetime, high-level decisions on the allocation of resources to defense in general, and military equipment in particular, were taken in rubles. In this respect decisions about military and civilian construction were no different.²⁶ Even if decisions were also taken that fixed the strength of the Red Army in terms of numbers of men and units of equipment, defense officials could not forget that they were constrained by cash limits. How was the defense ministry placed to get a good deal for its defense rubles? Value for money was intrinsically hard to assess in a nonmarket economy. Although Soviet military leaders were typically suspicious that their suppliers were exploiting the funding of development, production, and acquisition of weapons for some private gain, in a noncompetitive environment they had few means of subjecting this view to a market test. For a variety of reasons noncompetitive behavior characterizes the defense procurement process in all countries, including market economies such as the United States. However, in the Soviet-type system the market structure was uniquely unfavorable to competition.

The problem of value for money took different forms in production and invention. In production it was hard for the authorities to monitor the quality and quantity of producers' efforts and materials used that would determine the reliability and performance of the final product and whether or not unnecessary costs had been incurred. But there was at least a tangible product the technical specifications of which could be written down in advance. In invention there were additional layers of uncertainty and scope for deceit. Because it was impossible to specify in ad-

26. See Davies, "Making Economic Policy," chap. 4 in the present volume.

vance the outcomes of experimental work, it was inevitable that at any given time a substantial proportion of scientific resources would be devoted to exploring what would later turn out to be dead ends. A dead end from the point of view of the state was not necessarily without utility to the scientist or designer, who might happily spend millions of rubles and many years exploring them. The underlying risk in innovation was the same as in production, that public resources might be diverted to private ends, but it took a different form from producers' skiving and skimping, and could be harder and take longer to detect.

The Role of Monitoring

To control value for money in general the Soviet authorities deployed a range of monitoring and incentive mechanisms; here I shall mention only those specific to the defense sector. In production, permanent teams of "military representatives" of the defense ministry monitored the work of every establishment from within. Military inspection was less effective in innovation activities because the information asymmetry was greater, and probably increased relatively through the twentieth century: Soldiers knew relatively less about science and technology than about production compared with the professionals, and their relative ignorance rose with the advent of atomic science, aerospace, and military radioelectronics. In several fields, among which aviation provides the best example, the difficulties of monitoring could be lessened by creating rivalry among designers, which gave them stronger incentives to allocate effort toward the authorities' objectives. Over a significant period, roughly from 1937 to 1956, the burden of monitoring was increasingly shared by the security services, its intensity was raised to an unprecedented degree in penal colonies created especially for scientists and engineers to work under close guard, and the threatened penalties for failure to give useful results from innovation resources were increased to prolonged imprisonment or death; extreme penalties were made credible by the

legacy of 1937. Increasingly the results of espionage abroad were used to direct and monitor innovation at home, especially in atomic weapons. For several years after 1945 a number of penal colonies were established specifically for German scientists and engineers whose work, mainly in uranium enrichment, jet propulsion, and radar, was used partly as a standard of comparison by which the security services could evaluate the work of Soviet designers, and also to a lesser extent in its own right.

How much of this account of the management of defense resources could not have been written before the opening of the archives? In a factual sense virtually nothing, but in spirit and interpretation a great deal. The reason is that before the archives our interpretation of the management of defense resources was based largely on anodyne official histories and on the accounts provided by producers and designers in biographies and memoirs and émigré interview testimony. Consider the problem as one of principal and agent. The official histories presented a version from the standpoint of the principal (say, the Politburo and defense industry leaders) which denied the existence of the problem (the divergence of the agent's interests from those of the principal). The memoirs and biographies presented a more truthful account, but from the self-interested perspective of the agent (the producers, designers, and scientists). This account was more truthful because it reported the tensions and disagreements among principals and agents as they actually occurred. But it was still biased because it tended to attribute such problems to the principals' low education, lack of trust, excessive regulation, and oppressive behavior toward those of superior culture and understanding—that is, the agents.

This bias took on an extreme form when Western historians came to write about scientific research. For example, no group of agents suffered more mistrust or misunderstanding than the atomic scientists. No group revealed a greater superiority of scientific culture and knowledge of the agent over the principal. No group was less trusted or more suspiciously scrutinized. No field

of scientific activity was previously more firmly located in a matrix of worldwide contacts and correspondence (and no branch became more deeply penetrated by espionage). The atomic scientists were citizens of the world and of the Soviet Union at the same time, both patriots and cosmopolitans; they spoke their minds to the Kremlin and brought to the corridors of power the noblest perceptions of world scholarship and global community; in later life they also gave the best interviews, or wrote the most interesting memoirs. In short, they were rather like us Western historians as we wish we might have been in their shoes. And the tendency for Western historians to identify with their account became almost irresistible.²⁷

The Rationality of Mistrust

What the archives tell us that we did not know before is the evidence-based rationality of the principal's mistrust. This is to be found above all in the records of the defense commissariat and general staff, which give us for the first time a full account of the principal's problem.

