Science, Modernity, and the Making of China's One-Child Policy

SUSAN GREENHALGH

CHINA'S ONE-CHILD-PER-COUPLE POLICY represents an extraordinary attempt to engineer national wealth, power, and global standing by drastically braking population growth. Since its introduction in 1979–80, officials claim, the policy has averted over 300 million births, with profound effects on virtually every aspect of Chinese life.[1] Outside China the policy has attracted acute attention from a world surprised by the fall in fertility to subreplacement levels and troubled by the human costs incurred in the process.[2]

Yet despite the policy's external notoriety and internal might, its origins remain shrouded in mystery.[3] Where did the idea come from of restricting all the couples in a country of 1 billion to one child? What made such a radical idea thinkable? Such questions have rarely been posed, let alone satisfactorily answered.

In the absence of scholarly research on these matters, in the United States public discourse about the policy has been shaped by larger strands in American political discourse, in particular anticommunism and the right-to-life position in the abortion debate. Throughout the 1980s and 1990s, powerful media images of coerced abortions, family planning jails, orphanage dying rooms, and much more gave fresh life to Cold War notions of China as "totalitarian Other," the foil to the "democratic West." In America China is all too often seen through binaristic East–West lenses that make it different from, and always less than, the United States (poor not rich, backward not modern, unfree not free, superstitious not scientific) (e.g., Zhang 1998). These Othering practices, while worrying in themselves, are also problematic because they have a broad range of political, cultural, and intellectual effects that generally go unnoticed. The pervasive discourse on China as intellectually backward and politically repressive, for example, has contributed to a view of the one-child policy as a product of China's (restrictive) politics, not its (weak) science.

In China itself, however, the one-child policy is not about a strong state or its coercive practices (although the use of coercion has been hotly debated). It is about the nation's dreams for achieving wealth, modernity, and global power through selective absorption of Western science and technology. Scholarship on the making of modern society highlights the connections between population, science, and prosperity, posing fresh questions about the scientific origins of modern projects of population governance. In his seminal essay on Western modernity, *History of Sexuality*, the French philosopher and social critic Michel Foucault drew attention to the role of population science in constructing population as an object of scientific discourse and in working with institutionalized political power to govern population so as to enhance human welfare, order, and utility, especially for the developing capitalist economy (Foucault 1978: 91–108). Social studies of science and technology have shown that science is humanly constructed in historically contingent contexts (Latour and Woolgar 1979; Latour 1987; Lynch and Woolgar 1990; Pickering 1992, 1995). This work emphasizes the human values and biases that shape the practices labeled "science"; the active role of scientists in creating their formulations and advancing them through the use of rhetorical devices; and the role of the larger historical and political context in shaping the science that gets made (Latour and Woolgar 1979; Lynch and Woolgar 1990). Work on governmentality—the combination of governing and political rationality—has shed light on the crucial role of governmental rationalities such as problematizations in the formulating of governmental policies and programs (Foucault 1991; Burchell, Gordon, and Miller 1991; Rose 1999; Dean 1999; Rabinow 2002). This work suggests that problematizations—that is, particular formulations of the population problem at hand, together with its solution—do not simply reflect a preexisting reality. Instead, they actively constitute a new demographic and policy reality by shaping what is thinkable in the domain of population.[4] These bodies of research allow us to ask new questions about the Chinese case. What was the role of Chinese population science in the making of the one-child policy? Where did the particular problems and solutions adopted come from? How and how much did the values of the scientists and the specificities of the historical context shape the science and policy that got made?

In this article and the book in progress on which it draws, I look closely at the role of population science in the making of China's one-child-per-couple policy.[5] Drawing on more than 15 years of interviews with Chinese population specialists and policymakers, documentary research on the history of Chinese population science and policy, and ethnographic insights gathered over many years of working with Chinese specialists as research collaborator, coauthor, co-panelist, and so forth, I wed the ethnographic approach of anthropology to the deconstructive approaches of work in sci-

ence and governmentality studies to see how the scientific, and especially numerical, construction of population by population scientists became a new mode of governing population size and growth, and a constitutive feature of Chinese modernity. The project focuses on the years 1978–83. It was then, just after the historic third plenum of the party's Eleventh Central Committee shifted the nation's focus to socialist modernization, that population became a crucial object of Chinese science and a sustained object of Chinese governance. In those six years, population science was reborn, the one-child policy was created, and that policy was strictly enforced in a massive sterilization campaign whose unanticipated political and bodily effects were so harmful to China's rural people and so intolerable to China's leaders that the policy and its enforcement were significantly revamped (Greenhalgh 1986). In this article, I delve into one critical slice of this larger story: the scientific construction of China's population problem and its optimal policy solution.

Some parts of this story have been told by H. Yuan Tien, especially in his blow-by-blow account of the development of population science and policymaking in *China's Strategic Demographic Initiative* (Tien 1991; also 1981). Tien's work includes many details of the policymaking process during the late 1970s and some speculative insights about the underlying dynamics. With a much longer period of interviewing and a deeper level of involvement with Chinese specialists, I am able to fill out the story with information not available to Tien. More importantly, by writing here from a dual position—as (distanced) participant in the scientific process hoping to shape its thinking, and as observer of Chinese demography reflexively charting its evolution—I present a very different perspective on the nature of population science and the relationship between science and politics. Tien's approach is the conventional one that sees a sharp divide between science and politics, and views science and numbers as conveyers of "the truth." (He writes, for example, that the "vicissitudes of politics...cannot alter the precepts of knowledge" and that "the demographic education of China's political leaders...was a long-drawn[-out] affair" [Tien 1981: 696; 1991: 85].) Following work in science studies, I maintain that because science is humanly made and because population science is closely connected to population policymaking, Chinese population science—like all population sciences—is not detached from, but linked to and in varying degrees shaped by politics. A sharp distinction between the two domains is hard to sustain. I also contend that the numbers of science tell a truth, but it is only one truth. That is because the numbers are created by particular human beings working in specific historical contexts, and both the people and the context leave their imprints on the science that gets made.

I will argue that at the heart of China's post-1979 population policy lie two powerful notions: that China faced a population crisis that was sabotag-

ing the nation's modernization, and that the one-child policy was the only solution to it. In China for most of the past 20-plus years, these ideas have had the status of self-evident truth.[6] I question those apparent truths by looking at how they were constructed. I show that these ideas about China's population problem and its ideal solution were actively fabricated by Chinese population scientists, using numbers, numerical pictures (such as tables and graphs), and numerical techniques (such as projections) to tell a particular story about China. In contrast to the coercion account, which points the finger at "communist coercion," this close look at the actual making of the policy reveals instead that practically all the key ideas on which China's one-child policy was based were borrowed from the West, and from Western science at that.[7] The borrowers were a handful of natural scientists who defeated the social scientists in a major struggle for policy influence. The natural scientists' ideas got built into official policy, leaving China with a policy that may have restrained population growth, but did so at great human cost. Those numerical facts about China's population and the rhetorics of science, modernity, and truth in which they came packaged also performed important political work. The numbers masked the sometimes weak scientific procedures and always complicated politics that tied the science to the political center, enclosing everything in a black box that got labeled "science" and then was closed to further inquiry. Even today, interviews with many Chinese scholars suggest, the foundational science that lay behind the one-child policy remains largely unquestioned and unquestionable.

Despite the sensitivity of these matters, prying open that black box is a critical and, I believe, constructive project. Doing so will allow us to demystify the science underlying the one-child policy and clear the way for fresh consideration of policy alternatives that have lain dormant (at least publicly) for over two decades. Now is a propitious time to undertake this work, for China's population "crisis" has been largely resolved, permitting the gradual emergence since the mid-1990s of a new, health-oriented rationale for and approach to population work (Greenhalgh and Winckler 2001; Winckler 2002). Although it is not my aim here to criticize the makers of the one-child policy, this analysis will reveal some highly problematic practices of science-making. A full evaluation of the science will be presented in the larger project.

The rise of population science

Because of Mao Zedong's ambivalence about population, both population control and population studies had a checkered history in the Maoist years, 1949–76 (Aird 1972; Tien 1973). In the late 1950s population studies was effectively abolished. Over the next 20 years, social scientists of population were actively deskilled, deprived of data to analyze, and cut off from methodological and other advances occurring in international population stud-

ies. State birth planning, China's distinctive approach to population control, was interrupted again and again, becoming a political reality nationwide only in the early 1970s, with the inauguration of the later-longer-fewer (*wanxishao*) policy promoting later childbirth, longer spacing, and fewer children (Chen and Kols 1982).

