2 Economic Cybernetics and Its Limits

Civilian computer networking in the Soviet Union first developed among cyberneticists who applied their science to a unique environment—the command economy. By examining the work of economic cyberneticists—a field found only in the territories of the former Soviet Union—we can begin to understand the significance of the internal economic crisis to Soviet scientists and civilians and the ways in which Soviet scientists, administrators, and policymakers in 1959 to 1963 viewed the command economy itself as a complex cybernetic organization. In this light, the same terms were used both by key Soviet network entrepreneurs to envision the first national networks as well as by the critics who condemned those projects. By reviewing the organizational theories and practices that characterize the Soviet state socialist economies, this analysis explores and begins to complicate the divide between the private markets and the public states that underlie conventional conceptions of the cold war.[1]

The command economy contained in its operations the cybernetic seeds and complex sources of its own undoing—nonlinear command and control, informal competition, vertical bargaining, and what I am calling *heterarchical networks* of administrative conflict. In this chapter, I develop these observations through a series of examples that outline the basic operations of the command economy in theory and in practice, the various schools of thought concerning economic reform (especially around the transition from Nikita Khrushchev to Leonid Brezhnev in 1963), and the political tensions that economic cybernetics tried to square itself with in an attempt to reform (often with long-distance networks) the structural contradictions underlying the practices of the command economy. These contradictions slowed efforts at technocratic economic reform and also ensured the enduring appeal of nonlinear cybernetic systems thinking.

The term *command economy* originated from the German *Befehlswirtschaft*, which was used to describe the Nazis' centralized economy and socialist

economy. A command economy is one in which the coordination of economy activity is carried out not by market mechanisms but by administrative means through commands, directives, targets, quotas, regulations, and the like.[2] Karl Marx and Friedrich Engels said almost nothing about economic planning, except that it would be necessary, and Engels left the decisions to the workers.[3] They also asserted that socialism would be impossible to build in impoverished societies, which Leon Trotsky associated with tsarist Russia before fleeing to Mexico. Nikolai Bukharin foreshadowed what followed next when he said that "as soon as we make an organized social economy, all the basic 'problems' of political economy disappear: problems of value, price, profit, and the like. Here 'relations between people' are not expressed in 'relations between things,' and the social economy is regulated not by the blind forces of the market and competition, but consciously by a … *plan*."[4] On such promises, the Russian revolution was built. Nonetheless, from 1917 until the collapse of the Soviet state in 1991, a perennial puzzle dogged the Marxist-Leninist state planners: How precisely was that plan supposed to work? How can a state command an economy?

Some tenets of the Soviet answer are clear.[5] All the means of industrial production were nationalized, and although Soviet citizens could own some "individual" (not "private") property (including houses, apartments, and automobiles), few could afford to do so.[6] The Soviet state appointed three state ministries to serve as the nation's economic brains, budget-keeper, and managers of the nation's vast property holdings and means of production—the Gosplan (State Planning Commission), the Gosbank (State Bank), and the Gossnab (State Commission for Materials and Equipment Supply). (*Gos* is short for *gosudarstvo* or Russian for *state* or *government*.) Gosbank, the central bank that prepared the state budget with the Ministry of Finance, played a transactional accounting role and the least critical role of the three.

Gosplan and Gossnab carried out crucial and different roles. Gosplan was entrusted with creating the economic plans of action—the governing documents defining the economic inputs (such as labor and raw materials), the timetable for execution, the wholesale prices, and most of the retail prices—divided into five-year increments (the so-called five-year plans). These nationwide economic plans were first rolled out from 1929 to 1933 under Stalin and ended, with one seven-year exception (1959–1965) under Khrushchev, with the twelfth plan (1986–1990), which oversaw Mikhail Gorbachev's reform policies of *uskorenie* (acceleration) and *perestroika* (rebuilding). The thirteenth five-year plan was cut short by the dissolution of the Soviet Union in 1991.

Gossnab, in contrast, was responsible for implementing Gosplan's plans by procuring and supplying producer goods to factories and enterprises and by monitoring the schedules for the production plans. Gossnab thus fulfilled the market role of allocating goods to producers and bridged the three levels of the command economy—national, regional, and local planning and production. The three-tiered model, established under Stalin in the 1930s, presents a straightforward pyramid. Gosplan sat at the top level and politically determined the national targets for each sector and industry, those targets are divided hierarchically among the midlevel of regional ministries, and they are further subdivided at the bottom level among enterprises and factories themselves.[7] If Gosplan planned it, Gossnab carried it out across all three levels—or at least that was the plan. As I lay out below, Soviet bureaucrats came to understand that at its heart, Soviet economic planning was a cybernetic process. This understanding goes a long way toward explaining the curious fact that the same state planners and economic agents later resisted attempts to implement large-scale cybercomputing networks in the Soviet Union.

The Soviet command economy grew at tremendous human, environmental, and organizational costs. In wartime, the command economy worked well enough to survive the extreme national duress of World War II, in which a devastating 26 million people or 14 percent of the Soviet population perished between 1941 and 1945. For the next few decades, Soviet gross national product grew faster than elsewhere in the world, enjoying a peak growth rate of 7 percent in the 1950s and 4 to 5 percent in the 1960s (before flattening out to a 2 percent growth rate in the 1970s and finally stalling at zero in the 1980s). In 1987, the "oppositionalist" Soviet economist G. I. Khanin estimated that Soviet economic productivity grew a total of 6.6 times (not the official claims of 84.4 times) since 1928—which by raw indices alone, is a history of economic growth similar to normal industrialized economies.[8] By far the most unforgivable and unforgettable cost to Stalin's rapid pace of economic development came in human lives. Some estimate that as many as 10 million lives were lost, many of them forced famine victims, surely among the most despairing statistics in modern history.[9]

Stalin built the state at inhuman cost, but he built it nonetheless. Under Lenin's and Stalin's leadership, the command economy modernized a preindustrial country that was run by a few into a mighty industrial power. It began in 1917 with a small group of professional socialist revolutionaries who lived in a few cities in a huge country that was 84 percent rural and whose population was over 95 percent illiterate peasants. After their

October coup, the Bolsheviks eliminated the remnants of the oppositional armies run by the tsar and the Mensheviks, among others, and developed an advanced industrialized economy that, after a couple of decades of forced modernization, helped the Allies defeat the Nazi war machine. As the cold war ensued, the Soviets, fueled in part by state paranoia and in part by scientific ambitions, maintained military parity with the United States, obtaining nuclear energy and weaponry before most of the rest of the world and pulling ahead in the space race in the late 1950s.

