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## 5. The East-West Politics of Global Modeling

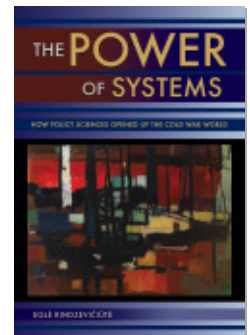
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## THE EAST-WEST POLITICS OF GLOBAL MODELING

In this chapter I focus on computer-based global modeling, a new technology of knowledge production that emerged in the early 1970s and played an important, transformative role in Soviet governance by opening it up to East-West cooperation. Global modelers conceptualized the planet as a complex, interconnected system, the understanding of which required transnational scientific cooperation, enabling both scientists and data to cross national boundaries and Cold War divides.<sup>1</sup> Furthermore, Soviet scientists forged and used models of possible long-term futures of the world to reveal and criticize problems being experienced, but not always acknowledged, in the Soviet Union. A history of computer-based global modeling is, therefore, a history of East-West transfer, the transformation of the late state socialism and globalization.

The first computer-based global models of social and economic development were produced under the auspices of international organizations, which brought together individuals from the Eastern and Western blocs: the Club of Rome, the United Nations agencies, and, most importantly, IIASA.<sup>2</sup> Although historians habitually refer to these international organizations as examples of the emergence of global governance, we still lack evidence about concrete projects that were pursued within the framework of these organizations and their outcomes, particularly less tangible ones such as professional and social networks.<sup>3</sup> This chapter fills this gap in knowledge by examining several cases of East-West cooperation in computer-based global modeling carried out by the UN and IIASA.

But what is global modeling? Indeed, “global modeling” refers to a great many different concepts and techniques, which could be digital or analog, purely

conceptual or calibrated to run on particular computers. Computer-based global modeling so far has been overlooked in histories of computing, although the impact of computer-based global modeling on modern governmentality cannot be overestimated.<sup>4</sup> Thus the first historical studies of global modeling originated in the field of environmental history and the history of Earth's systems, suggesting that global modeling had important epistemological implications for governmental practices.<sup>5</sup> First, global models encouraged policy makers to look at complex relationships that stretched beyond national borders. Second, global models posited a possibility and therefore a need to look further ahead, to operate with longer time horizons, and to evaluate present-day policies in light of their long-term consequences. Even when the computer power to process large volumes of data was still limited, the idea of computer-assisted long-term planning fascinated both scientists and policy makers: even before adequate technology and data emerged, in 1961 the United Nations adopted the resolution *Planning for Economic Development*, calling for long-term projection and planning of the world economy.<sup>6</sup> Third, to be able to plan for the long term became synonymous with being an advanced, postindustrial state, and the foremost tool for this kind of planning was the computer. In line with Peter Galison and Bruce Hevly, I suggest that being an expensive undertaking, requiring huge investments in computer technologies and transnational cooperation in collecting and sharing data, global modeling was part of "Big Science" and, as such, a symbol of state power.<sup>7</sup>

Another important aspect of global modeling is that it was based in a very particular social setting. Global computer models were traditionally associated with the small, closely knit teams that created them. As a result, this technology was tied to its producers: the majority of global computer models could not be easily reproduced or circulated through anonymous channels. Unlike computer hardware, the blueprints of which could be stolen through espionage, transferred internationally, and reproduced in another context, computer software for global modeling often had to be *coproduced* through *face-to-face* collaboration in order to be transferred. This is because the ability to run global models depended on almost tacit knowledge of particular systems, a feel of certain conditions under which the given machine would become unstable or tend to err in a certain direction. As a result, computer modeling platforms were disseminated through personal connections among the modelers.<sup>8</sup> Hence, the history of global modeling is also a story of the emergence and spread of particular informal groups of both scientists and policy makers. These informal groups of global modelers were probably too loose and ad hoc to be described as transnational communities, but, following Fleck, they certainly could be understood as distinct thought collectives, mobilized by their aim to produce a new type of science, global modeling.<sup>9</sup>

This chapter discusses several such thought collectives, which were both influential in the Soviet Union and active at the international level: these are the scientists based at the Computer Center and the Institute for Systems Research (VNIISI) of the All-Union Soviet Academy of Sciences in Moscow. Both the Computer Center and VNIISI were strongly anchored in international networks through the United Nations and IIASA. In what follows, I briefly review the origins of global modeling in the Soviet Union and the West. Then I proceed to describe the development of several international nodes, by which I mean ad hoc, temporary constellations of technology, scientists, and political rationales, which led to the East-West coproduction of the model of a new, long-term, and global future.

## **How to Join Capitalist and Communist Futures**

How could it be possible to accommodate capitalist and communist futures in one world model? Did the communist future not exclude a capitalist economy and society by default? In previous chapters I have outlined several strategies of depoliticizing the systems approach as an instrument of scientific governance. Here I propose a particular case of global modeling as an example of how a technology, which had been depoliticized, could continue having deeply political implications, undermining some of the foundations of the existing ideological systems. Global modeling belonged to a branch of exact science, based on mathematical methods and computer technology. It also built on universalism and global thinking, both of which have a long cultural and political history. But global modeling gave a particularly powerful form to the idea of global interconnectivity in the last three decades of the twentieth century. Although always highly specialized by being geared to particular sectors, global modeling relied on systems thinking, probing into deeper, unexpected changes resulting from the intertwining of industry, society, and the economy.