With the death of Mao and the rise of Deng Xiaoping in the late 1970s, the planned control of population growth became a critical component of China's socialist modernization. Population experts were needed to help the party define and then reach its goals. In the late 1970s and early 1980s, China was home to one of the most rapid institutionalizations of a field of population studies in history (for parts of that story see Tien 1981, 1991; Greenhalgh 1990; Zhang 1984). While this is not the place to tell that fascinating story, it is important to note here that China's population specialists had particularly close ties to the Chinese state. Like virtually all intellectuals in China, the population specialists were located within the institutions of the party-state (in particular, universities, social science academies, and government bureaucracies), and they were expected to devote their energies to serving society by serving the state (Goldman 1981, 1994). Thus, the mission the new field was assigned was not to build population science for science's sake. It was to develop population science to assist the state in solving the country's population problems, a solution that, in turn, would accelerate the achievement of the four modernizations—in industry, agriculture, national defense, and science and technology (Chen 1981). Because population control was essential to the achievement of urgent economic goals for the year 2000—per capita income levels of US$800 to $1,000—the political stakes attached to finding a way to slow and then stop population growth were extraordinarily high.

Population scientists, natural and social

In the early and mid-1970s, state birth planning had belonged to the realms of party politics (Mao's specialty) and state economic planning (Zhou Enlai's contribution). Population discourse was not about population size, natural growth rates, or trends in the total fertility rate. Indeed, such terms were hardly to be found in the two main types of population texts produced at the national level during 1970–77, official policy statements and popular propaganda materials. Instead, population discourse centered either on the need to plan population in a planned socioeconomy (in staid official texts) or on the Cultural Revolutionary battles against the reactionary fallacies of Lin Biao and Confucius and the crimes against birth planning committed by the Gang of Four (in the more lively popular materials).

The overarching contribution of the newly empowered population specialists as a group was to bring population and its control within the realm

of science. Redefining population as a domain of science was to entail constituting population as a new, numerically describable, scientifically law-abiding domain of governance; and then using science to define the nature and importance of the population problem and determine the optimal solution to that problem. The fledgling field of population studies was internally diverse, however, made up of competing groups with varying intellectual backgrounds, institutional locations, and views about what should be done—and at what social cost. As the population question began to command the attention of a broad spectrum of the top leadership, various small groupings of specialists began to maneuver to bring their policy ideas to the attention of the country's decisionmakers. Along with the top leadership, these experts became the key makers of China's population policy, playing behind-the-scenes roles that have been only partially illuminated (in particular, in Tien 1991). The group that could provide the most compelling definition of the population problem and its optimal solution would gain extraordinary power over population thought and practice in the reform era.

In the mid-1970s (1974–78) the emerging field of Chinese population studies was a social science. Population was viewed as part of society—in particular, of the economy. The most prominent group of specialists was a handful of scholars who had been recruited in 1973 to create the official ideological rationale for the nationwide birth planning program in preparation for China's participation in the 1974 International Conference at Bucharest (IF,11/13/85,BJ). Moving to the People's University of China in mid-1978, Liu Zheng and his colleagues Wu Cangping, Lin Fude, and Zha Ruichuan widely popularized the Marxian-theoretic rationale for birth planning (Liu et al. 1977, parts of which are translated in Tien 1980). Although largely trained in statistics, these scholars were preoccupied with formulating China's population issues in terms of the dominant Marxian theory of the "twofold character of production," that is, the production of material goods and of human beings. As part of this project, they were concerned with developing a Marxian formulation of China's population problems as an imbalance between economic and demographic growth, and with fashioning a reasonable policy that took account of its social costs and consequences. When the domain of population was officially removed from the list of "forbidden zones" in 1979 (Chen 1979), scholars from many backgrounds—social science (especially economics), statistics, genetics, history, medicine, public health, and more—and located at universities and party schools around the country formed an intellectually diverse and growing group of specialists interested in the population question. After 20 years of intellectual isolation and deskilling, however, these more socially oriented scholars entered the contest to shape China's population policy with a serious handicap.

Meantime, behind the scenes, a group of three politically well-placed natural scientists and systems engineers, all interested in control theory,

got together in 1978 and began to apply their skills to the population question, one that, they told me, interested them personally (IF,11/16/99,BJ). The leader was Song Jian, control theorist at the Ministry of Aerospace Industry (then called the Seventh Ministry of Machine Building [for missile and space development]), with a long and luminous career in missile science. He was joined by Yu Jingyuan, a colleague, and Li Guangyuan, of the Chinese Academy of Sciences. Yu and Li were systems control engineers trained in cybernetics. The natural scientists, however, had limited understanding of population dynamics. In the fall of 1979 they recruited Tian Xueyuan, a Marxian economist at the Chinese Academy of Social Sciences, to work with them (IF,11/16/99,BJ). In the Maoist era, defense scientists such as Song and Yu had been part of a privileged and protected elite, actively supported when most intellectuals were persecuted (Feigenbaum 2003). As a result, this group entered the Deng era with crucial resources denied to the social scientists: access to Western science, data, computers, prestige, and political connections. It was this group of three natural scientists interested in control theory, and one economist, all located close to the centers of power, that gained the dominant position.

The scientific revolution at Chengdu

The scientific revolution in Chinese population studies occurred on or around 13 December 1979. That was the closing date of the Second National Symposium on Population, which was held in Chengdu. The symposium was attended not only by the usual cast of social scientists, but also by members of the Song group, who used mathematical models and newly available computer technology to forecast the future growth of the Chinese population (Song and Li 1980). Their work turned heads. Both scholars and, more importantly, government officials in charge of population policy emerged from the conference enamored of the natural scientists' contribution (Zha 1980; Wang and Yang 1980).

But what was meant by population science? In the Chinese political context, where the "correct" policy could only be determined by political leaders, science certainly could not mean the systematic testing of hypotheses and rejection of ones that lacked empirical support. Both published discussions from the Chengdu meeting and interviews I conducted a few years later make clear that science meant quantification and mathematical manipulation of numbers, especially using what were seen as advanced analytic techniques from abroad (IF,11/13/85,BJ; IF,12/3/85,SH; IF,12/3/86,XA). The systems engineer Wang Huanchen put the point forcefully, arguing that Chinese social science, "because it lacks quantitative things" (*dingliang de dongxi*), was not up to the task required of the population field, but that quantitative research, especially along the lines of population sys-

tems engineering, could provide the answers to China's critical problems of population policy (Editorial Board 1980: 2).

Innocuous and even progressive though it must have seemed in 1979, the intervention of the natural scientists in the conversations about population produced revolutionary effects. In a short time, a Marxian theoretical field belonging to the social sciences had been reinvented as a scientific—that is quantitative—discipline. The mathematical science of population that was to revolutionize China's population thought and practice was an unusual amalgam of cybernetics, control theory, systems engineering, and Club of Rome–style limits-to-growth thinking that had been popular among some Western academics and a sizable chunk of the general public in the West in the early to mid-1970s (especially Meadows et al. 1974; Mesarovic and Pestel 1974; on the work's public appeal, Wilmoth and Ball 1992). The group's leader, Song Jian, got the idea for this project on a delegation visit to Europe in 1978. Song's description of his encounters with some work inspired by the Club of Rome brings out the excitement his discovery produced. This passage also provides a backward glimpse at the larger intellectual climate of the 1970s, when notions of explosions of population growth were prevalent around the world and applications of control theory to abstract economies facing such situations were standard fare in Western population economics:[8]

> After more than ten years' isolation from the outside world, during a visit to Europe in 1978, I happened to learn about the application of systems analysis theory by European scientists to the study of population problems with a great success. For instance, in a "Blueprint for Survival" published in 1972, British scientists contended that Britain's population of 56 million had greatly exceeded the sustaining capacity of ecosystem of the Kingdom. They argued Britain's population should be gradually reduced to 30 million, namely, a reduction by nearly 50 percent.... I was extremely excited about these documents and determined to try the method of demography. (Song 1986: 2–3)

Although numerous economic and sociological critiques of the Club of Rome work had appeared in the West by the late 1970s, the critiques were not transported to China (in economics, e.g., Cole et al. 1973; Nordhaus 1973; an excellent overview is O'Neill 2001; in sociology, systems theory was critically assessed in, inter alia, Lilienfeld 1975; Ludz 1975). Enamored of the mathematics, Song did not bring those more sociological and economic critiques back with him from Europe. Only the crisis mentality and the top-down, engineering-type control solutions to the crisis made their way to China. That shift from social to natural science as the dominant voice was important, for the mathematicians' equations treated people like numbers to be manipulated from a center of control. In their

work, population was construed as a biological entity belonging to nature (see especially Song 1999 [1980]). Social and cultural factors were explicitly excluded from their calculations.