The political economy was also engineered to advance meaningful civilian causes such as socioeconomic justice. In most empires, the revenue flows from colony to center, but in the Soviet Union the funds ran in reverse: Moscow invested more in supporting satellite republics and regions than it stripped from them. The state mandated education, raised literacy rates for millions, granted women skilled and technical positions in the workplace, and successfully exported huge amounts of natural resources, ensuring a Soviet presence on the international economic stage. In the 1920s, before the Great Depression and before the 1930s purges, the gulags, and other Stalinist abuses became widely known, most intellectuals in the West admired at least some parts of the ambitious social projects that rode the coattails of the Russian revolution.[10] Optimism glimmered again after the death of Stalin in 1953 and through the heady years of the early 1960s, when all outside indicators suggested that the magic of the command economy—a fairytale on which a repressive empire had been built—might actually be working.

Yet those backstage had a better view of the problems. The degree of information coordination between Gosplan and Gossnab—the brain for planning and the hands of the command economy—was taxing the peacetime state administration. Many things could go wrong and did. Gosplan planned it, but Gossnab did not follow through. Or Gosplan planned wrongly so that, even when properly executed, the plan did not meet the economy's needs. Rarely, if ever, did the command economy work as planned.

The problems that economic planners and practitioners faced multiplied in application. They include an accounting burden accumulated from innocent calculation errors, compounded incentives that distorted reporting, toilsome paperwork, structural inconsistencies across industry standards, prohibitively technical product orders, uncoordinated silos of the national planning apparatus already awash in pricing decisions and administrative deluge, and many other practical problems that manifested themselves to

cyberneticists and other economic planners as informal competition in the command economy.

The institutional map of the command economy grew labyrinthine as the immense accounting burden—a hulking coordination problem (or in cybernetic lingo, an information-processing problem)—that was shouldered by Gosplan and Gossnab was complicated by the participation of the Ministry of Finance, the Central Statistical Administration, and the Ministry of Defense (defense is thought to have occupied as much as one quarter of the USSR's GDP in the late 1980s, although estimates vary widely).[11] In the first six months of 1962, the priority industries that produced steel tubes, mineral fertilizers, agricultural machinery, chemicals, oil, cement, and light steel fell to at least 7 percent under quota—which some critical accountants attributed to human calculation errors. A calculation error could mean too low production targets for heavy machinery one year, and too little heavy machinery that year meant cross-industry shortfalls the next.[12] Even growth, when unforeseen, spelled trouble: in 1962, it was discovered that the ongoing seven-year plan had overlooked the 1959 census data and that by July 1962, the Soviet population had grown by 4 million more than had been planned for. Khrushchev once predicted that the population discrepancy by the late 1960s would border on 15 million people unaccounted for in the young, nonproductive workforce.

Even the best-laid plans, no matter how accurately made at the ministry level, went awry from ministry to regional council to factory. On the factory floor, people encountered widespread problems when translating the quotas and orders into day-to-day operations. One factory was known for decades after the war as the producer of a series of increasingly obsolete automobile models, including the luxury government limousine known as the ZIL (the abbreviation for *Zavod imeni Likhacheva*). The ZIL factory (or Likhachev factory) received orders and quotas that were so specialized that they required especially trained experts to interpret and execute. Yet as investigators discovered in the early 1960s, only two out of sixty-four factory employees had any higher education, and twenty out of sixty-four had not completed high school. Few on the factory floor could read, yet alone fulfill, the specialized orders they received.

Every information-planning problem was also a coordination and thus organizational-institutional problem, and the further up the economic hierarchy, the more intractable the coordination problems. Even at the top of the ministries, the economic plan did not necessarily exist in a single coordinated document, and so silos of attention regimented and splintered

the planning process. Consider this 1962 complaint in *Pravda* from a factory director about the determination of cost:

> The department of Gosplan that drafts the production program for Sovnarkhozy [collective farms] and enterprises is totally uninterested in costs and profits.... Ask the official in the production programmed department in what factory it is cheaper to produce this or that product. He has no idea.... He is responsible only for allocating production tasks. Another department, uninterested in costs, decides the plan for gross output. A third department or subdepartment proceeding on the principle that costs must always decline and productivity increase, plans the costs, the wage fund, and the labor force on the basis of past performance. Allocations of materials and components are planned by numerous other departments. Not a single department of Gosplan is responsible for the consistency of these plans.[13]

Some ministries tried to address these problems by tailoring their own plans in-house. For example, the Ministry of Wood and Wood Processing streamlined and unified the procedural notation for its medium-sized industry. The resulting code, once formulated and printed, weighed in at a wrist-breaking eighteen hundred pages and proved incompatible with other industries.[14]

Given such perpetual misfits between plan and practice, the Soviet search for the "perfect" economic organization was, in Gertrude Schroeder's understatement, "continuous." The annals of Soviet economic planning match decade after decade of bold conceptual innovations with perpetual practical setbacks. The Gossnab ministry itself was dissolved or recreated at least once every decade after its creation in 1947. It was fully dissolved in 1953 after Stalin's death; was recreated in 1965 under Brezhnev, where it oversaw the delivery of over two thousand essential products; underwent various shufflings of responsibilities; and finally was stripped of the political supply of petroleum products in 1981.[15]