Earlier I discussed the role of scientific-technical revolution as a developmental discourse, recognized on both sides of the Iron Curtain as a driver of universal change that produced the new idea that the future could not be divided strictly into capitalist and communist camps.<sup>10</sup> Yet what brought the communist and capitalist regimes together was not even the shared understanding of the importance of the scientific-technical revolution per se, but the insight that economic growth, driven by the scientific-technical revolution, had complex global consequences. This became quite apparent in the changing Soviet discourses. In a somewhat

roundabout way the idea of a worldwide scientific-technical revolution significantly changed the meaning of “global” in Soviet scientific and policy thinking. If, as archival documents reveal, Soviet economists used the term “global models” to refer to models of the national economy in the 1960s, a decade later, in the 1970s, they used the term to refer to the world economy.<sup>11</sup> At the same time, Soviet international relations theorists used the word “globalism” to refer to US ambitions for world hegemony. Accordingly, the latter definition of “global” was charged with negative undertones in this context.<sup>12</sup> A completely different use of “global” emerged in Soviet geophysical sciences, where scholars used it to describe planetary processes as early as the 1950s. I suggest that it was through computer modeling that this geophysical notion of “global” eventually migrated into Soviet economic and, at a later stage, political discourses. The culmination of Soviet global thinking was reached in 1985 when the notion of “global problems” was used for the first time to describe world issues in the official documents of the Congress of the Communist Party.<sup>13</sup>

The emerging understanding of the global system as a phenomenon that was simultaneously natural-geophysical and man-made, a phenomenon that was undergoing a deep transformation following the scientific-technical revolution, was articulated and actively promoted by a new type of actor on the stage of world politics: international organizations. The first impetus to computerize planetary processes involving nature, economics, and population came from the Club of Rome, an organization established by Aurelio Peccei that joined members of state governments, industries, and academia hailing from both East and West.<sup>14</sup> In the early 1970s the Club of Rome commissioned the creation of a world model from American engineer Jay Forrester and a group of researchers directed by the young Dennis Meadows at the Massachusetts Institute of Technology.<sup>15</sup> Consisting of five interacting blocks of agriculture, natural resources, pollution, population, and capital, this model was used to demonstrate the strength of relations between these different sectors. The key goal was heuristic: to demonstrate that such relations existed and were strong, rather than to produce a reliable, detailed forecast of the future state of these sectors. In fact, the ambition to forecast world trends accurately was futile, not the least because of a lack of robust and detailed empirical data pertaining to all countries.<sup>16</sup> It is important to note that in Meadows’s model the long-term dimension emerged as an unintended side effect: this model extrapolated the possible development of world economic growth until it obtained an interesting result, namely, a dramatic decline of the world economy, population, and living standards in 2050. Thus, it was not the desire to know the future lying many decades afar that drove the modelers, but rather the long-term future emerged as a side effect of this heuristic experiment. The results, published in the report *The Limits to Growth* (1972), were used by the authors to argue

that the long-term effects of current economic growth had to be considered in order to avoid a future disaster: the collapse of the world economy because of rising population and pollution. If humanity wished to maintain its living standards in the future, the report suggested, the leading Western nations had to revise their consumption habits and accept the idea of no growth.<sup>17</sup>

How did the Soviet Union, struggling to “catch up with and overtake” the West, react to *The Limits to Growth*? First of all, this report did not take the Soviets by surprise, because through Gvishiani the Soviet government had a direct link with the academic and policy circles in which this study originated. Gvishiani first met Aurelio Peccei, then the head of Olivetti, during his business trip to Moscow in the early 1960s, and since then Gvishiani had interacted regularly with Peccei and Alexander King of the OECD to become a member of the Club of Rome.<sup>18</sup> This network was used to bring innovative ideas to the Soviet Union before they were made public in the West: Gvishiani, for instance, invited Forrester and Meadows to Moscow to present their world model to a group of leading Soviet scholars in computer science and modeling in the winter of 1970. East-West scholars also met to discuss the thesis and methodology that would be used in the report *The Limits to Growth* in a seminar organized in Italy, in 1971.<sup>19</sup>

The very organization of the visit of Forrester’s team to Moscow testified to the fact that the top Soviet research administrators were not only seriously interested in global modeling, but also willing to convey the importance of this approach to the Party elite: the American scientists were whizzed straight to the villa of the mayor of Moscow, where in an informal environment they briefed high Soviet officials, including Gvishiani and his protégé, the future head of global modeling at VNIISI, Viktor Gelovani.<sup>20</sup> Later events that followed the publication of *The Limits to Growth* and the subsequent controversy over its thesis of the risk of overpopulation, made it clear that the Soviets were able to differentiate between the fiercely Malthusian implication of *The Limits to Growth* and global modeling as a new type of technique for generating policy-relevant knowledge.

This dual approach was evident in the Russian translation of the report: the thesis of no growth was censored out of the Russian translation, whereas the author, Dennis Meadows, was warmly welcomed in the Soviet Union, which he visited more than twenty times to lecture on computer-based modeling in Moscow and a dozen other cities. Before the publication of *Limits*, Gvishiani initiated the translation of Forrester’s *Industrial Dynamics* (1961), which was published in Russian under the title *The Foundations of the Cybernetics of Firms* in 1971.<sup>21</sup> Gvishiani also supported the translation of *The Limits to Growth*, which was done at the Institute for Information on Social Sciences (INION). However, the Russian translation of *Limits* was distributed only in limited circles within the

Soviet Academy of Sciences and held in the tightly restricted special collections at the Lenin Library in Moscow.<sup>22</sup> Although some entrepreneurial individuals secretly copied the INION's translation of *The Limits to Growth* and sold these copies for 300 USD on the black market, the wider Soviet public had access only to the ideological commentaries on this report.<sup>23</sup>

In all, in the Soviet Union, just like in the West, *The Limits to Growth* was received with both fascination and skepticism. Although it has been described as the most criticized model ever, *The Limits to Growth* played an important role in opening up Soviet interest to a fundamentally new understanding of the parameters required for scientific governance. Both my respondents and published sources reveal the strong interest of Soviet scientists in developing the technique of global modeling and applying it to different policy areas, and inviting Western scholars to the Soviet bloc to raise the profile of this new, cutting-edge field. For instance, Mihajlo Mesarovic, a prominent American systems theorist and computer scientist of Serbian origin, the author of another global model also sponsored by the Club of Rome, presented his work at the House of Friendship in Moscow, the public forum from which many prominent Western scientists addressed Soviet audiences.<sup>24</sup> But the popularization of science was just one area; what interests me here are the developments which took place in less public institutional settings, equipped for hosting long-term collaborations between East and West scientists. In the next section I show how global modeling was developed at two international platforms of East-West interactions: IIASA and UN. Then I return to the developments inside the Soviet Union to discuss the consequences of these international interactions for the authoritarian, centralist governance.