In the research community, the scientization of population studies would create deep rivalries and antagonisms. Specialists with mathematical skills gained visibility, voice, and influence over population policy. Meanwhile, as interviews conducted in the mid-1980s suggest, social scientists in general, and those preferring qualitative methods and offering humanistic insights in particular, found themselves struggling with diminishing success for public voice and policy clout (e.g., IF,11/18/85,BJ; IF,10/12/87,TY).

Science and national salvation

The intense appeal of "science" in China in the late 1970s makes sense when one understands the deep yearnings associated with that term in modern Chinese history. Throughout the twentieth century, and especially during the May Fourth period around 1919, "science" or, more accurately, *scientism*—the idea of science as a totalistic body of thought, the prime source of truth, and an all-powerful solution to China's problems—figured prominently in Chinese dreams of modernity, wealth, and power (Kwok 1965; Hua 1995). (Indeed, one of the appeals of Marxism-Leninism lay in its scientistic nature, its claim to be a comprehensive body of thought uniting the human and natural worlds [Miller 1996: 5].) In the post-Mao era, modern science and technology have been seen as antidotes to the horrors of the Cultural Revolution, as progressive forces, and as all-powerful cures to China's ills (Hua 1995; Miller 1996). The top leadership actively fostered this science worship—for worship it was. The Deng regime named science and technology the first of China's four modernizations, the key to the achievement of national wealth, power, and glory. In its policy of opening up to the outside world, the regime called on the nation to actively learn from the technologically advanced West. China would rely on Western science and technology to reach its ambitious national goals for the year 2000 and, ultimately, to catch up with the West itself (Miller 1996). China's leaders and urban elite were not the only ones believing in the religion of science. For the general public too, Western science and technology seemed to promise a quick fix that would bring China prosperity, modernity, and that long-awaited place in the world of nations (e.g., Suttmeier 1980, 1989; Simon and Goldman 1989; Li and White 1991).

Given these larger associations of science with progress, truth, and modernity, the embrace of highly quantitative scientific work by population specialists and policymakers alike becomes comprehensible. Yet it was risky. Despite caveats to absorb Western science and technology critically, the attitude toward foreign techniques was closer to idolatry, with everything for-

eign seen as superior to everything Chinese (e.g., IF,12/2/85,SH). This was to prove consequential, as we shall see shortly.

A virtual crisis is born

Despite the often rapid growth of its population, China throughout the 1950s, 1960s, and 1970s officially had no population crisis. As late as mid-1978, Hua Guofeng, Mao's short-lived successor, justified the harsh restrictions on reproduction then in place in terms of the necessity of planning in a socialist society and the benefits to national development and maternal and child health (Hua 1985 [1978]). Using concepts associated with the planned economy, China's social scientists had framed the population problem as one of disproportion between economic and demographic development. By mid-1979, however, around the time the natural scientists joined the debate, China suddenly faced a virtual population crisis, one that was ruining the country's chance of achieving the four modernizations by century's end. That crisis could only be virtual because China's official stance, articulated forcefully at Bucharest, was that population explosions were Malthusian concoctions imposed on the third world by the superpowers (Huang 1974). Marxist China could have no population crisis. China's population specialists seeking to emphasize the perils of population were thus constrained to avoid explicit crisis language, creating instead a virtual crisis—a picture of economic and ecological devastation that was catastrophic in all but name.[9] The virtual crisis they created bore notable resemblances to the catastrophe constructions of the Club of Rome work, both substantively and rhetorically. China's crisis was created out of numbers, the most compelling of which came arranged in tables and graphs.[10]

With the term *scientific inscription*—a visual display in a scientific text—the science studies scholar Bruno Latour has drawn attention to the work performed by such mundane tools of the scientist as tables, figures, and charts (Latour 1987: 64–70; also Latour and Woolgar 1979; Lynch and Woolgar 1990). Unremarkable though they appear, such pictorial representations can have powerful intellectual and political effects. In China in the late 1970s, new tabular and graphic pictures of China's population size and growth, and of their impact on economic growth, created a powerful narrative of virtual population crisis that constituted both a new regime of truth about the nature and urgency of the population problem and a scientific rationale for the forceful control of population growth. Put another way, these scientific pictures did not simply reflect a preexisting reality; instead, they actively constituted a new reality.

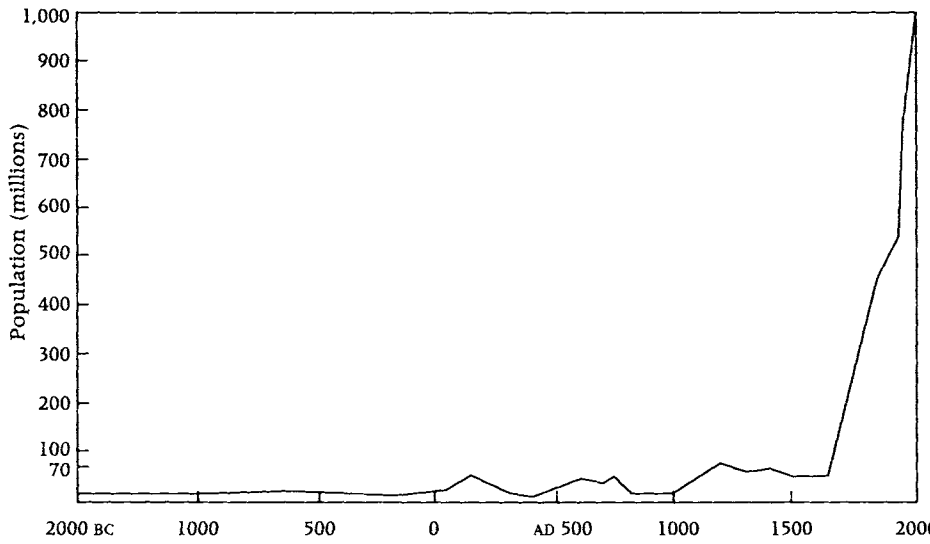
The textual and pictorial representations that began to come out around 1979 seemed to show two things: that China's population was growing exceedingly rapidly; and that the increase in human numbers was sabotaging

economic development, ruining the environment, and preventing China from achieving its rightful place in the world.

Population increase brings economic and environmental peril

Writers seeking to emphasize the perils of the rapid rise in human numbers stressed its historically unprecedented nature. Although the numbers were presented as unquestionable facts, those facts were humanly created through the choice of time period—long or short—and the choice of measure of population growth—aggregate numbers versus, say, natural growth rates. One vivid graph showed China's population remaining low for 3,750 years, rising worryingly in the next 200 years, and then spiking up to 1 billion in the final few decades before 2000 (Figure 1). The tone of the author's commentary on these trends conveyed the alarm readers were supposed to feel. He wrote: "Facing the rapid increase in population, countries everywhere are watching developments with grave concern" (Song 1981: 25–26). Had the author instead shown trends in population growth in the 1970s, the alarm would have been more muted; indeed, the tone would have been upbeat. According to figures available at the time, the years 1971–79 saw the crude birth rate and natural growth rate fall by a striking 50 percent (from 30.7 to 17.9 per 1,000 and from 23.4 to 11.7 per 1,000, respectively

FIGURE 1 Estimated historical trend of Chinese population, 2000 BC – AD 1980



SOURCE: Song, Tuan, and Yu 1985: 2.

[Tian 1985 [1981]: 81]). Although the graph helpfully highlighted the large effects of population momentum on population growth in the near future, the very long time frame used told a more gripping story about the urgency of the problems China faced. In shaping their numbers to tell a particular story, the scientists were simply following the practices of ordinary science. What was out of the ordinary was the story they told, what it obscured, and the authoritarian political context into which they introduced it.

Articles on population growth deployed a rhetoric of numbers that emphasized the size of the population figures. One article carried the title: "[We] erroneously criticized one person; Population mistakenly increased three hundred million" (quoted in Tien 1981: 688).[11] Numbers that could only be educated guesses were represented at two decimal points, a technique that was meant to emphasize their precise, scientific character. What was ironic about these representations was that, at the time they were deployed, neither China's newly minted population specialists nor its leaders had any firm idea of the size or internal characteristics of the population. The last population census had been conducted in 1964 and the results kept secret.[12] Yet the precise-looking numbers concealed such problems, presenting the figures as objective and exact. The procedures by which the numbers were produced—their source, any adjustments, and so on—remained obscured.