Defense production involved ceaseless innovation. In his classic investigation of innovation in Soviet industry, Joseph Berliner defined the traditional view of the Soviet manager deterred from innovation by high risks and low rewards.²⁸ In defense industry, managers made assiduous use of information biases to reduce

27. There is a vast literature on the Soviet management of scientific, research, and development resources. If I single out David Holloway's wonderful, pioneering study of *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939–1956* (New Haven, Conn.: Yale University Press, 1984), it is because it is the very best of this literature and yet expresses most perfectly the bias that I describe. An alternative view of the atomic scientists, based not on archives but on a moral-hazard approach, is advanced by Christoffer Mylde, "Dictators, Scientists and Trust: The Soviet Atomic Bomb Project, 1943–1951," University of Warwick, Department of Economics (EC319 Extended Essay in Economic History), 2000. Thanks to the author for permission to cite this unpublished paper.

28. Joseph S. Berliner, *The Innovation Decision in Soviet Industry* (Cambridge, Mass.: Harvard University Press, 1976).

risks and raise rewards. They drove hard bargains before agreeing to defense contracts in the first place, withholding consent in order to extract concessions ranging from “soft” cost limits to illegal cash advances. Once engaged, they did all they could to conceal costs and raise prices, even invoking state secrecy to withhold sensitive accounting records from the military. When subject to inspection they tried to buy the inspectors’ goodwill with bonuses and services and wean them away from the loyalty the inspectors owed to the army as military officers, until they were prohibited from doing so. Although unable, in the final analysis, to prevent the inspectors from rejecting defective output, producers persisted in finding ways of making the purchaser pay for the output rejected, or else, in the case of some dual-purpose commodities, produced defective output deliberately so as to be able to redirect it to more lucrative secondary markets. Thus the apparently harsh and wasteful character of the inspection regime with its associated high levels of output both produced and rejected was simply the result of both sides maximizing their net private benefits within the rules of a noncooperative game. Moreover, by incurring these costs the authorities ultimately enabled both mass production and rapid innovation.²⁹

Roughly similar conclusions may be reached with regard to the management of scientific research and development. The principal’s problem revealed by the documentary record was how to allocate scarce R&D resources among the abundant opportunities presented by the population of scientists, engineers, and designers. One could think of this population as defined *ex post* by three unobservables: a distribution of talent, a distribution of motivations, and the true state of nature. The state of nature decided which projects were ultimately feasible and which would fail. The distribution of talent decided which projects would provide knowledge synergies of intrinsic worth whether or not they failed. The distribution of motivations decided the extent to which the

29. Harrison and Simonov, “Voenpriemka.”

perceived self-interest of the agent was aligned with that of the principal. Where the project was feasible, as well as of intrinsic merit, and the agent's motivation was so aligned, the result was the *Katiusha* rocket mortar, the atomic bomb, and later the sputnik. Call these agents geniuses: G. E. Langemak, A. D. Sakharov, and S. P. Korolev, respectively the fathers of Soviet rocket artillery, the Soviet hydrogen bomb, and the Soviet space program. On the other hand, projects might fail for at least three reasons: because the agent's project was of scientific value but the state of nature did not allow it to succeed (call this agent, however obedient and talented, unlucky); because the agent, although obedient, lacked talent (call this agent a crackpot); and finally because the agent, whether or not talented, pursued a divergent self-interest (call this agent a fraudster). Naturally still other cases are possible but these were the most important.

Consider two stages: selection and implementation. At the *selection* stage the authorities wished to fund geniuses while denying resources to crackpots and fraudsters as well as to the merely unlucky. On a plausible interpretation of the records, the authorities were able to weed out large numbers of crackpots and untalented fraudsters at the first hurdle or after minimal outlays.³⁰ But it was harder to be sure of excluding talented deceivers, and impossible to exclude those necessary failures that are the price of success. In fact, selection may even have been adverse: The higher were the standards of success that the authorities set, the more likely were talented agents with a realistic view on the chances of failure to exclude themselves, leaving only crackpots and fraudsters in the game.³¹

30. For example, RGVA, f. 29, op. 56, d. 349, d. 354, d. 361, contains numerous military aviation projects submitted by members of the public, chiefly military men and professional engineers, to the Red Army administration for military inventions in 1934–1936, all rejected after cursory consideration or minor preliminary investigation.