All in all, the coordination problem was simple to state yet bewildering to solve: how could the nation best manage, harmonize, and organize all the information variables, planned and otherwise, that were flowing through its economy? How, if at all, could the Soviet knowledge base—including economic cyberneticists, a group known for a taste for circular problems—hope to account for the deficiencies of accounting in the system? In 1962, the State Committee for Automation and the Institute of Statistics estimated that roughly 3 million citizens (about 1.3 percent of the 220 million total) were engaged in public accountancy, data registration, statistical and planning calculations, and other supporting information services for the planned economy and that the number was rising fast. And yet no one, outside of strong-armed national commanders under extreme

wartime conditions, could manage and execute all the operations necessary to sustain the administrative creep of bureaucrats that was necessary to oversee the businesses, factories, and industries that were driving a national economy. In 1962, Viktor Glushkov, the prominent cyberneticist and architect of the OGAS Project, formulated the problem that his network project proposed a cybernetic solution for: he estimated that if the current paper-driven methods continued unchanged, the planning bureaucracy would grow by almost fortyfold by 1980, requiring the entire adult population of the Soviet Union to be employed in managing its own bureaucracy.[16]

The Many Pathways and Pressures to Reform

Under Stalin's centralizing rule, the pressures to reform the cumbersome bureaucracy of the command economy were immense yet bottled up. At 21:50 on March 5, 1953, Iosif Vissarionovich Dzhugashvili, or Stalin (a portmantetau of Russian *stal* or "steel" and "Lenin"), died of an apparent brain hemorrhage. His was possibly the most consequential death of the twentieth century. It set off waves of economic reform. A mere ten days after he died, as a salute to their deceased strong leader and out of a gut instinct for damage control, the Politburo combined twenty-four ministries into eleven strengthened ones. The reformer Nikita Khrushchev would have been foiled from implementing systematic administrative and economic reforms because the reforms had begun before he could ascend to power as the new general (and then first) secretary: under his administration, a series of uneven and troubled reforms were enacted between 1956 and 1965.

By the time that Khrushchev secured power, the winds of administrative reform were blowing in the opposite direction (even administrations follow dialectical patterns). Beginning in 1954, he began introducing dramatic reforms to decentralize Stalin-era control over the economy, ceding some Kremlin power to national, regional, and local subcommittees. Gossnab itself—the national ministry for allocating goods—was dissolved from 1954 to 1964. In 1955, new laws significantly broadened the powers of regional and local planning councils, leaving in their hands for the first time in decades questions about their own financing, planning, capital investment, labor and worker pay, and even some cultural and social projects. Factory directors also took more direct responsibility in determining their factory's planning, financing, and pay situation. In 1957, Khrushchev did away with national industrial ministries and replaced them with regional economic councils (called *Sovnarkhozy*). He continued to implement similar measures

over his years in power, further splintering and territorializing the single national economic administrative hierarchy into 105 economic-administrative regional councils that were overseen by ten general and fifteen union-republic ministries. The 1957 economic decentralization, Khrushchev hoped, would help streamline and localize the planning process for a monstrously complex and administratively top-heavy postwar economy with over 200,000 industrial enterprises.

The causes and effects are hard to sort out. It is estimated that of the 44.8 million workers in the Soviet Union in 1954, the administrative personnel made up 6.5 million of them, or 15 percent of the national workforce.[17] No doubt Khrushchev also harbored some hopes that his decentralizing reforms would release him from bearing sole responsibility for the health of the whole Soviet economy. And yet the reforms did not work as hoped: GNP growth plunged from 8.4 percent in 1956 to 3.8 percent in 1957, the year of Khrushchev's major reforms, and bounced around a 5 percent average until the Khrushchev-toppling disaster that was the poor harvest of 1963 (-1.1 percent decline, the only year with a negative GDP growth until the end of the Soviet Union).[18]

Cybernetic economists quickly learned a point that network theorist Alex Galloway has subsequently clarified: control does not necessarily dissipate with decentralized or distributed networks.[19] It exists in the protocols and the (network) administrators and their rulings, and planning protocols were periodically scrambled. Instead of accounting production by volume, piecemeal targets were set after decentralized planning decisions. Instead of empowering and streamlining the local economy, the decentralizing reforms enraged the old guard in Moscow against its reformer and enlarged the nation's economic administrative apparatus. The overwhelming political effects of widespread decentralization among economic administrations alienated and frustrated many party officials, exacerbating the disarray and discontent already attached to Khrushchev's volatile leadership. Nonetheless, Khrushchev's decentralization allowed for several schools of economic thought in the early 1960s to percolate into public discussion and to cohere in the debates among the top party leadership about the best path of reform.

Orthodox, Liberal, and Cybernetic Economists

In the transition from Khrushchev to Brezhnev, several camps (*schools* presumes too much order) of thought coalesced around the question of economic reform. The first camp included a generation of orthodox economists who clung to positions that many had gained under Stalin, held

the then contemporary functioning of the command economy (with its pyramid bureaucracy of paper stretching across national and regional planners, accountants, and quotas), and was not only doing just fine but was the only ideologically approvable means for advancing socialist economy toward communism. The most severe of the antirevisionists had long put forward a rearguard defense of their own positions in power, which was the historical paradox that any reform to the political system would be an unacceptable deviation from the original Marxist project. Not even Marx knew how such an economy would work, and his Soviet legacy was one of continuous political economic reform. Even ultraorthodox economists had trouble persuading others that there was no room for any economic reform in the wake of Khrushchev's own economic reforms, the political thaw, and unstable economic growth. With so much at stake, no one could disagree: something had to change. The orthodox economists had to concede that there was room for debate.