## Global Modeling at IIASA

IIASA played a fundamental role in the development of global modeling thanks to its unique institutional design and scientific agenda for developing cutting-edge policy sciences. As I mentioned earlier, during the process of establishing IIASA, the trajectories of the future members of the Club of Rome and the US-Soviet negotiators often intersected: for instance, Peccei facilitated the meeting of Gvishiani, Bundy, and Zuckerman in 1968 and was involved, although not always directly, in the negotiations.<sup>25</sup> It is interesting, however, that this intertwining of the networks of the Club of Rome and the East-West institute turned out to be both an asset and a problem. Purely coincidentally, IIASA's charter was signed just a few months after the publication of *The Limits to Growth* in 1972. As the report's no-growth message was traveling around the globe causing controversy, some of the signatories grew extremely anxious that the public might

confuse IIASA and the Club of Rome, which would taint the reputation of the newly established institute. Indeed, some of IIASA's founding members were fiercely critical of the Forrester/Meadows model.<sup>26</sup> Zuckerman, for instance, argued that global problems should be faced "in a hopeful and scientific spirit and not in one of hysterical computerized gloom" in his address to the UN conference on the Human Environment in Stockholm in 1972.<sup>27</sup> MIT scholar Carl Kayesen, who was McBundy's right-hand man in the negotiations over IIASA, was similarly skeptical about Meadows's model, not least because it placed the crisis in the long-term horizon, whereas according to Kayesen focusing on the contemporary crisis would make more sense.<sup>28</sup> Even Gvishiani initially criticized *The Limits to Growth* at IIASA's council meetings.<sup>29</sup>

It is quite clear that in this context of ongoing controversy around the findings of the first global model, it was far from self-evident that IIASA should include global modeling in its research agenda. Some insisted that the newly born IIASA had to carefully build its scientific reputation and, consequently, avoid controversial projects. But many also realized that global modeling was a genuine innovation and therefore offered an opportunity to situate the institute at the forefront of science. The dilemma of whether to embrace global modeling at IIASA was finally resolved by Howard Raiffa. Following a suggestion by Tjalling Koopmans that IIASA could organize conferences on "global simulation," Raiffa proposed that instead of developing original global models, IIASA should become a clearing house for global modeling experiments undertaken in different countries.<sup>30</sup> Accordingly, methodological studies of "long-run global simulation" and a series of conferences on this topic were included in IIASA's research strategy for 1973.<sup>31</sup> Beginning in 1974 IIASA hosted six symposia on global modeling and, indeed, successfully profiled itself as the first platform for sustained international exchange in the area of global modeling.<sup>32</sup>

I suggest that IIASA's global modeling conferences played an important role in socializing scientists from East and West into a shared understanding of the possibilities, but also, importantly, the limitations of global modeling. First of all, global modeling was institutionalized as a "normal," albeit postpositivist science. In their internal discussions and published papers, scientists acknowledged that many of the projections generated by global models could not be verified by empirical experiments. Furthermore, the modelers recognized that modeling results were often messy and inconclusive, and many modelers, although not all, never attempted to hide the inconclusive character of their studies. Scientists, for example, agreed that precision was at best something to be aspired to, but could hardly ever be achieved. Although for a lay observer mathematical methods appeared to be precise, the complex calculations involved defied the notion of order, precision, and control: big numbers behaved chaotically and the data



produced by computer models were subject to random errors generated by the computer. Another peculiar feature of global modeling was the discrepancy between shortage of input data, which were often severely limited and imperfect, and overflow of output data. Indeed, computers would churn out such volumes of alternative calculations that further software filters had to be designed to figure out which results made sense and which did not.<sup>33</sup> As such, global modeling provided neither accuracy nor proof, but uncertainty.<sup>34</sup>

In this context, it turned out that particular social skills were necessary to be able to navigate this complex world of global modeling. For instance my interlocutor, a Russian mathematician, emphasized that a particularly high degree of “mathematical culture” was prerequisite to being able use a global computer model properly. According to this scientist, such a mathematical culture could not be learned from books, but could only be acquired from close and lengthy interaction in modeling teams.<sup>35</sup> It is doubtful that IIASA, where most scientists were visiting and the directors were appointed on temporary contracts, could ever become such a highbrow milieu of mathematical modeling, where sustained face-to-face contacts were paramount. However, IIASA could and did provide mathematicians from East and West with a unique place for encounters that led on to the development of cooperation outside IIASA (I return to this in subsequent chapters).

Discretion was another important quality that IIASA conferences could offer the emerging world community of computer modelers. Being an international, nongovernmental organization, IIASA could more easily position itself as immune to bias toward particular national or industrial interests. Printed sources and interviews alike underscore the importance of IIASA’s organizational culture of discretion, which enabled computer modelers from East and West to discuss quite politically unorthodox versions of the future development of economic, social, and even political systems. For example, in 1980 IIASA’s conference on global econometric modeling discussed possible implications of the Peoples’ Republics of Poland and Hungary joining the European Economic Community: a rather extraordinary example of an economic forecast that appeared to defy geopolitical dogmas and to question the notions of stagnant late state socialist governmental imagination.<sup>36</sup>

But discretion was highly important, not only for political, but also for commercial reasons. Scientists were anxious about the risk that their models in progress could be secretly copied, threatening their potential future income from commissions. However, complete discretion also posed a serious problem: without access to a model’s architecture, no outsider could tell whether a particular model really worked, that is, if a model had an internal dynamic in which inputs did not straightforwardly determine outputs. Indeed, the history of modeling

shows that the refusal to disclose the internal architecture of computer models ultimately jeopardized their authority.<sup>37</sup> As I show in this and subsequent chapters, the success of computer-based modeling as a policy tool depended on carefully managed transparency, a condition that had deep implications for the Cold War divide.