This increase in human numbers was worrying to China's population specialists because of its dire effects on economic growth. Articles published in leading newspapers and magazines at the time showed how the rapid increase in China's population was worsening serious problems of employment, accumulation, livelihood, and education, pushing China's modernization into the distant future (e.g., Tian 1985 [1979]; Liu 1980; Liu, Wu, and Lin 1980). One author, after laying out the declines in labor productivity in recent years, described the China of the late 1970s as no better off than the China of the Han dynasty 2,000 years earlier (Tian 1985 [1979]: 13). Although the author mentioned problems in investment, by calling population growth "a direct major cause" of China's economic problems and focusing exclusively on it, he made population stand out as the major cause of China's poverty. Population growth was represented as an all-purpose villain, responsible for exacerbating if not creating nearly every problem of development. Poor choices in the area of social and economic policy in the 1950s, 1960s, and 1970s remained unmentioned.

Not only China's economy, but also its environment was said to be collapsing from the weight of the country's excessive population. Painting scenarios of ecological devastation, scenes that echo those in the Club of Rome work, Song Jian warned:

> As population increases, forests are chopped down. Now forest coverage is about 30 percent worldwide; in China that figure is only 12 percent.... In our

> country there is only 1.5 *mu* [one-sixth of an acre] per person.... The decrease in forest area, arable land per person, lack of food supplies, lack of protein, increase in pollution, and the use of natural resources are growing with the increase in population.... However, the expendable power of nature's stability is limited. To guarantee future generations adequate or good survival conditions, we cannot exceed our limit on taking natural resources or use a method that destroys the balance and stability of the ecosystem. (Song 1999 [1980]: 552–553)

Population growth keeps China backward

Although the economic and environmental predicaments facing China were serious enough, the ultimate concern of China's population commentators was with the fate of the Chinese nation. In the late 1970s there emerged a cluster of notions according to which China's rapid population growth was self-evident proof of the country's backwardness and a major cause of China's continued failure to achieve its rightful place in the world. These notions had been quietly circulating in demographic circles for some time. As elements of public and political discourse, however, they were actively produced through the process of text and table construction.

From mid-1979 a number of comparisons appeared ranking China alongside key industrialized nations on per capita measures of development. A typical table showed China, whose per capita income had risen only modestly between 1950 and 1976, followed by the United States and Japan, whose incomes had spurted in the same period (see Table 1). Such tables—which appeared everywhere in these early reform years—gave China's apparent backwardness a striking new visibility. By making population growth the only thing that separated China from the great powers, the tables and their associated text also seemed to make China's excessive population the main cause of its backwardness, keeping other sources of China's economic problems out of sight.

TABLE 1 Per capita grain output and national income, comparison of China with the United States, France, and Japan

Measure	Country	1950	1955	1965	1970	1976
Output of food grains per capita (catty[a])	China	479	599	536	589	614
	United States	2,001	1,938	2,166	2,164	2,750
	France	810	992	1,292	1,328	1,262
National income per capita (dollars)	China	28	49	78	95	139
	United States	1,746	2,194	3,245	4,352	7,028
	Japan	195	245	785	1,630	4,193

[a]1 catty = 604.8 grams.
SOURCE: Chen 1979: 2.

Choices of comparison countries also shaped the story told. By making China's peers the already-developed countries, rather than the developing countries of the third world, the group with which China had closely and loudly identified for 30 years, Chinese writers made the severity of the country's problems stand out with special force. Reflecting the party's new goal of rapid modernization, these international tables also fostered a national identity in which China was only a temporarily backward country, whose rightful place was among the industrial powers of the world. The viewer is invited first to imagine China among the leading industrial powers, and then to contemplate how drastically the country's population growth must be limited in order to arrive quickly at this desired destination.

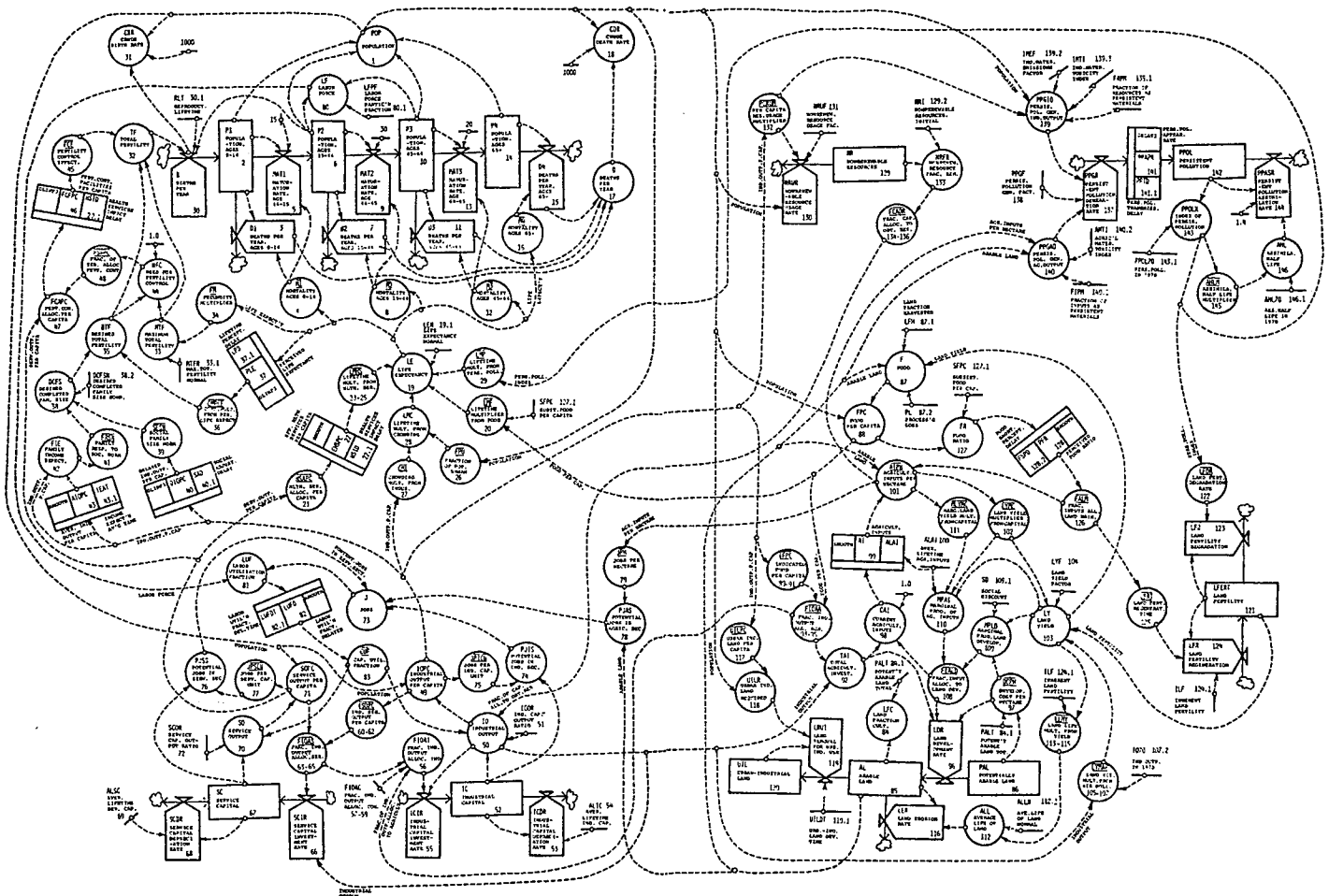
My point here is not that China had no population crisis. By all accounts, in the late 1970s China's rapid population growth was slowing economic development and harming the environment. My point, rather, is that the formulation of those relationships as a virtual crisis reflected a particular Western perspective and required a particular solution. The choices and biases behind that formulation were veiled by the language of facts and science and, in this way, closed to scrutiny.

The scientific solution: One child for all

Once population was problematized as a national crisis, the solution could only be a drastic one, for now the well-being of the Chinese people and the economic and global ascent of the Chinese nation hung in the balance. It was thus that the particular problematization adopted became constitutive of a new policy and, in turn, a new political reality. The ingredients for the scientific solution to the problem were to come from the same mix of cybernetics, control theory, and systems engineering that had provided the stuff for creating the problematization. The engineering model in the second edition of *The Limits to Growth* that is shown in Figure 2 vividly captures the type of thinking that was carried to China—and that found its ideal application in the one-child policy (Meadows et al. 1974: 102–103). Population processes and their various causes and consequences can be found in the upper-left-hand portion of the figure.[13]

The appeal of this engineering-type solution lay not only in its status as Western, scientific, and apparently advanced, but also in its tight fit with China's own socialist-planning approach to social planning and policymaking. In the early reform era, Chinese economic policymakers adopted a dual-track system in which the traditional plan continued to coordinate economic activity even as the market grew (Naughton 1995). Western science thus offered a way to enhance Chinese socialist practice, allowing Deng's dream of achieving "socialist modernization" to come true.