The second camp took up what later was called the liberal economic position and came onto the public scene in early September 1962 with the publication of a *Pravda* article by a once obscure economics professor, Evsei G. Liberman. Liberman, the youngest son of a Ukrainian Jewish forest guard from Galicia (who eventually emigrated to New York), came to the field of economic planning relatively late at the age of thirty-seven while visiting factories in Germany in 1933. He also was responsible for introducing punched-card computers—Powers and Hollerith perforating machines—for planning in Ukrainian factories. In that 1962 *Pravda* article (titled "Plans, Profits, and Bonuses"), Liberman introduced the signature piece of his reform platform, the idea of profit reform, which he had developed in his 1956 dissertation "Profitability of Socialist Enterprise." Liberman offered up a galvanizing call for economic reform—one that would require little more than the stroke of a pencil and a slight retooling of the planning apparatus.[20] He proposed that the efficiency of an economic enterprise should be measured by its profitability rather than its output, that profit measures would encourage production efficiency and quality, and that profitable enterprises should be incentivized by increased salary and bonuses. Liberman's proposal initially gained the support of Vasily Nemchinov, a leading Soviet economist-mathematician and early economic cyberneticist, and many others. His ideas also found early favor with Khrushchev, who tested the profit hypothesis in two garment factories. Even after Khrushchev's ouster in 1964, General Secretary Leonid Brezhnev and Premier Aleksei Kosygin, an economic planner committed to systematic reform, continued to support most of Liberman's ideas in the partial and piecemeal roll out of the 1965 Kosygin-Liberman reform.[21]

The fundamental thrust of *Libermanism*, as it became known, was not a sweeping reform of the command economy or its complex accounting (for example, he retains several mandatory target measures in his 1962 article) but rather a retooling and focus of command economy accounting on profit—or what might be called a profit-in-command system.[22] At the heart of these reforms lay an attitude about information that other cyberneticist economists and classical liberal economists on both sides of the cold war recognized at the time: it was an information index that reveals enough about that product and its economic environment to be properly managed. For free-market economists, that golden piece of information was the price of a good; for Liberman, it was the profitability of an enterprise. This reform finds its roots in a compromise between the preservation of the command economy administration and a sideways appeal to ongoing economic calculation debates in Europe. Although Liberman could not explicitly argue against the establishment of a central pricing board (as Friedrich Hayek did in 1945), Liberman's reforms appealed to the efficiency of decentralized economic mechanisms that communicated local knowledge in real time without direct administrative intervention. To Liberman in the late 1950s and early 1960s, it appeared that a self-correcting marketplace of profitability might help eliminate economic inefficiencies, if only factories and enterprises that generated more values than costs could receive their rewards.

Although these two indices—price and profitability—appear to stand as key indicators that distinguish between liberal economists within and without the Soviet Union for streamlining accounting problems besetting any national economy, the opponents to Liberman's reforms insisted that reforming profit measures would also compel a concomitant reform in price: for profit to be a meaningful index, it had to reflect relative scarcities in the economy. This would make visible the hidden subsidies that the state used in the existing pricing system to redistribute resources from one sector to another. It is not clear that Khrushchev understood the full consequences of his decisions: his statements on investment priorities were unclear and changing, perhaps deliberately so, because as a staunch supporter of heavy industry, he enjoyed the discretion to redirect and subsidize certain sectors over others—the very discretion that full profit reforms would have threatened.[23] Nonetheless, the opponents to Libermanism—including the cyberneticists—insisted that, whether in a market or planned economy, all indicators were complexly interconnected. Changing one would surely precipitate a change in the other.

Liberman's reforms met an uncertain end at the hands of those institutions that implemented them in the late 1960s (simultaneously with efforts

to advance the OGAS Project for economic reform). Adopted by Aleksei Kosygin and implemented incrementally and partially by a hesitant new general secretary, Leonid Brezhnev, the Liberman reforms nonetheless correlated with increased national production during the next five-year plan (1965–1970), even though they also met fierce resistance from bureaucrats and economic planners, especially in Ministry of Finance, who were set on disrupting the raw materials supply chain and decrying the wage-differentiating reforms as a form of class warfare.[24] By the early 1970s, Brezhnev continued to resist the orthodox economic planners but also abandoned the Liberman reforms.

During the early 1960s, a third camp of thought about national economic reform began to coalesce. The economic cyberneticists championed what might be called *planometrics*, or a combination and application of econometric mathematical tools that included input-output models (not dissimilar from planned supply and demand), linear programming, and sophisticated statistics to the problem of economic planning. Like the liberal reforms, the economic mathematicians, cyberneticists, and econometrists comprising this loose camp conceived of the command economy as a vast information-coordination problem. Unlike the liberal economists, however, the cyberneticists were less concerned with reducing the complexity of the economy understood as an information system to a single golden index. They held that the other two camps did not take seriously enough the numerical nature of all economic exchange and the capacity of modern computing to process them. Mathematicians and theorists such as Leonid Kantorovich, Vasily Nemchinov, Viktor Novozhilov, and B. Mikhalevsky and in the mid-1950s cyberneticists such as Viktor Glushkov and Nikolai Fedorenko realized that universal economic computability meant that all economic relations could be modeled, optimized, and managed with sufficient help from computers and their numerate keepers. In theory, it did not matter which indices were considered, whether price or profit or some proxy variable for peace or propaganda, so long as the boldest socialist ambitions for national economic and social justice could be calculated. In theory, very fast computational speeds made this possible. Computers were thus yoked, quoting Aksel' Berg's book series title on cybernetics, "in the service of Communism" with more enthusiasm than any other toolkit before. By cutting through the political debates of the orthodox and liberal economists, the cybernetists effectively intoned in the face of any economic problem the immortal words of the patron saint of cybernetics, Gottlob Liebniz in 1685: "*calculemus*" or "let us calculate, without further ado, and see who is right."[25]

The most prominent pioneer and precursor to economic cybernetics was Leonid Kantorovich (1912–1986), a prodigious polymath who contributed to the fields of mathematics, economics, and computer architecture. Kantorovich has been compared to John von Neumann (1903–1957), another polymath born of middle-class Jewish parents in early twentieth-century eastern Europe to contribute to the same fields (figure 2.1).[26] Kantorovich's work on computationally optimizing economic exchanges, which later became known as *linear modeling*, began before World War II.[27] The only Soviet economist to be awarded a Nobel Prize (1975), Kantorovich developed linear modeling in 1939 to balance a series of competing variables algorithmically. A simple example adds a dash of dust bowl empiricism to its computational merger of both profit and planning logics. Suppose that farmers—or after Stalin in the 1930s, the managers of a collectivized farm—distribute crops across their fields and that the farmers know the cost of fertilizer and pesticide, the cost of planting, and the selling price of wheat and barley. A linear programmer can determine how much land they should devote to each to optimize their annual yield. Linear modeling—now evolved into the field of *linear programming*—allows the farm managers to calculate in matrix form the maximum revenue, or profit, that they can expect from their available resources and to know how best to distribute their crops (for example, how much barley and how much wheat to plant).[28]