## Global Modeling at the UN

Whereas IIASA offered a place for scientists to discuss their global models in a discrete environment, where the informal exchange of ideas and mutual scrutiny behind closed doors was made possible, UN agencies operated on rather different principles. Based on governmental membership, UN agencies could not offer the same level of discretion and informality (since IIASA's members were not governments, but academic organizations). Nevertheless, the global modeling pursued at UN agencies was significant, because the UN had a particularly important mandate to collect and share data from all countries. Even in this large organization, the importance of personal contacts and, to a more limited extent, face-to-face cooperation, was paramount. This is exemplified in the efforts to develop computer models of the world economy under the aegis of the UN.

Of course, the UN was not the first to take an interest in the world economic system. It has to be recalled that the institutionalization of mathematical modeling in economics dates back to 1930, when the Econometric Society was established by Ragnar Frisch in the United States. However, these early models were mainly theoretical exercises, and econometricians began to fill their models with data only after World War II. As mentioned earlier, in 1961 the UN began promoting long-term economic planning based on new computer technologies. In 1965 the UN acquired its first mainframe computer and from about that time began organizing a series of econometric conferences. To meet its needs for international data calculation, the UN established its International Computing Center in 1971.<sup>38</sup>

Initially the United Nations supported econometric research as part of their worldwide development program, the rationale for which was initially shaped in line with modernization theory. According to this view, third-world countries should imitate Western standards and implement Western economic structures. At a later stage the UN's developmental agenda was widened to include environmental issues, because they were proved to have a strong link with economic growth in *The Limits to Growth*. Thus, following the ground-breaking publication of *Limits*, in 1973 the UN initiated a study of the interrelationships between growth, resources, pollution, and abatement policies.<sup>39</sup> For my argument it is

important that it was this coupling of the economy and the environment that justified the inclusion of communist and capitalist regimes into a single modeling system: the geophysics of the Earth did not observe national boundaries or ideological divides, and computer modelers had little choice but to respect this, if they wished their models to make sense.

In this context the key Soviet organization to liaise with the UN's program for the planning of world development was the Central Institute for Mathematical Economics (TsEMI) at the Soviet Academy of Sciences in Moscow. Established in 1963 and directed by Nikolai Fedorenko (also a member of the Club of Rome), TsEMI enjoyed limited scientific autonomy in the Soviet empire of science and actively sought to link to the most prominent research milieus in West.<sup>40</sup> Hence in 1965 Fedorenko attended the first econometrics congress in Rome at the invitation of Wassily Leontief;<sup>41</sup> TsEMI was also involved in the Copenhagen conference on long-term economic planning, organized by the UN Economic Commission for Europe in 1966.<sup>42</sup> Archival materials show that TsEMI regularly corresponded and exchanged publications with such pioneering modelers of long-term scenarios as Ragnar Frisch, Jan Tinbergen, and Richard Stone during the 1960s.<sup>43</sup>

Here the key actor was Wassily Leontief, who could be fairly described as a tireless mediator between the emerging communities of Western and Soviet econometricians, although, as the reader may remember, Leontief was asked to refrain from assuming an active role in the negotiations around the East-West institute in the late 1960s. A recipient of the Nobel Prize for his method of calculating interbranch balance in 1973, Leontief was born into a well-off family of Russian industrialists and academics in 1909 and grew up in Saint Petersburg, where he witnessed the October Revolution unfold literally before his eyes.<sup>44</sup> Leontief left Russia in 1925 to return for the first time in 1959. At the beginning of his exile he worked at the University of Kiel in Germany, one of the first institutions in Europe to study the world economy. In the 1930s Leontief was invited to advise the Chinese government on developing its railway infrastructure. It was during his long trip to China and back that he first encountered the third world. In 1931 he was invited to join the US National Bureau of Economic Research and soon thereafter became a professor at Harvard. Leontief first presented his theory of systems dynamics to the military in Washington; in 1948–1949 his empirical input-output studies were funded by the Rockefeller and the Ford foundations under the Harvard Economic Research Project.<sup>45</sup> Leontief's mathematical skills, his life experience, and his proximity to government agencies made him a rather unusual nonacademic economist, who was keenly interested in the development of large-scale and long-term models.

It was during de-Stalinization that Leontief's work entered the Soviet space to later become a standard reference in Soviet global thinking.<sup>46</sup> First banned by

Stalin, mathematical methods in economics were rehabilitated thanks to the efforts of the mathematician Vasili Nemchinov in the mid-1950s. Although input-output methods were developed by Leonid Kantorovich as early as in the 1930s, historians suggest that it was Leontief's pupil, the Polish economist Oskar Lange, who also disagreed with Hayek, claiming that it was possible to apply a neoclassical economic model to a centrally commanded economy, and thus inspired the Soviets to introduce input-output methods to calculate their economic plans.<sup>47</sup> In turn, in 1959 Leontief was officially invited to Moscow, a visit which he described in his memoir as unsatisfactory, his impression being that the Soviet economists whom he met were not mathematically competent: reportedly, Soviet economists presented to Leontief examples of the application of his own methods which unfortunately contained many mistakes. However, following this visit Leontief began vigorously building East-West links: he established and chaired the US-Soviet Statistics Bureau in Cambridge, Massachusetts, where many young Soviet administrators were subsequently trained.<sup>48</sup> In this context, it is not surprising that it was Leontief, so well personally integrated in East-West networks, who was commissioned to direct the first study of the world economy for the UN.

At the request of the UN Center for Development Planning, Forecasting and Policies, Leontief created the first world trade balance model, the results of which were reported in *The Future of the World Economy* (1976). One of his coauthors was Stanislav Men'shikov, a Russian economist who would later feed the data gathered for Leontief's report to the information-starved economists in Moscow. The data, typically, did not flow easily in the opposite direction: Leontief's report did not list any Soviet sources.