31. Groucho Marx supplied the classic analogy for adverse selection: “I don’t want to belong to any club that will accept me as a member” (thanks to Stephen Broadberry for the quotation). In the case of aerospace inventors the analogy is

The documents show that, in the course of *implementing* military R&D projects, the authorities also found it exceptionally difficult to monitor progress and differentiate those necessary failures attributable to bad luck from those attributable to scientific fraud. The difficulty of monitoring progress is clearly exemplified by the standard form in which bureaus and institutes reported periodically to higher authority, which did not lend itself to qualitative or value-for-rubles assessment: x number of themes under investigation, y percent of budget fulfilled, z number of prototypes built, tested, or accepted for production or into armament. The difficulty of interpreting failure may be illustrated by comparing two cases. During the 1930s the authorities invested many millions of rubles in developing two aviation propulsion technologies that eventually turned out to be dead ends: steam turbines and rockets. Eventually they wrote off the steam aviation project as a case of bad luck. In contrast, the attempt to build a rocket aircraft had more severe repercussions.

In 1937 Marshal Tukhachevsky, a leading proponent of the military applications of rocketry, was arrested and executed as a traitor. Subsequently several leading rocket specialists were arrested, including Korolev, who was accused of being a Trotskyist saboteur and sentenced to ten years' forced labor, and resources were switched away from rocket aviation to rocket artillery and jet-engine development. Among the advocates of the jet engine the demise of Tukhachevsky and Korolev was a cause for celebration.³² To them Korolev's criminality lay in the fact that he had been wasting public funds on a pipedream of interplanetary space flight, the tangible product of which was a rocket aircraft capable of flying at no more than 140 kph for less than two minutes. Of course it could be said that they lacked foresight; they had no

better reversed: the fact that anyone would put themselves forward to join the inventors' club was good reason to regard them with extra suspicion.

32. For example, RGVA, f. 4, op. 14, d. 1925, ll. 17–18 (memorandum from members of the Academy of Sciences Institute of Theoretical Physics to Molotov, December 29, 1937).

inkling that this was a future hero of the Soviet Union whose work, ten years later, would turn out to be the key to national security, who after his death would have streets, an aerospace corporation, even a whole city named after him. But even the lessons of hindsight do not fully vindicate Korolev: While he was playing with rockets, the Soviet Union was approaching a catastrophic war in which the role of rocket aviation would be absolutely insignificant, and in which one fifth of the citizens whose taxes were then financing Korolev's research would fail to survive. Even if Korolev had been granted unlimited funding instead of being arrested and imprisoned, there is no chance that his work would have shown any significant return within less than a decade.

In short, the authorities found the problems of managing defense innovation extremely hard to solve. Among these problems were adverse selection and moral hazard. The solution they chose was direct repression.

I do not propose that this interpretation is sufficient; for example, it does not explain why repression was initiated at a particular moment, why the authorities came to rely on repression so exclusively, why so many were repressed, or why some were repressed and not others. The case of the rocket specialists also requires an understanding of the wider processes that provided its context. Something got out of hand in the rivalry among principals and agents in the Soviet system as a whole. Any bureaucrat might reasonably have tried to cut off Korolev's funding, but only under special circumstances would one have tried to cut off his head.

Costs of Repression

It must be added that even the resources of the security organs did not finally eliminate selection bias and opportunism in military R&D, and in some ways the repressive atmosphere made things worse. For example, the xenophobic nationalism of the late 1940s made it more difficult to replicate foreign technology even

when replication would have been optimal. From the archives Nataliia Lebina describes the case of the Leningrad hydraulic engineer I. N. Voznesensky, who temporarily foisted an unworkable but “patriotic” design for uranium filtration on the first Soviet uranium enrichment plant at Sverdlovsk-44; the plant was returned to the tried American design only after costly failures and delays.³³ A similar case is found in the memoirs of the rocket specialist Boris Chertok: Korolev was able to marginalize the influence of the German rocket specialists held on Gorodomlia island by refusing collaboration with them.³⁴ Both cases involved Soviet innovators manipulating the nationalist atmosphere to strengthen their personal positions. Korolev was a genius and Voznesensky was a crackpot, but both behaved in such a way as to raise the cost of meeting national priorities.