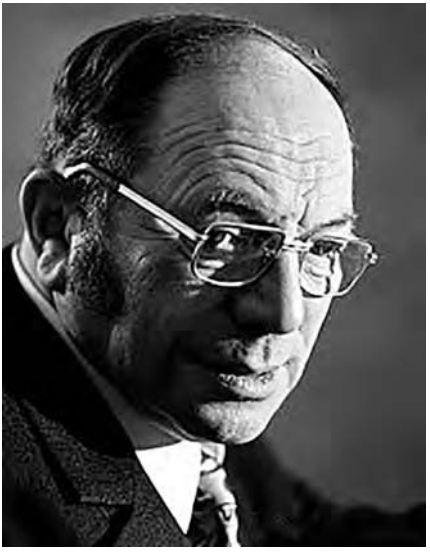

Figure 2.1
Leonid Kantorovich

Economists worldwide recognized the promise of this profit-by-planning model, especially after Kantorovich in 1939 and George Dantzig in 1947 separately took pains to propose methods that could scale to much larger problem sets. Dantzig, for example, showed how the task of distributing seventy jobs to seventy people could be optimized, and Kantorovich's methods found aggregate use in the national wartime efforts to maximize the costs of enemy losses and to minimize those of the Soviet army. (Decades later, their methods remain in use today in modern operations research, such as in Walmart's supply chain.)

Despite the apparent promise of profit by planning in military contexts, linear modeling did not spread in Soviet circles after Stalin had dismissed input-output "balances" as a "numbers game" in 1929.[29] Sped by cybernetics of the late 1950s and the translation into Russian of two articles (a 1958 translation of Wassily Leontief's 1953 edited volume *Studies in the Structure of the American Economy* and an article by Oskar Lange), the majority opposition to economic cybernetic planning methods in 1956 had become a minority position by 1960, and momentum continued to build into the late 1960s.[30] By 1967, the Council on Cybernetics reported over five hundred institutes and tens of thousands of researchers working on cybernetic problems, over half of which featured economic cybernetic research. To this day, the label of *economic cybernetics* lies exclusively within the former Soviet Union and its area of influence.

The scaling successes of economic cybernetics in the late 1950s suggested to Anatoly Kitov, Vasily Nemchinov, Viktor Glushkov, and others that economic planning methods should be applied nationally—perhaps even, as Kitov advised, in a real-time network of computers. The promise of the scalability of the linear programming and computational methods bolstered the political appeal of the supposedly apolitical planometric calculation. The next step with a scalable computational tool is to scale it all the way up, and that would require a communication infrastructure—computer networks—for processing the nation's economic coordination problems. Because computational methods do scale, the economic cyberneticists enthused that maybe *the* principal question for economic reform (who should control the command economy and how?) might be resolved without either the price of politics of the politics of price. It might, the cyberneticists reasoned, be solved with computers.

Many of these proposed reforms—cybernetic, liberal profit, and the Taylorist reforms in the 1920s under Lenin—merited serious attention and, if implemented, would likely have borne fruit had they not collided in application with serious institutional constraints from the bureaucracy. It was

self-evident to the economic bureaucracy that computers were not value-neutral: cyberneticists ran them, and no state resolution could convince the bureaucrats to behave like rational bureaucrats in ceding power to cyberneticists. The resulting messy resistance and nonhierarchical dynamics of the administrative base that directed the Soviet command economy reveal institutional tensions and contradictions that foreclosed against multiple attempts to reform the national economy computationally, liberally, and otherwise. Just as Khrushchev's reforms were frustrated and fractured by the internal resistance of administrators who clung to the current positions of power in the late 1950s and early 1960s, so too did the cybernetic appeals to technocratic reform begin to break against the practical problem of reforming a national economy that refused to behave like the hierarchical system that it appeared to be on paper.

Liberal economists and economic cyberneticists (at least initially, under Viktor Nemchniov) appeared to be bound for a great alliance. In the early 1960s, Nemchinov proposed a "self-supporting (self-accounting) system of planning" that integrated both decentralized computational and market mechanisms into the planning apparatus. The basic proposal was to solve the incentive problem in a way that no factory would have a reason to act against the wishes of the center and the center would have no reason to compel the factory to act.[31] With time, however, the cybernetic economists and the liberal economists clashed over whose method would win the balance of state approval. In 1963, both Liberman's profit proposal and Glushkov's OGAS project appeared positioned to affect real economic reforms. Leading liberal economists, including Evsei G. Liberman, A. M. Birman, and B. D. Belkin, voiced the public opposition to mathematical economic reform in general and the OGAS Project, in particular, although without spelling out the secret project by name in the press. These leading liberal economists immigrated to the United States and Israel after the Liberman-Kosygin reforms were formally accepted but botched (or rather deliberately butchered) by the administrative apparatus. Birman criticized the economic cyberneticists not for their methods but for their politics. As late as 1978, he contended that the introduction of computers and automated systems of management (ASUs) into Soviet economics constituted no more than a "costly delusion" and was a question of the complexities of human interests, not precise accounting.[32] In effect, the liberal economists accused computational economics of harboring conservative politics and of trying to work in the framework of the existing political system without any social change.

Most cyberneticists came from the technical, theoretical, and natural sciences—fields that attracted many of the brightest Soviet minds because of the state support they received and the safety of choosing ostensibly nonpolitical specialties. The competition to join the top sciences was immense, and few chose to leave the sciences for the social and humane sciences (Kitov was forced into economics, and Glushkov was an exception). Leading figures in the mathematical economic camp (such as Kantorovich, who received the Nobel Prize in 1975) were known to defend orthodox political values about the price of labor, even while the younger generation of cyberneticists sought to avoid the politics of price by arguing that a sufficient change in the organizational values of the system must also cause a concomitant change in the political values. By attempting to rationalize and decentralize the planning process, the cyberneticists hoped that anyone, with the help of a computer, could contribute to a reformed, well-oiled economic model and plan, make the system work better, and open a quiet back door to political reform. Even so, Birman and other veteran economic reformers wondered whether the deliberate planning that was inherent in a cybernetic reorganization of economic planning would exacerbate and reaffirm preexisting constraints and coordination problems in the command economy. The liberal economists saw in cybernetic reform of the planning administration no promise of a transition to the market economy that they sought. This belief that technological and organizational reforms bring political ramifications recurs as an article of faith in the annals of Soviet cybernetics.