Outlining scenarios for world development for the next twenty-five years, *The Future of the World Economy* tread carefully on the terrain of Cold War political divisions. First, the rationale for making such a model was motivated by environmental concerns, deemed to be globally relevant and universal to all countries irrespective of their political ideologies. The structure of the model was primarily economic, as it built on investment and trade flows, but it was precisely because of the environmental effects of economic growth, argued Leontief, that the introduction of a long-term perspective into the study of economic development was necessary.<sup>49</sup> Second, the political implications of Leontief's analysis were carefully managed. For instance, the finding was that the developing countries could not narrow down the income gap between them and developed countries by the year 2000 without additional and significant foreign investment. As such a statement would have placed direct responsibility on Western governments, it was therefore regarded as politically controversial by the UN; in the end this finding was only left implicit in the report.<sup>50</sup> Third, Leontief employed several ways to depoliticize the very conceptual structure of his model of the world economy.

For instance, the model elaborated on possible changes in internal economic structures in developing countries, but no change at all was modeled for the communist regions. Then world regions were defined according to their economic-administrative system and geographical features. Hence the Soviet Union and Eastern Europe were called “developed centrally planned regions”; meanwhile Western Europe was split into high- and medium-income regions.<sup>51</sup> As a result, Leontief’s model, on the one hand, erased the communist and capitalist divide from the future of the world economy and, on the other hand, conserved the political status quo by refusing to model any possible changes within the communist system.

## Modeling Soviet Decline

Both Meadows’s and Leontief’s models grew out of attempts to clarify the possibilities of economic development and its consequences for the environment from a long-term perspective. Although these models used new computer technologies, the concern with the environment obviously was not a novelty in itself. In Soviet Russia an important role was played by the Russian intellectual tradition, which was particularly conducive to the emerging global environmentalist thinking. Indeed, the Soviet intellectual interest in modeling global processes predated both Meadows’s and Leontief’s studies, because it stemmed from prewar thinking, in particular from Vladimir Vernadskii’s theory of the biosphere/noosphere, formulated in the 1930s.<sup>52</sup> Beginning in the 1960s Vernadskii’s thought was promoted by the prominent Soviet biologist Nikolai Timofeev-Resovskii and the equally prominent mathematician and research director of the Soviet Academy of Sciences’ Computer Center in Moscow, Nikita Moiseev.<sup>53</sup>

As in Western scholarship, Soviet efforts at global modeling oscillated between the poles of economy and geophysics. Under Moiseev the Moscow Computer Center became the center of geophysical modeling, with a particular focus on climate and ecological systems. The center also focused on interaction between the economy and the environment, with a particular interest in systemic breakdown, which was directly inspired by *The Limits to Growth*, as it was discussed at Moiseev’s seminars.<sup>54</sup> Moiseev himself was first introduced to the *global problematique* of the Club of Rome by the prominent Canadian economist of Russian origin Paul Medow, who lectured on Forrester’s model at the center in the early 1970s. Medow, in turn, invited Moiseev to take part in a meeting organized by the Club of Rome and RAND.<sup>55</sup> In all, global modeling at the Moscow Computer Center evolved at the interstices of cutting-edge scholarship, where disciplinary boundaries were negotiated in relation to both intel-

lectual and pragmatic rationales, all of which, as I show later, underpinned intense forging of transnational networks.

Just like his Western colleagues, Moiseev found Forrester's and Meadows's world models mathematically imperfect and limited in their conceptual structure. According to Moiseev, the world models were not useful at all as tools for policy decision making, because they dealt with highly aggregated numbers. In addition, Moiseev was generally skeptical about the use of modeling in economic planning. This skepticism was rooted in his hands-on experience with the development of statistical variables for social and economic indicators at Gosplan, where Moiseev became convinced that socioeconomic processes are simply too complex to be translated into statistical language, not the least because different governmental agencies attributed different meaning to the same phenomena. The internal departmental infighting that he witnessed at Gosplan also put off Moiseev from economic modeling.<sup>56</sup> However, understanding that economic utility was a strong argument that could be used to obtain governmental funding for global modeling, Moiseev did compromise, contending that global economic models could be created in principle, but only on the basis of "proper" geophysical modeling. In any case, Moiseev's position remained firm, arguing that if natural processes were not properly understood and represented, it was pointless to model the economy, as it was dependent on natural resources.<sup>57</sup>

A rather different approach to global modeling emerged at the Institute for Systems Research (VNIISI), which listed global modeling as one of its research priorities. VNIISI's global modeling program was directed by another Georgian, Viktor Gelovani, who established a close personal link with Dennis Meadows. If the Moscow Computer Center made a major contribution to the field of geophysical modeling, VNIISI innovated global economic modeling in the Soviet context.<sup>58</sup> Both the Moscow Computer Center and VNIISI cooperated closely with IIASA and the UN, where both Gvishiani and Moiseev played important personal roles.<sup>59</sup> Whereas Gvishiani was the director of VNIISI from 1976 to 1992 and vice director of IIASA from 1972 to 1987, Moiseev was involved in launching the water project at IIASA and organizing the center's participation in the major UNESCO program "Man and Biosphere," which launched an ambitious international study of the intertwining man-made and natural systems on the planetary level. In consequence, Gvishiani's and Moiseev's networks intertwined: for example, Moiseev's group presented a paper on computer-based modeling and the idea of the noosphere at the ninth IIASA conference on global modeling in 1981,<sup>60</sup> also the Balaton Group at IIASA was established jointly by Meadows and Gelovani in 1982 and included junior scientists from the Moscow Computer Center.<sup>61</sup>