FIGURE 2 The world model of population, capital, food, nonrenewable resources, and pollution interrelationships



SOURCE: Meadows et al. 1974: 102–103.

Seizing the initiative in a moment of great flux in population policy, in 1978–79 the Song group used control theory, which is essentially an engineering approach to controlling objects in nature, not society, and newly available computer technology to perform two crucial sets of calculations. In the first they determined the future ideal or target population to serve as the end of population policy. The control or optimization problem was to determine the best fertility trajectory by which to reach that long-term goal, given certain constraints. As part of that work, the researchers projected future population growth under different fertility assumptions. On these bases, they then formulated the quantitative goals of population policy for the new reform era. Wrapped in a rhetoric of numbers and national progress through science, their quantitative research showed that "the only solution" was a policy to encourage all couples to have only one child, regardless of the costs to individuals and society. Let us take key portions of their work apart to see the kinds of procedures and politics embedded in their research. I call their science a "science story" to emphasize the scientistic rhetorical packaging in which the work was presented.

The natural scientists' science story

Almost everywhere it was presented, the natural scientists' science story began with a brief for science itself—that is, for the idiosyncratic brand of control theory/cybernetics/systems engineering the group employed in its work. This style of "natural science" was presented as an "accurate," "quantitative," and "powerful" approach (Song et al. 1980: 35) that self-evidently trumped the social scientific perspective that dominated population study at the time:

> Some people ... once thought that the population issue was solely the province of social scientists. There has been a radical change in this view today. Scientific and technical developments now provide us with powerful theoretical methods and practical techniques with which to handle quantitative descriptions of the complex problem of population growth. Applying control theory, systems engineering and computer technology, we can fairly accurately solve problems of quantitative population analysis, and of population projections and control. Only by linking social sciences with the natural sciences and technology can the question of population be comprehensively studied and correct population plans and their corresponding policies be drawn up. (Song 1981: 27)

By linking their policy preference to science, the Song group endowed it with unassailable legitimacy. The language of science also connected their work to China's century-old struggle to emerge from the darkness of tradition and superstition into the light of science, technology, and modernity.

Commentators on the radio and in other, more popular, print media repeated the message, elaborating on the scientific basis for the conclusions. A broadcast carried on 13 February 1980, apparently the first public disclosure of the Song group's results, conveys the awe that reporters and others had for the new mathematical science of population and its ability to know the future. The passage also reveals the authority that science and numbers carried in the political discourse of the time:

> Several scientists in Beijing have recently for the first time used the modern cybernetic method to make a number of predictions and calculations.... Working out mathematical formulas ... and making short- and long-term predictions on the basis of data collected through fairly precise calculations ... will be reference material of great value to the state in formulating population policy and economic plans.... This reporter saw numerous figures typed on paper by electronic computers—the first fairly detailed, reliable data and predictions that have been made of our country's population growth in the next 100 years. This dazzling data clearly shows the different results of population growth according to different plans. (Yu 1980: L11)

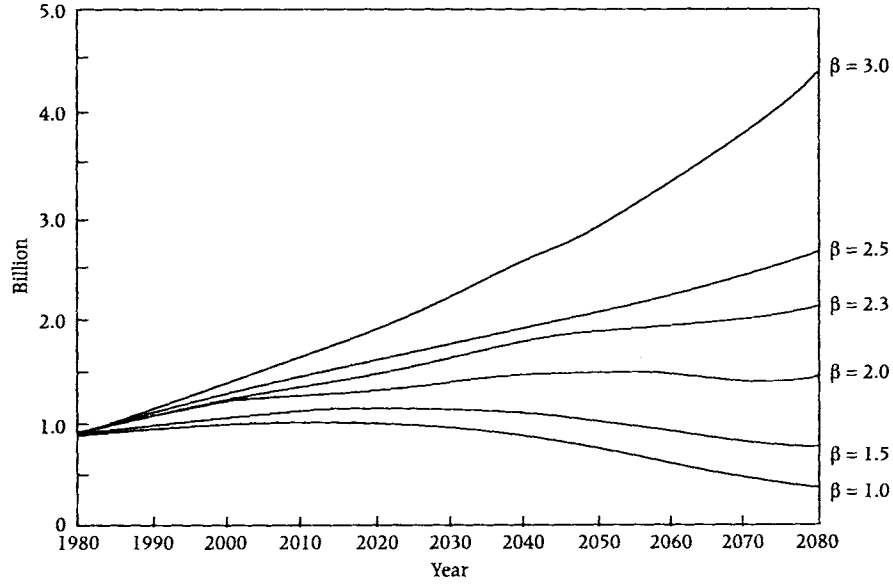
Rhetoric such as this—"reliable data," "precise calculations," "detailed predictions"—impressed on the public that science had the correct answer to China's population quandary, and it was the one-child policy. In the China of the early reform era, the science story had powerful appeal. Yet behind the rhetoric lay some problematic procedures.

Using the conditions of the modern (i.e., advanced industrial) countries as their goal and guide, the Song group first ascertained the size of an "optimal," stable population for 100 years in the future. Considering the "ideal" levels of economic development, food resources and diet, and ecological balance and fresh water resources, the scholars determined that the most desirable population in 2080 would be between 650 and 700 million, roughly two-thirds of China's 1980 population (Song 1981: 28–30; Song and Yu 1985; Song, Tuan, and Yu 1985: 213–285). The natural scientists buttressed their radical proposals with citations to British and Dutch research suggesting optimal populations half the size of those nations' actual populations (Goldsmith et al. 1972; Kwakernaak 1977). What Chinese readers could not know was that the European researchers had produced only heuristic devices for thinking through policy options. In the process of sinification, what had been merely a scientific exercise in Europe became a real policy proposal in China. The choice of comparison or aspiration countries again affected the conclusions reached. For example, the scientists argued that the proportion of animal protein in the Chinese diet should rise from its very low current level to the 70 to 80 percent level seen in the French and American diets (Song 1981: 29). Such large changes in the

Chinese diet necessitated substantial shrinkages in the population. There was a lot of contention about these numbers and about the concepts "carrying capacity" and "optimal population" among the social scientists, but that is a story for elsewhere (IF,11/22/85,TJ; IF,12/3/86,XA; IF,10/12/87,TY).

The scientists next performed a series of projections, under different fertility assumptions, to determine the current population policy that would produce that future optimal number. The results of this work were published in the journal *World Economy Research* (*Shijie Jingji Diaoyan*) in late January 1980 and then in the official party organ, the *People's Daily*, in early March (Song, Yu, and Li 1999[1980]; Song et al. 1980). These articles presented the results of five or six projections of population growth over the next 100 years, in which only one variable, the total fertility rate, was altered (see Figure 3). Most demographers consider such projections highly problematic, especially when unaccompanied by discussion of the range of uncertainty, since population growth in the distant future is affected by a large number of unpredictable factors (Cohen 1995: 109–110; Bongaarts and Bulatao 2000: 188–195). The Song group's projections were more problematic than most, given the absence of reliable demographic data for the country as a whole. Indeed, one member of the group described to me in an interview how they managed the fact that "there were no [good] input data" (*meiyou ziliao*): they pulled together numbers from various urban and rural local studies that they thought were relatively typical and reliable, as well as from the 1975 Cancer Epide-

FIGURE 3 Future projected trends of population control



SOURCE: Song and Li 1980: 63.

miological Survey and some 1978 data from the Public Security Bureau, checking them against the data available from the 1964 census. The data were "difficult" (*kunnan*) but, they felt, "workable" (*kao de zhu*) (IF,11/16/99,BJ).[14] The Chinese scientists were simply doing what all scientists faced with data limitations do: they improvised, making the most of what was available. Yet Chinese science, especially that published in the *People's Daily*, was different in that it was not open to democratic discussion and debate. Even as it informed and shaped the policy process, it served political ends, whisking methodological problems out of sight. Following conventional practice in China, the authors of the *People's Daily* article introduced no note of caution about their science. Nor did they identify their data sources or state whether and how the input data had been adjusted for such factors as age. Instead, they presented their results as accurate, beyond question, and, most important, sound, scientific bases for policymaking.