Despite Glushkov's complaints to the contrary, it is not clear that liberal economic opposition to the economic cybernetic school held up or delayed Soviet attempts to carry out economic reform by computer networks.[33] By 1970, when the top echelons of the Party were ready to consider such proposals in earnest, the liberal economic opposition to the cyberneticists might have helped ingratiated the cybernetic cause to more orthodox Party members who were fed up with Libermanism. (By that point, liberal reforms had a five-year track record of generating more heat than light in many of the economic administrations.) At the same time, the military and the Party were tantalized by the promise of a third generation of integrated circuits in computing in 1970s and maybe even the fourth generation of microprocessors on the horizon of computing industries abroad. Given the political and technological climate, the ears of the state were primed to hear Glushkov's declaration that "the scientific-technical revolution has thrown such a challenge to the science of governance, and much will depend on how we dare to answer that challenge."[34]

Vertical Bargaining and Other Organizational Dissonance in the Soviet Command Economy

This chapter's consideration of the inner workings of the command economy looks directly into the political heart of socialist economic reform, of which the cybernetworks were a small part. To organize an economy properly was the litmus test for the Soviet experiment in socialism and social justice. Few other national projects claimed and endured as much in search of a Soviet network. As a consequence, the organizational dissonance that all economic reformers, not only cyberneticists, encountered in trying to make the economic numbers line up was both the cause and effect of continual economic reform. In this industrialist mindset, computers brought to perennial problems a new set of tools (linear processing, input-output modeling, and the possibility of real-time network communication and surveillance). This section examines some sources of what David Stark has called the "organizational dissonance" that underlies the command economy and that helped ensured the economic system could not be reformed or reaffirmed because every reform introduced new problems without solutions.[35]

"Vertical bargaining" was a feature, not a bug, of the perpetual misalignment of incentives in the Soviet economic hierarchy. Named by a Hungarian economist and critic of socialist economic systems, János Kornai, vertical bargaining takes place among the three levels of relationships among a local enterprise, a branch directorate, and the national planning ministry. Vertical bargaining took place continuously in the annual planning process that, as Spufford describes it, pulsed with paperwork between Gosplan, regional councils (or Sovnarkhozy between 1957 and 1965), and the enterprises (such as firms, factories, farms). Every spring, the enterprises asked Gosplan for the supplies they needed as a percentage change from the output of the previous year. Around the end of June, Gosplan sent draft production targets to the regional councils, which disaggregated the targets and then negotiated with the enterprises toward trim but not unmanageable requests for inputs. Gosplan then reaggregated these requests into each commodity's total supply for the nation that year. When the figures did not match, a second negotiation period between Gosplan and the regional councils proceeded into the autumn until Gosplan had limited demand and maximized supply. The finalized supply quotas and production targets could then be passed down the chain in late October to allow enterprises to select next year's items from the "specified classification," a list of every item that officially was produced in the Soviet Union (think of the Sears mail order catalog on steroids, minus the advertising), just in time for the process to begin again.[36]

All negotiation processes were structured for expressing "mutually contradictory motives," although the administrators had no special access to mechanisms for resolving a priori conflicts between the interests of the layers of the hierarchy, which compromised the integrity of the economic plan that they were developing.[37] Without a plan for regulating the planners, the planning processes confronted economic leaders—everyone from administrative planners to factory managers—with multiple registers of conflicting value. "Suppose a leader feels he has received an incorrect order," Kornai asks: "Should he carry it out or should he protest, out of party loyalty and professional pride?"[38] If he accepts the flawed order but fails to deliver on it, Kornai continues, he and his colleagues will be held responsible and possibly accused of sabotage. If he opposes the order, he could be accused of party disloyalty. Either way, the actor, not unlike Vanek in Vaclav Havel's play *Audience*, is stuck.

Without a single path forward, levels had to negotiate for their own institutional self-interests vertically across the formal administrative hierarchy. To do so, requests began to misrepresent economic reality in both directions. Requests for input (or demand) rose upward and request for outputs (or supply) sank downward—the planner's vertical equivalent of selling high and buying low in a horizontal market. Imagine the behavior of the ministry that oversees a branch directorate and the factories that the directorate oversees. The branch directorate is charged with reporting to the ministry statistics about the annual production, material allocation, and labor of its subordinate factories. To do so and because the experienced directorate anticipates that factory managers are responsible for shortfalls and thus systematically underestimate their output capacity and overestimate their input needs, the director will "prescript a plan 10 or 20 percent tighter than they themselves consider realistic, calculating that the firm will want to beat them down."[39] When reporting its plan, the branch directorate bids to the superior ministry just as the factory manager did to it. An apocryphal anecdote of a job interview for a new accountant in a factory captures something of this haggling spirit. To each candidate, the factory manager asks only one question: "How much is two and two?" A single candidate, a former convict, has the winning answer: after hearing the question, he stands, closes the door, and asks in a loud whisper, "How many do you need?"