Internal Soviet institutional competition apart, an important feature of the East-West exchange in global modeling was building horizontal, transnational

relations between strong scientific milieus. Here, interestingly, global modelers were not on a quest for originality. The development of Soviet world models could be compared to a creative bricolage rather than to creation *ex nihilo*. For example, in an interview, a Russian mathematician involved in the development of one of the first global models stressed that his team did not strive to compete for originality; on the contrary, they found it perfectly acceptable and purely expedient to borrow existing models created by Western scientists. Remember, the first computer-based world model simulating the interaction between the ocean and atmosphere was developed by American scientists Syukuro Manabe and Kirk Bryan in 1972. Somewhat later the Soviets began developing their own geophysical global models, adjusting Western models to local research goals and computer equipment, namely, the center's BESM-6.<sup>62</sup>

In 1977 the Moscow Computer Center launched a research program to build a world ocean-atmosphere model suitable for environmental analysis; this model was completed in 1982.<sup>63</sup> The center borrowed a global circulation model created by Yale Mintz and Akio Arakawa at the University of California Los Angeles, later improved by Lawrence Gates, first at RAND (1971) and later at the University of Oregon (1978).<sup>64</sup> Well anchored in Soviet networks, Gates did not mind giving his model to the Soviets and even proposed sending two American scientists to Moscow to help adjust the model to the BESM-6.<sup>65</sup> Indeed, not only models, but also data were shared: the Moscow Computer Center received atmospheric data from the Norwegian Meteorological Center.<sup>66</sup>

The conceptual rationale of Soviet global models echoed the concerns of *The Limits to Growth*, but extended them further with an aim to reconceptualize the role of humanity on Earth. Thus, Moiseev envisioned an integrated model of the biosphere, coding the natural, socioeconomic, and cognitive environments into one modeling system, which would ideally allow the study of "large scale effects of anthropogenic activities."<sup>67</sup> This model simulated interconnections among global climate, the ecology, and economic systems, aiming to identify the conditions under which environmental change would set boundaries for economic development.<sup>68</sup> As mentioned above, the economy was of secondary interest for Moiseev's group: this model, involving land, ocean, and atmosphere blocks, was first used to simulate CO<sub>2</sub> emissions and climate change in the early 1980s. Another aspect illustrating the difference and possibly some rift between Moiseev's and Gelovani's teams is that the Moscow Computer Center's global model was created independently of IIASA: the center's scientists did not participate in IIASA's global modeling conferences, instead fostering their own, direct links with the leading American atmosphere modelers.<sup>69</sup> The center's cooperation with IIASA would intensify only in the 1980s, when it became clear that even geophysical global models could lead to the formulation of innovative

political and policy ideas.<sup>70</sup> Here the most prominent study was the examination of the environmental effects of a nuclear war, leading to the hypothesis of global nuclear winter, discussed in detail in chapter 6.

The effect of global modeling efforts at VNIISI was quite different but no less significant. If global modelers at the Moscow Computer Center first and foremost developed their models as heuristic tools for gaining new scientific knowledge about geophysical systems, VNIISI sought to generate policy-relevant knowledge. Global modeling was a prominent part of VNIISI's research agenda from its establishment in June 1976: the first report of annual activities included the development of a conceptual framework for global modeling.<sup>71</sup> VNIISI was exceptionally well positioned to tap into international science, because it was created to be the Soviet counterpart of IIASA and as such was effectively in charge of many administrative duties in relation to the Soviet membership. Claiming that the Eastern Bloc lagged behind the West in global modeling, the institute's purpose was to catch up with the West by developing interdisciplinary research on large-scale, complex, and global problems. It should be added that the modeling of global development at VNIISI was also based on Marxist-Leninist principles.<sup>72</sup>

Patronized by Gvishiani, VNIISI was safeguarded from political volatility and had a direct link to the very heart of Soviet power. For instance, in 1977 a high-level meeting of global modelers, including members of the Club of Rome, was organized in Moscow, which five members of the Politburo, the *de facto* highest decision-making body in the Soviet government, attended.<sup>73</sup> The global modeling program at VNIISI was cochaired by Gvishiani himself and applied mathematician Viktor Gelovani.<sup>74</sup> This global modeling group stemmed from a GKNT team for operations research, involved in creating complex models of world development.<sup>75</sup> This team also included a prominent scientist, Sergei Dubovskii, with modeling experience from the highly esteemed Institute for Control Sciences. These and other scholars who later shaped the core of VNIISI were closely involved in the formation of IIASA's research agenda from 1972 on.<sup>76</sup> In the context of Soviet academia, VNIISI was an important, large, and well-funded organization. Unlike IIASA, which never hosted more than a hundred scholars at a time, and in the true spirit of a Soviet organization, VNIISI employed more than three hundred staff and grew to almost seven hundred by the late 1980s.<sup>77</sup> The institute was well provided with a large building and its technical equipment was more than adequate: VNIISI modelers used PDP-11/70, an American computer.<sup>78</sup>

The principal task of VNIISI was to forecast the development of countries and regions over a twenty- to thirty-year period.<sup>79</sup> The idea of forecasting social and economic development up to the year 2000 stemmed from the work of the US Commission for the Year 2000.<sup>80</sup> Such forecasts were made in the Soviet Union in the 1960s, although most of them were kept secret. A glimpse at the archives



and memoirs reveals a much more complex and diverse landscape of Soviet scientific expertise than previously thought: at VNIISI, scientists looked further ahead to test the impact of globally significant changes on the Soviet Union. For instance, the first global dynamics model developed at VNIISI forecasted the impact of the arms race on the Chinese economy. The model showed that increased investment in defense would devastate the Chinese economy; accordingly, the scientists concluded that China was not likely to embark on military expansion, suggesting that the Soviet government did not have to invest to counteract Chinese military growth. Ironically, this model used the existing intelligence data on China, but could not model any nuanced impact on the Soviet Union, because Gosplan refused access to the Soviet data.<sup>81</sup>

Nevertheless, other studies attempted to explore the development of the Soviet economy as part of global dynamics. In 1981 VNIISI had a model that consisted of three blocks representing the United States, Japan, and China; in 1983 this model was expanded to include the communist bloc. Unlike Leontief's model for the UN, which did not divide the world according to nations or political regimes, VNIISI's model divided the world along political allegiances into nine blocks: the Soviet Union, the Eastern European bloc, the European community, the United States, China (which was of growing concern to the communist leaders), Japan, "other capitalist countries," then OPEC countries and developing countries. The sectors this model included were demography, trade, energy resources, the environment, and climate.