The rhetorics in which the results were presented led the reader, step by step, to the only reasonable conclusion: that anything other than minimal childbearing would exacerbate the population crisis and delay the arrival of China's modernization. In the first scenario, a total fertility rate (called the "average birth rate") of 3.0, China's 1975 level, would yield a population of 4.26 billion by 2080, "almost equal [to] the total population of the entire world" (Song et al. 1980: 36). This was the finding that, according to Song, "shocked the scientific circles and politicians" (Song 1999 [1995]: 537). In the second and third projections, fertility rates of 2.3 (the 1978 level) and 2.0 (a level not yet attained at the time) would stretch the population to 2.12 billion and 1.47 billion, respectively, in 100 years. (This article did not discuss the 2.5-child option. The TFRs 3.0, 2.3, 2.0, and 1.5 start in 1980; the TFR of 1.0 begins in 1985.) A fourth estimate used a fertility level of 1.5 and showed a population decrease to 777 million, close to the scientists' ideal level of 650 to 700 million. The fifth scenario called for a marked decline in fertility to 1.0 by 1985. By holding it at that level until 2080, the numbers showed, China could reduce its population to 370 million, a mere two-fifths of the actual (estimated) population of 1980. Given the seriousness of the population problem, the authors argued, the first three solutions "obviously cannot be adopted" (Song et al. 1980: 37). The fourth scheme, based on a 1.5-child family, would be "disadvantageous to our country's four modernizations ... and to the raising of the people's standard of living" (Song et al. 1980: 37). This, despite the fact that the 1.5-child rule would produce what they had deemed the ideal population in 2080. Yet the fifth scheme, they found, "could be a comparatively ideal scheme for solving our country's population problem":

> If, in the period of the next 20-odd years, we can really take this step of lowering the population's natural growth rate to zero, we will have gained the initiative in controlling population growth and afterward it will be compara-

> tively clear sailing. The objectives of the population development plan can then be attained on schedule, and the strategic task of controlling population growth can then be completely victorious. (Song et al. 1980: 37–38)

"[T]he key to the entire problem," they declared in closing, "is to lower the average birth rate to 1 before 1985, i.e., the practice of 'one child per family'"(Song et al. 1980: 38). In this rendering, the universal one-child solution is a technical matter that has been resolved by the application of an objective, lawlike, quantitative science. In this story, the new national one-child norm appeared as a product of science, not politics. Yet explicitly political considerations did play a crucial role, as we shall see shortly.

"No other choice"

In the earliest presentations of the scientific results, the one-child-for-all policy was described simply as "the most ideal scheme" or "the most effective solution." This best-choice discourse, however, was soon transformed into an "only choice" discourse, again under the banner of science. Although the source of this phrase is impossible to pinpoint (indeed, the phrase may have had several sources), strikingly similar phrases were used in the world-in-crisis work of the Club of Rome. The authors of the first report to the Club of Rome (*The Limits to Growth*) saw "no other avenue to survival" (Meadows et al. 1974: 196). Chapter Nine of the second report to the Club of Rome (*Mankind at the Turning Point*), titled "The only feasible solution," uses exactly the kinds of rhetoric found in the *People's Daily* article (Mesarovic and Pestel 1974: 115). Whatever the source of the phrase, its use spread rapidly. In the early 1980s Song Jian repeatedly used this "only choice," "no other way," or "the only measure" formula to describe China's options for the future (e.g., Song, Yu, and Li 1999 [1980]: 541; Song 1981: 31; Song, Tuan, and Yu 1985: 268). Prominent social scientists soon picked it up (Liu 1980: 17; 1981: 16). This "only choice" language soon appeared in important speeches by top leaders and party documents (e.g., Zhao 1985 [1981]; Central Committee and State Council 1985 [1982]). By late 1981, if not earlier, the strict one-child policy had been officially coded China's only choice.

Unsophisticated though it was, this no-other-choice formulation had powerful and insidious effects. It produced those effects by defining only two alternatives, labeling one scientific and effective, the other unscientific and ineffective, and then concluding that the former was the only viable choice. In other words, it forced a false choice between two extreme options, excluded all other approaches by definition, and then concealed this process of closure behind a rhetoric of science. The only-choice formulation was critically important, for once it got embedded in the dominant discourse on population, it became part of everyday, commonsensical knowl-

edge. Given the state's monopoly over the means of communication, the official discourse on population was the only extant discourse, the only way available in China to think about the nation's population problems and their solutions. Repeated endlessly and unthinkingly, this formulation closed both officials' and ordinary people's minds to the existence of other, less extreme ways to solve the population problem.

Another political effect of this only-choice framing was to silence concerns about the social costs of the one-child policy. Many social scientists worried about such macrosocietal consequences as rapid aging, a worsening dependency burden, and shortages of labor and military recruits. Others, speaking in a more humanitarian register, voiced concern about the plight of the peasantry, for whom children, especially sons, carried crucial cultural, social, and economic values, and about the coercion that would be required to enforce a one-child policy in the countryside (IF,11/18/85,BJ; also, Su and Kou 1978; Liang 1985[1979]; Kang, Pang, and Gu 1981; Gui 1983, among others). To reduce these costs, the social scientists called for other, less restrictive policies. The Liu group urged a go-slow policy of gradually increasing the share of first births while stopping all third births (Liu, Wu, and Lin 1980). Others called for a two-child-plus-long-spacing policy (Liang 1985 [1979]). Yet in the crisis atmosphere of the day, the alternatives were rejected and the social and human consequences were deemed secondary. In an interview, the social scientist in the Song group explained the dominant mentality this way: "Controlling population growth was the number-one (*diyiwei*) problem. If we did not control the numbers, nothing else could be done. All other problems were secondary. The aim was to minimize them to the extent possible" (IF,11/16/99,BJ). Given the social and human problems that did later emerge, the silencing of the socially concerned scholars proved to be a weighty move.

Population politics: From science to policy

So far I have been arguing that the rhetoric of science and modernity surrounding this only-choice policy hid the problematic scientific procedures by which the calculations were performed, dampening doubt and closing off consideration of other policy options. But the language of science and modernity also obscured the politics by which the one-child policy became the policy of choice. In February 1980, soon after completing its projections, the Song group took advantage of its status as government insiders to get its ideas into the hands of the top leaders. Song sent copies of the *World Economy Research* article to two of the nation's leading scientists, one social, the other natural. The scientists sent the materials on to China's top policymakers with their endorsements (for details see Greenhalgh, in progress). Far from worrying about such technicalities as whether the input data were

representative and properly adjusted, or whether the basic concepts such as optimal population and carrying capacity were sound, top leaders reportedly were "very impressed with the science and the numbers" (IF,1/22/99,NY). As one insider put it, even among the top leadership there was an incredible awe for science and a sense that the country would collapse from the weight of population (IF,1/22/99,NY). After internal deliberations between the leadership, ministerial-level officials, and a handful of scholars, many conducted in a series of key meetings held between March and May of 1980, the Song group's policy ideas were adopted in modified form—a 1.0-child rather than the scientists' optimal 1.5-child policy—and then presented to the public as the ideal and only scientific solution to China's population problems. My interviews with a wide range of actors make clear that the shift from a 1.5- to a 1.0-child policy was motivated by political considerations, in particular the fear that peasants allowed 1.5 offspring on average would press for two or more (e.g., IF,11/16/99,BJ; IF,10/12/87,TY). With the key decisions all made in those spring 1980 meetings, it was but a small step to get them embedded in central policy.

In mid-September 1980 the third session of the Fifth National People's Congress gave its seal of approval to a new policy designed to keep the population within 1.2 billion by the end of the century by encouraging one child for all. The Government Work Report issued by the NPC was the first general call for one-child families (Government Work Report 1985 [1980]). This policy was then widely publicized in a highly unusual Open Letter dated 25 September from the Central Committee to all members of the party and the Communist Youth League. Packed with numbers of every kind, the Open Letter embodied the new, numerical mode of political reasoning about population. In its formulations of the population problem, the Letter combined the social and natural scientists' formulations into a picture of a grave population-economy-environment crisis. With all scientific uncertainty having been put to rest, the Letter outlined China's severe crisis in grim terms:

> According to the present average of 2.2 children per couple, China's population will reach 1,300 million in 20 years and will surpass 1,500 million in 40 years.... This will aggravate the difficulties for the four modernizations and give rise to a grave situation in which the people's standard of living can hardly be improved.... Moreover, too fast a growth of population not only creates difficulties in education and employment but will overtax the energy, water, forest, and other natural resources, aggravate environmental pollution and make the production conditions and living environment downright bad and very hard to be improved. (Central Committee 1985 [1980]: 27)

Yet the policy solution bore the clear fingerprints of the cyberneticists' work. The Letter presented the policy of "one couple, one child," to be maintained for the next 30 to 40 years, but particularly during the coming 20 to 30

years, as the "most effective" way to keep the population within 1.2 billion in 2000 and thus avert the crisis (ibid.: 27). The Letter noted "some comrades'" worries about social problems such as population aging, a labor shortage, or a distorted sex ratio that might arise in carrying out the policy. Yet it discounted all such problems, claiming that some were based on misunderstanding, others could be resolved through ideological exhortation, while still others could be solved in the future, when they became serious (ibid.).