The vertical bargaining process also penalized the future of productive factories by "planning in" their previous successes as the new baseline, ensuring that the plan would be ratcheted upward in perpetuity.[40] Manuel Castells notes that the entrepreneurial managers and workers in the

chemical complex of Shchenkino in Tula, Russia, "were trapped into being, in fact, punished with an intensification of their work pace while firms that had kept a steady, customary level of production were left alone in their bureaucratic routine."[41] This ratcheting effect, a kind of institutionalized variant of the tall poppy syndrome, has its corollaries in the mutually reinforcing relationship between demand and supply. In corporate and command regimes, if the supply of one's quality goods meets demand, one must work harder to meet future elevated demand. If the supply of one's goods falls short of the need, the capitalist market actor will adjust or go bankrupt, and the socialist administrative actor will be punished. So long as labor is isolated from those who manage the means of production—Marx himself railed against the doyens of exchange value (*Tauschwert*)—management profits and alternately pays or punishes workers for past productivity. Unlike market behavior, any deviations from the plan could send culpable ripple effects down or up the chain, and the plan itself could be understood in the context of its local knowledge. So the ideal standard of factory or firm behavior is to fulfill the plan by "exactly 100 percent, or perhaps 101 or 102 percent." The lively fitfulness of vertical bargaining disrupted and distorted the representativeness of the economic statistics that the cyberneticists sought to input into the linear modeling and programming and economic reform projects.

Shoehorned instead into numerical fit, the command economy plan never fully reconciled in its manifold details, and the compounding complications and activities that organizational dissonance invited were anything but planned. Administrative roles blurred as needed. One leader might find himself playing the politician, a bureaucrat, a technocrat, and a manager in different situations. To secure more input on the accounting sheets, a leader might encourage workers on the factory floor to produce more output in the name of the plan but, behind closed doors, might misrepresent the numbers to undercut the same plan. Not at all the rigid hierarchy caricatured in modern memory, the everyday practices of Soviet economic life abounded in pervasive informal forms of competition and caprice.

These early cybernetic economists faced an associated and monumental challenge. In theory, their reforms would be approved to track the formal (or white or first) economy, and any attempt to reform the distortions in that formal economy would further incentivize more informal (or gray, second, or shadow) economic activity. The reality of the latter half of Soviet economic history reveals that private life increasingly depended on the resilience and robustness of people's connections to the informal economy.

The command economy operated on hidden networks of *tolkachy* (literally "pushers") or "go-to-guys" or "fixers" who got the job done outside of the formal economic plan. Without the support of *tolkachy*, thousands of official economic quotas over decades never would have been met.[42] Recent economic studies based on previously unconsulted archival data have estimated that a stunning average of 24 percent of annual expenditures per household in the Soviet Union went to the informal economy between 1968 and 1990.[43] The estimated percentage of GNP not accounted for by the informal economy over the same period ranges between 17 and 40 percent.[44] Despite both official claims and its enemies' fears otherwise, Soviet economic life drew its vitality not from the strictures of top-down command and control but from the fitful hustling and the scrambling that came about because of those commands.

Informal behavior and bargaining were not separate from Soviet statecraft: the state embodied them. Even Stalin, with his reputation as an all-knowing leader and steely strongman, bowed to the deeper logic of informal influence and favors—what is known simply as *blat* (ostensibly from Polish Yiddish for "someone who covers for someone else," or from the German for "blank note").[45] Instead of committee decisions, Stalin often invited local leaders to private consultations where Stalin could claim that all other parties had endorsed his recommended policy and provide the local delegates with an opportunity to leverage "personal connections" to personal advantage at home.[46] Control over science and society was extended by the same informal means. In 1952, an editorial in Hungary proclaimed that "the teaching of Stalin embraces all the universal principles of nature in its smallest details. He solves all the practical problems of understanding natural science," and "it is only Stalin … who is able to analyze clearly and find with mathematical precision the exact way toward solution of present day problems."[47] So too did his social radar appear impossibly omniscient thanks to strategically placed ambassadors and Party secret police embedded with party *apparatchiks*. The strongman seemingly did not want the state to behave as a well-ordered hierarchy but rather as a sprawling network with informal connections to a strong but sporadic center. The terror of his rule was not its rigid centrality but its informal uncertainty. Stalin and his henchmen could be anywhere. To encompass everything was Stalin's job: he already had everything covered. And for this reason, his death formed the vacuum into which cybernetics stepped.

Khrushchev's thaw attempted to distance the nation from its Stalinist past, but his decentralizing reforms sped the sporadic, informal, and

unregulated nature of his rule. Even his famous "secret speech" to a crowded Party congress in 1956, which was the act that distanced him from Stalin, denounced Stalin as a cultish personality but *not* as a governor whose mode of informal management Khrushchev wanted to break from.

The administrative infrastructure came to reflect this infusion of informal administration in a number of ways. Administrative personnel and staff officials had separate telephone lines and mailboxes for the same supervisor, which ensured that formal communication lines were clogged with official requests and that the actual negotiations took place along informal lines—not on the golf courses of modern business but in the transit sites such as hallways, trains, and dachas (seasonal cottages or summer homes outside the city). Because formal mechanisms proved ineffective, hiring and promotion practices often relied on interpersonal and informal "career friendships" or tight bonds that lasted lifetimes. Soviet specialist David Granick notes that "with this absence of formal clarity, it is natural that emphasis has always been placed on the need for the closest ties and a comradely atmosphere between the management and a plant's Party organization."[48] Interviews with émigré bureaucrats have revealed a pattern of administrative behavior that stressed the career necessity of not "spoiling relations," the significance of who you know, and the career advantages of being a "yes-man" in formal relations with superiors.[49] Administrative conflicts between the elements of that system—such as the Academy of Sciences and the Ministries of Finance, State Planning, Interior, Defense, and State Security (home of the KGB, or Committee for State Security)—were resolved not by an appeal to hierarchical authority but through a variety of informal mechanisms that were internal to the ministries themselves. One reform initiative after another was aborted, and those that were enacted were condemned to stumble on, in Schroeder's phrase, the late Soviet "treadmill of reforms."[50]

Compelled to operate within an official hierarchy, Soviet administrators benefited by behaving and working across complex informal networks that crisscrossed across institutional interests. A young economist, Menshikov, summarized the nonlinear or nonhierarchical behavior of the command economy not as "aiming at increasing the well-being of the population" but as "maximizing the power of the ministries in their struggle to divide up the excessively centralized material, financial, labour, natural, and intellectual resources."[51] He continues, noting the path-dependent creep of administrative misbehavior: "Our economic-mathematical analysis showed that the system had an inexorable inertia of its own and was bound to grow more and more inefficient." Whether in vertical bargaining between

the levels of the planning, the reluctance of ministries to cooperate outside their assigned territory, or the struggle of other agencies to collaborate, the fundamental paradox of planning became increasingly obvious to the economic cyberneticists and others who sought systemwide reform. The planners and executers of that plan were to create gaps in the plan and leverage those gaps with very competitive logics that the command economy sought to prevent.