However, just as before, Gosplan was not forthcoming with Soviet economic data; only highly aggregated statistics were available, which were not suitable for the forecast. What did VNIISI modelers do? They turned to their personal, transnational contacts to solve this data gap. The key was Leontief's above-mentioned colleague, Russian economist Stanislav Men'shikov, the vice director and then director of the UN Department of Prognosis, Planning and Development, 1974–1980.<sup>82</sup> This cooperation built on strikingly intertwined sociotechnical networks, which joined machines, organizations, and individuals: Men'shikov worked with Leontief on the UN's world economy model. Furthermore, Leontief's world economy model was computed at the Feldberg Computer Center on a PDP-10, the same type of machine used by VNIISI.<sup>83</sup> Then, IIASA provided the data about global markets to VNIISI scientists.<sup>84</sup> Indeed, the Russian scholars interviewed recalled that they could easily obtain CIA reports on the Soviet economy, industry, and society, but not the data from Goskomstat, the Russian state statistics service.<sup>85</sup> This work resulted in a gargantuan modeling system joining 47 models of subsystems, 4,700 averaged points, and 5,000 variables, and based on the quantification of 370,000 empirical observations. On this basis the world system and Soviet development was projected for the next twenty years.<sup>86</sup>

It should be clear by now that for Soviet scientists to model such long-term projections they needed to be able to leave the isolation of a computer laboratory and engage in highly heterogeneous practices, such as communication across different disciplines, forging social and political alliances, continuously probing the limits of mathematical methods. These efforts, however, were not limited to satisfying pure scientific curiosity, but were, instead, mobilized to criticize the status quo of the Soviet society: Soviet scientists used long-term projections to reveal current problems that the Soviet Union faced, but which could not be easily introduced into public debate, as they undermined the official ideology of victorious communism. Long-term projections into the future, meanwhile, constituted an important rhetorical resource to articulate the present problems, the authorship of criticism belonging as much to the machine as to scientists.

Thus VNIISI scientists reported to Prime Minister Kosygin and, later, Nikolai Tikhonov, in 1979, 1982, and 1984, each time demonstrating that the growth of the Soviet economy would sharply decline in the future unless the Soviet government greatly upped investment in research and development.<sup>87</sup> This was not a trivial warning. Indeed, very few communist scientists dared to model the deceleration or, worse, stagnation of the Soviet economy. For instance, TsEMI's director retrospectively wrote that he "just could not accept" even as a hypothesis the zero-growth option proposed by Meadows's report.<sup>88</sup> In turn, the hypothesis of zero growth was censored out of the Russian translation of *The Limits to Growth*.<sup>89</sup> Yet there was some, albeit limited, space for Soviet scientists to offer negative feedback to the government. A well-known example is that of the Russian economist Gregory Khanin, who repeatedly wrote letters to the Central Committee reporting his own estimates of the future Soviet economy, which were much lower than the official figures.<sup>90</sup>

Whereas Khanin was tolerated and, probably, ignored, other scientists were less fortunate: for instance, the East German scientist Wolfgang Harich calculated a version of nongrowth communism, for which he faced serious repercussions.<sup>91</sup> Another example of a reaction to economic forecasts showing the decline of Soviet economic power involves IIASA's project on modeling economic growth, directed by the West German economist Wilhelm Krelle. Dissatisfied with Krelle's results, several Russian scholars complained that it was "a big mistake" to show that the impact of the Soviet Union on world economic development was minor. Had Krelle used the official Soviet forecast for the year 2000, wrote the disappointed scholars, the global role of Soviet trade would have appeared to be much more significant.<sup>92</sup> This was still a mild criticism; Soviet modelers knew that they were walking a fine line of permissibility: according to my interlocutors, VNIISI scientists did fear repression and this is why the scenario of the collapse of the Soviet Union was not tested at all.<sup>93</sup>

Furthermore, the process of developing the VNIISI model of the future Soviet economy revealed a deep internal split among the scientists involved, who disagreed about the actual purpose of long-term analysis. One scientist involved in this project told me that several VNIISI economists involved in the development of this model simply refused to believe that the modelers seriously expected to produce unanticipated results. Well-drilled in the communist planning system, these economists assumed that the modeling exercise was merely a ritual, an attempt to create “a mechanical proof” for plan targets specified in the Party directives. Others were anxious that their results might be understood as a criticism of the standard of Soviet life, so demographers simply refused to take into account the influence of the quality of life on birth rates.<sup>94</sup> The final report was also auto-censored: it is very likely that the curve pointing out the decline of Soviet growth from 4.5 percent in 1980 to 2.1 percent in 2000 was also a cautiously selected one. Indeed, this curve was diplomatically accompanied by another curve, which showed that US growth would slow down even more.

Nevertheless, it is clear that some Soviet modelers regarded their task as a serious and genuine contribution to policy making by “speaking truth to power,” to quote Aaron Wildavsky, and not just a mere ritual. They also sought to make their study public. In 1984 this VNIISI modeling exercise was described in a report titled *On the Threshold of the Millennium: The Global Problems and Development Processes in the USSR*; the following year some of the results were published in VNIISI proceedings. However, General Directorate for the Protection of State Secrets in the Press (Glavlit) requested that most of the information concerning the Soviet Union be removed in order to make the results suitable for a wide audience.<sup>95</sup> Whereas Soviet censorship found it acceptable to publish studies on the complete extinction of Soviet citizens during a nuclear winter (discussed in the next chapter), it refused to release a forecast of the slowing down of Soviet economic growth from an optimistic 5 percent to what was considered a meager 2 percent.