The policy impact of the control theorists

Clearly, the control theorists led by Song Jian had a profound impact on China's population policy. But what was the nature of that impact? More specifically, what was the extent of their influence relative to that of China's political leaders? Much evidence suggests that between mid-1978 and mid-1979, China's top leaders and population policymakers were moving toward adoption of a policy encouraging one-child families. At its first meeting in June 1978, the newly revamped Birth Planning Leading Group, the forerunner of the State Birth Planning Commission, recommended that "it is best to allow only one birth, two are the most, and third births must be strictly controlled." This recommendation was approved by the Central Committee of the party and by the State Council (Li 1980: 5). In March 1979 paramount leader Deng Xiaoping emphasized the disadvantages of China's huge, largely rural population and instructed that "We must greatly increase our efforts in [birth] planning" (Deng 1984 [1979]: 172). In the late spring of 1979, Chen Yun, a leading economic policymaker, proposed the formulation of a law limiting couples to one child and the provision of benefits for couples having only one child (Chen Muhua 1981). At its June 1979 meeting, the second session of the National People's Congress, while not adopting Chen Yun's proposals, nevertheless issued instructions to reward couples having only one child (Government Work Report 1985 [1979]). Some NPC deputies, however, called openly for the adoption of a one-child policy (Xinhua 1979). Clearly, talk of one-child families was in the air and gaining political weight.

Yet in the summer of 1979, instead of codifying the policy as a national rule or a national law, China's leaders authorized the buildup of a corps of population specialists precisely to help them formulate a policy to restrain population growth and ideologically legitimate it.[15] Whether the leadership had already committed itself to a one-child policy and simply sought scientific expertise to legitimate that fundamentally political decision, or it was wavering or internally divided and the scientists pushed them decisively in that direction, is a critical question. My research has produced no evidence that the central leadership was internally divided on the population question. To the contrary, a whole pantheon of top leaders was on record stating that excessive population growth was a serious problem keep-

ing China "backward" and had to be firmly addressed as part of China's modernization program (e.g., Chen 1981). The evidence suggests instead that the leadership was moving toward a one-child program of some sort, but wavering on the questions of speed and universality. Clearly, a universal one-child policy would be politically costly, provoking fierce opposition from the peasantry and thus political instability in the countryside. Moreover, in March 1979 the Liu group, the nation's leading population specialists headed by a scholar with superlative political credentials, had urged a go-slow policy of promoting one-child families only gradually.

By the spring of 1980, however, the leadership had committed itself to a go-fast policy of rapid adoption of one-child families, in both urban and rural areas. Although the process of policymaking was interactive, with the scientists and policymakers influencing each other, without doubt it was the Song group's work in general and their projections in particular that injected a sense of urgency into the policymaking process and changed minds. The evidence suggests that the graph of upward-sweeping curves created deep fears that the Chinese population was rising out of control, eating up economic gains, destroying the environment, and preventing China from escaping its poverty and backwardness. Packaged in a compelling story about modern science, this image convinced the leadership that it had no other choice but a policy of strict and rapid adoption of one-child families for all—despite the costs it certainly would entail.

A policy set in political stone

With the issuance of the Open Letter, the one-child policy was effectively set in political stone. Although the policy could and would be improved, in China's still very authoritarian political system, once the "correct" policy line is decided upon and made public, it can no longer be openly challenged. (Specialists can, however, point out problems with official policy and suggest ways to "perfect" it in closed forums such as academic meetings.) While publicly supporting the policy, in private many social scientists fervently opposed the strict one-child solution to the crisis because of the steep human costs it would certainly entail, especially in rural areas. In my interviews in 1985, leading scholars at such prominent institutions as People's University, Peking University, and Nankai University called it unrealistic, unenforceable, and even dangerous (IF,11/13/85,BJ; IF,11/18/85,BJ; 11/22/85,TJ). Liang Zhongtang of the Shanxi Provincial Academy of Social Sciences openly criticized it as potentially coercive and out of touch with rural reality (Liang 1985 [1979]; IF,10/12/87,TY). Yet these and other voices were drowned out by the powerful rhetoric of quantitative science deployed by the mathematicians. Some of these social scientists would have an influence on policy in the future, when the problems with the harsh one-child rule that they had warned about became reality. In 1980, however, the

science story won the day. With its apparently simple and compelling quantitative basis, the scientific solution of one child for all had captured the imagination of China's top leaders.

For many years thereafter, there would be no public questioning of that official narrative of crisis and no questioning of the one-child policy. Although the policy has been softened and the target raised over time, and fertility has fallen below replacement level, the notions that China faces a serious problem and potential crisis of population, and that the one-child policy is the best solution to it continue to resonate even today. These notions are embedded in the 2001 Law on Population and Birth Planning (esp. Articles 2 and 18; see "People's Republic of China law..." 2002; for discussion, Winckler 2002). The impact of the control theorists has been enormous. As the mathematical demographer Joel Cohen has written, in terms of the number of lives directly touched, Song Jian may well be the most influential mathematician of all times (Cohen 1990: 494).

Conclusions

How did this handful of maverick control theorists and engineers succeed in pushing aside the social scientists and convincing China's leaders that their proposal provided the necessary solution to China's problems? The answers lie in China's distinctive history, politics, and culture. First, the natural scientists packaged their ideas within a larger science story that deflected attention from methodological problems and political influences, while making their work part of a modern, progressive, global science that would fix the problems of the world. That larger story had particular appeal in the wake of the Cultural Revolution, when disorder, irrationality, and subjectivity—the very antitheses of science—had led China to the edge of ruin.

The predominance of the natural science story is also rooted in the history of science and social science in Mao's China. Alone among the natural sciences, Song's field of strategic defense science had been protected and supported by the state. Like the other social sciences, population studies had been literally abolished. As a result, China's social scientists had nothing but basic statistics and stale Marxist theory to offer in place of the impressive methods and perspectives from the West that the natural scientists and engineers brought to the table. The cyberneticists' extraordinary prestige and access to political power secured their preeminence in the struggles over population strategy.

Finally, the natural science story gained its power and persuasiveness from a larger, historically developed cultural climate in which science has been surrounded by a kind of mystical awe. This quasi-religious attitude toward science infected the leadership, who took the population scientists' numbers as gospel truth. Students of contemporary China have documented a broad shift in China's reform-era culture and politics away from human-

istic perspectives toward scientistic and technocratic ones (Suttmeier 1989; Li and White 1991; Hua 1995). The victory of the scientistic solution to the population problem must be seen as part of that larger sea change in the culture of Chinese modernity.

For population specialists in the West, China provides a sobering case study of how Western scientific ideas of population crises warranting drastic solutions can be transported to a third world context, transformed from an academic proposal into a concrete policy, and then imposed on a rural population with the political will and force of a late communist party-state, at great cost to human health, well-being, and even life. The China case gives one all the more pause when one realizes that this drastic solution was undertaken in the quest for national wealth, modernity, and membership in the club of advanced nations. The complex role of science, its travels, and its mutations in this process bears further consideration.

In this article, I have emphasized the humanly constructed character of the twin pillars of crisis and its only solution, and the problematic nature of some of the scientific procedures and political judgments that underlay them. If these two ideas were humanly constructed in the early reform-era context, then in today's very different political and demographic context they can be humanly deconstructed and replaced by other problematizations and other policy ideas that draw on social science and achieve reasonable population-control goals while respecting individual human rights and societal integrity. Today, many Chinese population specialists are looking for ways to move beyond the one-child policy. This article's new line of research, which dismantles the notion of crisis and demystifies the science underlying the one-child policy, provides one avenue by which to do so.

This article also has implications for the way China is viewed in the United States specifically and the West more generally. Whether as "totalitarian Other" or as "threatening Other," China is often seen through binaristic East–West lenses that make it different from, and inferior to, the United States. Although post-Mao China has retained many elements of communist discourse and practice that deserve sharp criticism—the limits on democratic discussion of the one-child policy are a pertinent example, as are techniques of policy enforcement not discussed here (see note 7)—this opposition keeps us from seeing other elements that do not fit the mold. By showing that China's one-child policy—offered by some as indisputable evidence for the totalitarian Other view—was built in part from Western science, I have tried to make the point that reform-era China is joining the modern scientific world that Americans and other Westerners inhabit, albeit on its own terms.