The cyberneticists thus faced a foundational paradox in reforming the national economy and perhaps other political economic systems. For an economic reform project to succeed politically at the national level, the reformers had to win the support of the very system that it meant to reform. If they sought to do so through new formal mechanisms, as the computational methods of the economic cyberneticists demanded in theory, those methods would face widespread resistance (one of few systematic behaviors that the system was regularly capable of). Conversely, if they sought to reform a broken system of political patronage, as they had to do in practice, they first had to win the favor of that system. The paradox that they faced is not unique to the Soviet cyberneticists. To reform a system, a would-be reformer first has to become part of it. Next, the better that one plays along, the less likely that one wants to reform the system; and so long as one continues to play along, one may not reform the system.

Faced with technocratic reform, economic management bureaucrats and politicians scrambled their own administrative orders to preserve their own personal careers. Bureaucrats were never mere bureaucrats, and the mechanics of day-to-day operations were never merely mechanical, even though the culture of technocratic governance swelled after Stalin to the point that, by 1989, 89 percent of those who sat on the Politburo were trained engineers (engineering training prepared Soviets for governance positions much like law degrees do elsewhere).[52] (The iconoclast economist Thorsten Veblen mused in 1921 that the West might one day be ruled by a "soviet of technicians" or a technical class that was capable of capturing the wealth that they produced.[53]) The Soviet system, much like a firm, sought to produce one solitary good above all else—the political good of a life apart from the capitalist experience. In a narrow sense, it succeeded: the marketplace of Soviet economic interactions became foremost a negotiation of political power rather than price. Its bureaucrats bowed to unintended incentives to exploit the rampant organizational dissonance that they oversaw, its technocrats lived by their social wits, and the system squeaked by on the capricious politics of planning run amok.

Conclusion

As Soviet economic cyberneticists emerged as a viable option in the early 1960s and again early 1970s, they confronted a monumental problem in managing and reforming the command economy. The question was identified by the Austrian school of economics decades earlier: which techniques and approaches would help resolve the mounting tensions among the formal command economy, the gray economy, and the infusion of informal practices in the administration of Soviet socioeconomic life? For the most part, the leading Soviet economic cyberneticists sought to fix the formal command economy by introducing ambitious, even grandiose, plans for automating and modeling the administrative planning decision process itself. And yet, as is shown, those formal plans—a networked plan to fix the planning process itself—did not work because even cybernetic plans could not account for nonlinear operations in the Soviet economy. Their formal plans to rebuild the command economy as a hierarchy had to overlook the complex crisscrossing networks of relations that made it function in practice—the gray economy and its entrenched currency of *blat* or informal favors that were entrenched in the governance structures. By reimagining the command economy as a heterarchical crisscross of hierarchical orders from above and a resulting swirl of unregulated practices in every other direction, the failure of these Soviet economic cyberneticists to reform, automate, and manage the command economy begins to make more sense.

There is one goliath exception to this critical description of the informal administration of the state and economic bureaucracy. The command economy, which staggered along a winding path toward the creation of a normal industrial civilian economy, was relatively functional at powering and sustaining superpower military technological initiatives. Formulated first as a wartime economic model by the Germans, the insatiable sink of the Soviet defense apparatus into which economic resources were continuously poured cannot be overestimated. Both official state and CIA statistics on Soviet military spending are controversial, although if a critic of both can believed, the Russian American economist Igor Birman estimated that by 1975 the CIA estimates of the size of the Soviet economy were two or three times larger than reality and that instead of spending roughly 6 percent of its GDP on military expenditures, the Soviet state devoted closer to 30 percent of its GDP on the military. The military-industrial complex enjoyed massive funding streams and the brightest and best intellectual and technological resources, and although the jury is still out on the exact nature of the Soviet military (most of its details remain closed to this day),

the military sectors also attracted the best and the brightest because those sectors were best managed. The strictly managed military sectors produced and sustained for decades world-class space and nuclear programs and secret computer networks across launch pads deep into Siberia. But the Soviet military's technological innovations did not as a rule spill over into civilian sectors. Nuclear-blast-resistant computer chips interested very few, and yet the Soviet military nonetheless developed these and other "special research" projects (so named in public documents).[54] The military enjoyed the status of being responsible for generating a seemingly infinitely defensible "public good"—national defensive and offensive readiness in an almost irrationally strategic cold war—and yet did not have the burden of having to be publicly accountable to civilian politicians.[55] Perhaps the caricature of the problems of the civilian economy makes most sense in light of its foil in the military economy. Unruly, informal, labyrinthine, and ineffectual suffering in the civilian sectors rarely met with the well-ordered, formal, hierarchical modernization in military affairs. The contrast between military and civilian economies recapitulates a structurally similar disconnect between the civilian command economy in theory (hierarchical, formal, well ordered) and in practice (heterarchical, informal, conflict ridden).

In summary, the separation between military and civilian sectors reflected a disconnect between the civilian economy and its own state goals, and it comes squarely into play in the central story, outlined in the following chapters, about early Soviet computer networks projects and those cybernetic entrepreneurs who set out to build them. This chapter has laid out the basic civilian economic operations as well as problems that motivated Soviet cyberneticists—whether orthodox, liberal, or cybernetic—to propose and design ambitious projects for reforming the national economy. The next two chapters examine the role that computer networks played as the promised deliverers of such reform, and they turn on why cybernetic attempts to network the command economy fell apart. The network entrepreneurs understood firsthand the institutional contradictions that they sought to solve with an automated system of management. This basic backdrop to the everyday administrative conflicts in Soviet social life—between the rational hierarchical plan of the command economy and its messy heterarchical misbehavior—was not lost on the pioneering Soviet cyberneticists who followed.