Mistrust was rational, but heightened mistrust reduced innovation returns. In the terms of Bruno Frey, coercion “crowded out” the motivation and teamwork of innovation organizations.³⁵ In rocketry the work of the German specialists deported to the Soviet Union in 1946 was unproductive.³⁶ They were not trusted enough to let them anywhere near the core programs of the Soviet defense-industry complex. The mistrust shown to them destroyed their morale.³⁷ The costs of mistrust should not be overstated, however. It is not clear that living under a generally repressive and mistrustful state weakened the motivation of Soviet scientists and engineers; in some respects it may even have strengthened it, be-

33. Nataliia Lebina, “The Defence–Industry Complex in Leningrad (2): The Postwar Uranium Industry,” in Barber and Harrison, eds, *The Soviet Defence–Industry Complex*, p. 188.

34. B. E. Chertok, “U sovetskikh raketnykh triumfov bylo nemetskoe nachalo,” *Izvestiia*, March 4–10, 1992.

35. Bruno Frey, “On the Relationship Between Intrinsic and Extrinsic Work Motivation,” *International Journal of Industrial Organization* 15, (1997): 427–39.

36. Mark Harrison, “New Postwar Branches (1): Rocketry,” in Barber and Harrison, eds., *The Soviet Defence–Industry Complex*, pp. 144–46.

37. For the effects of the *sharashka* regime on the motivation of the German aviation specialists, see Kuvshinov and Sobolev, “Ob uchastii nemetskikh aviakonstruktorov,” and Sobolev, *Nemetskii sled*, pp. 58–118.

cause it contributed to their perception of science and technology as an oasis of rationality, and of their own role as advocates of the same rationality, in a crazy world. Thus their motivation was damaged only when the mistrust and repression were applied to them professionally.³⁸

In summary, the high-level suspicion of scientific personnel in the defense sector, the divide-and-rule approach to them, and the eventual descent to the penal colony, were not irrational and, if costly, were not as wantonly destructive as may have appeared. Scientists and designers were self-interested agents with their own objectives, which often diverged from those of government principals. In such cases their intrinsic motivations led them away from national objectives. As with the inspection regime in production, intense monitoring was simply the way the authorities chose to tackle the problems of selection and opportunism arising when self-interested agents maximized their net private benefits. However one evaluates their efficiency compared with other possible arrangements, such incentive mechanisms created sufficient conditions for the Red Army to be supplied with the rockets, tanks, aircraft, guns, and shells that defeated Hitler's *Wehrmacht*, and for the postwar Soviet Union to compete effectively in atomic weaponry and aerospace. For a relatively poor country, regardless of its size, this was a story of success.

CONCLUSIONS

Simplification and abstraction are essential aspects of scientific method. Correctly used, they become a powerful searchlight that illuminates the core of social reality while relegating unnecessary detail to the shadows. Social scientists have always used such methods to try to penetrate the Soviet enigma.

The challenge of the archives lies in their nearly limitless detail. Do our simplified concepts retain relevance when we come to

38. See further, Mylde, "Dictators, Scientists, and Trust."

study the everyday routines and exchanges of the Soviet bureaucracy? To what extent should they be adapted in the light of new evidence, or should they be abandoned? From the present survey of archival studies related to the supply of Soviet defense a few preliminary conclusions can be outlined.

The archives show that the relationships of the leaders of the armed forces and defense industry among each other and with Stalin were habitually mistrustful. There is strong evidence of internecine rivalry, and little or none of coordination or collusion. The archives confirm that higher levels exercised relatively firm control over numbers and rubles at lower levels, although not without effort. The archives show the mechanisms through which the defense sector achieved both quality and quantity, but they also confirm that there were few institutional limits on the burden of costs that society had to shoulder in order to achieve them. The archives suggest that defense production and innovation were wide open to selection bias and opportunistic behavior. The monitoring and incentive systems employed to limit these were costly. High information and transaction costs account for many aspects of defense resource allocation that might once have been ascribed to an irrational mentality of secretiveness and mistrust.

Above all, the archives show clearly how the game of resource allocation was played according to Soviet rules, and then help to dispel the notion of Soviet bureaucratic life as an impenetrable enigma. The defense sector was one of the most successful aspects of the Soviet system; the archives show that this success was neither miraculous nor paradoxical. It was achieved in the face of numerous obstacles because the authorities created sufficient incentives and incurred sufficient costs to do so, and as a result ensured the alignment of the objectives of defense producers and designers with their own.