On the basis of these examples I argue that although there were pretty clear boundaries to the criticism of the Soviet regime, some Soviet global modelers persistently tried to push them. Soviet scientists used a sophisticated tool, computer-based global modeling, as a vehicle to criticize the existing Soviet economic policy by showing its imminent failure to the Politburo. In this way, the long-term projections, I suggest, enabled new kinds of criticism before the new policy of openness or *glasnost*’ launched by Mikhail Gorbachev in 1987.

For the Soviets, the struggle for the long term was inevitably a struggle for access to models, data, and computers. It is difficult to overestimate the role that the scientific methodology of global modeling played in international cooperation. No global model could run without empirical data. No national model of

natural or economic systems could be realistic if it was decoupled from global processes. Nothing clashed harder with the Soviet bureaucracy, pervaded with secrecy and compartmentalization, than the idea of the unrestricted international circulation of data. Here the modeling of geophysical processes and studies of the environment offered Soviet scientists some room to maneuver and formulate different versions of the Soviet future. If in the decades from 1960 through the 1980s hardly any Soviet demographic statistics were available, as Gosplan would not disclose the population mortality rates from the 1930s to the 1940s,<sup>96</sup> the data on the atmosphere and the ocean could be circulated more easily, which explains the Moscow Computer Center's focus on geophysical global models. But then models and data were coproduced: for instance, global models required new kinds of data drawn from specially conducted experiments, because, for example, nitrogen reactions were different in Siberia and Latin America. The modeling itself was not easy to replicate: without direct, face-to-face communication, wrote Moiseev, sophisticated mathematical models could never become "real."<sup>97</sup>

It is clear that global modeling was both an instrument of knowledge and a symbol of power: for the Soviet government global modeling was part of the struggle for superpower status. Soviet scientists aspired to use big computers to project large sets of data over a long-term and long-range world future and to do this just as well as US scientists. Brimming with political prestige, global modeling served as an important source of authority for Soviet scientists, who wished to innovate not only in science, but also in policy making. And they were innovative: global modeling posed deep challenges to the secrecy and compartmentalization of Soviet scientific expertise. In this chapter I showed that the development of global modeling required international, face-to-face cooperation to coproduce both the models and data. Responding to this, the Soviet government eventually began to release control over small communities of modelers, which remained at arm's length from central power. This was the case when a new scientific epistemology and technical infrastructure led to a major sociopolitical change, albeit limited to highly professional groups and, in the Soviet Union, rather narrow institutional contexts, yet vitally important for the incremental transformation of Soviet governmentality. Second, global models made visible—through graphs, maps, and statistical curves—different, unexpected, and negative consequences of long-term developments. In some areas, such as environmental or global economic trends, this long-term, global future was actively portrayed as politically neutral, because it affected all countries included in the model. It is highly significant that Soviet scientists used references to such a politically neutralized global future to criticize contemporary Soviet realities.

I want to stress that global modeling drove a deep, epistemological transformation of the notions of knowledge, certainty, and control in the computer-based Soviet governmentality. I have already suggested that the impact of the epistemology of computer modeling on government was not limited to what Donald MacKenzie calls the mechanization of proof, where computers are used to verify software and generate trust. Rather, Soviet discussions about the methodology of global computer-based modeling articulated and disseminated a nondeterminist worldview, in which a great many areas of nature and human activity were understood as probabilistic or even purely uncertain.<sup>98</sup> Computer models, in other words, were used as a safe medium in which to challenge the Soviet government's belief in control. In turn, a long-term perspective was used to challenge present decisions and trends. In this way, instead of producing certainty, global computer models time and again reminded officials of the boundaries of human knowledge and knowledge-based control.

Global modeling, in this way, permitted a different way of relating to the future of Soviet society. Although Soviet scientists cautiously avoided direct challenges to the ideological dogma of the superiority of the communist system, the uniqueness of the communist system was simply made redundant. The ideological differences simply did not matter. By the early 1980s the concern with global problems as the metabolism between humans and the biosphere, something which was beyond the Cold War struggle for global hegemony, became legitimate and central in the Soviet Union.<sup>99</sup> This globalist, environmental discourse slowly but steadily accumulated power as the key framework for economic development strategies and, in so doing, as a Russian historian of science Dmitrii Efremenko notes, the global environmental agenda ran parallel to and only rarely intersected with Marxist-Leninist political economy.<sup>100</sup> The focus on long-term global and environmental processes enabled Soviet scholars and policy makers to point out that the Soviet economy and society also had serious problems, which were of a universal and global character and which could not be resolved internally.

Moiseev was especially pointed on this, claiming as early as the 1970s that there was a need to focus on new problems in order to prepare for the new world of advancing computer technologies.<sup>101</sup> We should not dismiss this call as trivial rhetoric: it was, indeed, a smart way of suggesting that the Soviet system was stuck in solving its old problems. To suggest changing the whole system, built on politicized central planning and animosity to the West, would be a claim too revolutionary even for a Soviet scholar as independent-minded as Moiseev. Instead, he suggested turning to new problems, ones of global and long-term character. The attempt to solve these new problems could and did transform the Soviet system.

Most importantly, global models were constitutive to the emerging understanding of the global future as a truly interdependent phenomenon. The dis-

course of interdependence became a new diplomatic language of a non-zero-sum game. For instance, the GKNT's head of foreign relations would assure his Japanese visitors that the Soviets understood the world "as a system of partners," where "when the system as a whole wins, each partner wins."<sup>102</sup> Deeds, unsurprisingly, did not always follow from the words: Soviet statistical agencies regularly refused to provide data to either Soviet or Western scientists.<sup>103</sup> In spite of these difficulties, the impact of Soviet global modeling on sociopolitical change should not be underestimated, as it was, to use Brian Wynne's words, "more than its final results." Thus in the next chapters I discuss several cases in which global and computer-based modeling was transformed from a mere instrument, producing policy-relevant data, into a large enterprise of "policy argumentation."<sup>104</sup>