The China research also has implications for how we view the work of population science more generally. The literature in population studies generally takes the realist view that population problems exist as objects in nature that lie in wait of scientific discovery.[16] This article has laid out a social

constructionist perspective on the making of knowledge in population studies.[17] This perspective holds that population problems and their solutions are both real *and* socially constructed. By delving into the human and historical character of population research, we can gain a deeper understanding of how particular policies come to mirror their cultural and political settings, and how the scientific practices of the field can help to constitute demographic reality itself.

Notes

This article could not have been written without the help of many population specialists in China, who have shared their observations and insights with me over the years. To them I owe a great debt of gratitude. Also crucial was the support of the Science and Technology Studies Program of the National Science Foundation. A grant from that program (#0217508) facilitated the documentary research for this work. Some of the interviews were conducted with the support of an Individual Project Fellowship from the Open Society Institute. I acknowledge, too, the generosity of Leo Orleans, who shared with me his valuable collection of Chinese demographic materials from the 1950s through the 1970s, and the help of Brian O'Neill, who kindly brought me up to date on the status of the Club of Rome work in economics.

Earlier versions of this article were presented at the 2002 Annual Meeting of the Population Association of America, as well as at colloquiums sponsored by the Anthropology and Demography Departments at the University of California at Berkeley, the Chinese Studies Center and Department of Demography at the Australian National University, the Department of Anthropology at Brown University, and the Chinese Populations and Socioeconomic Studies Center at Duke University. I thank the many members of those audiences who shared with me their reactions to the work. Finally, I acknowledge the helpful comments of Leo Orleans on an earlier draft.

1 On the broad effects of the one-child policy, see, for example, Anagnost 1995, 1997; Davis and Sensenbrenner 2000; Peng and Guo 2000.

2 Among the most troubling of those social costs are the intensified discrimination and violence against daughters, evidenced in the rising sex ratio at birth (in 1999, 117 males per 100 females); threats to women's reproductive health; and the emergence of a huge "black population" of unregistered persons denied the benefits of citizenship. See, for example, Zeng et al. 1993; Li 1996; Lavely 1997, 2001; Zhu et al. 1997; Johnson, Huang, and Wang 1998; Chu 2001; Greenhalgh 2003.

3 H. Yuan Tien addresses the question of origins in passing in his book *China's Strategic Demographic Initiative* (Tien 1991). His work is discussed just below in the text. To my knowledge, no one has examined the origins of the one-child policy in a systematic or sustained way.

4 Related work on quantification has also underscored the power of numbers in modern political life generally and in these problematizations more specifically, as well as the depoliticizing effects of numbers on broad areas of political judgment (esp. Rose 1999; Rabinow 1989; Horn 1994; also Hacking 1982, 1986, 1990, 1991).

5 This article employs the conventional term, one-child policy, even though many couples are now allowed two children. In the period discussed here, the policy required virtually all couples to limit themselves to one child.

6 On the power of the "Malthusian myth" in China, see Lee and Wang 1999.

7 Methods of enforcement, however, derived from Chinese communist practice, in particular from longstanding practices of "propaganda and education" and mobilizational campaigns. Until the 1990s, when campaigns were phased out, these methods were the dominant means by which the policy was carried out. This subject is treated at length in the larger project.

8 I thank Geoffrey McNicoll for illuminating discussion of these points.

9 A close reading of the literature in Chinese demography between the mid-1970s and mid-1980s suggests that the makers of the one-child policy never used the term population crisis in a Chinese publication, nor did they cite Club of Rome work in China. Song and his colleagues were clearly influenced by that work, though, for they cited it in Western-language works and drew on it in their Chinese publications. The complicated politics of citation and international borrowing are explored elsewhere (Greenhalgh, in progress).

10 Most of the population numbers presented at the time were embedded in text. The ban on demographic research for two decades meant that the use of tables and graphs by population specialists was a novel practice in the late 1970s.

11 That one criticized person was Ma Yinchu, the eminent economist who argued for strong population control in the 1950s, only to be persecuted and deprived of his position as president of Peking University. Ma was rehabilitated in mid-1979, at a time when forceful population control was rising to the top of the policy agenda.

12 Because population figures were treated as state secrets, during the 1960s and 1970s the size of the Chinese population could only be guessed at on the basis of scattered and incomplete data. In the West, estimates of China's 1975 population ranged from 825 million to 930 million (Tien 1980: 4). During the mid to late 1970s, Chinese official sources generally referred to the population as "800 million" or around that figure (Banister 1987: 19). In June 1979, after a long dearth of numbers, the State Statistical Bureau released the official population size for year-end 1978: 975 million, including Taiwan. Although more data gradually became available, until the census and one-per-thousand fertility survey were conducted in 1982 solid demographic data were scarce and the numbers that were available were rarely shared with China's population specialists. There can be little doubt, however, that scholars with good connections to key central government agencies enjoyed access to the best data available.

Interestingly, the Club of Rome work exhibited a distinctly cavalier attitude toward numerical precision. In their world model, the analysts "quantified each relationship as accurately as possible, using global data where they were available and characteristic local data where global measurements had not been made" (Meadows et al. 1974: 90). The authors believed that numerical precision was relatively unimportant "when viewed against the inexorable progress of exponential growth" (ibid.: 51). Whether the Chinese scholars were influenced by the numerical attitudes of the Western analysts, or their hands were tied by Chinese statistical realities is a question for future research.

13 Given the political taboo surrounding the Club of Rome work in China, we may never know whether this particular figure informed the work of the Song group. Yet Song's writings are full of descriptions of complex multi-level, multi-variable systems that advance the same technocratic vision of a perfectly planned society with engineers and scientists at the controls (e.g., Song 1999 [1980]; Song and Li 1980; in English, Song, Tuan, and Yu 1985: 29–32).

14 China's 1975 Cancer Epidemiological Survey, designed to provide nationwide figures for age-specific mortality and causes of death, covered about 93 percent of the population. For more on the survey, see Banister 1987: 88–89.

15 The revitalization of demography was part of a general move in the late 1970s to reinstate social sciences and other academic fields that had been crushed during the long Maoist era. See, for example, Lin 1981; Cheng and So 1983; Rossi 1985.

16 In the last few years, some colleagues have begun to examine how social interactions shape the production and circulation of demographic knowledge (Carter 2001; Watkins 2000; Luke and Watkins 2002). Few, however, have approached the more fundamental question of how the cognitive content of population knowledge is created. Moreover, most of this work deals with popular knowledge about population; the creation of scientific knowledge about population has been little scrutinized.

17 For a judicious treatment of social constructionism, see Hacking 1999.

References

Aird, John S. 1972. "Population policy and demographic prospects in the People's Republic of China," in *People's Republic of China: An Economic Assessment: A Compendium of Papers Submitted to the Joint Economic Committee, Congress of the United States*. Washington, DC: US Government Printing Office, pp. 220–331.

Anagnost, Ann. 1995. "A surfeit of bodies: Population and the rationality of the state in post-Mao China," in Faye D. Ginsburg and Rayna Rapp (eds.), *Conceiving the New World Order: The Global Politics of Reproduction*. Berkeley: University of California Press, pp. 22–41.

———. 1997 "Children and national transcendence in China," in Kenneth G. Lieberthal, Shuen-fu Lin, and Ernest P. Young (eds.), *Constructing China: The Interaction of Culture and Economics*. Ann Arbor: Center for Chinese Studies, University of Michigan, pp. 195–222.

Banister, Judith. 1987 *China's Changing Population*. Stanford: Stanford University Press.

Bongaarts, John and Rodolfo A. Bulatao (eds.). 2000. *Beyond Six Billion: Forecasting the World's Population*. Washington, DC: National Academy Press.

Burchell, Graham, Colin Gordon, and Peter Miller (eds.). 1991 *The Foucault Effect: Studies in Governmentality*. Chicago: University of Chicago Press.

Carter, Tony. 2001. "Report on the Seminar on Social Interaction in the Production and Circulation of Knowledge, Brown University, 20–25 March; IUSSP Committee on Anthropological Demography," at www.iussp.org.

Central Committee. 1985 [1980]. "Zhonggong zhongyang, guanyu kongzhi woguo renkou zengzhang wenti, zhi quanti gongchandangyuan, gongqing tuanyaun de gongkaixin" (Open Letter from the Central Committee to all Communist Party and Communist Youth League members on the question of controlling China's population growth), in Population Yearbook of China Editorial Committee (ed.), *Zhongguo Renkou Nianjian (1985)* (Population Yearbook of China, 1985). Beijing: Zhongguo Shehui Kexue Chubanshe, pp. 27–29.

Central Committee and State Council. 1985 [1982]. "Zhonggong zhongyang, guowuyuan guanyu jinyibu zuohao jihua shengyu gongzuo de zhibiao" (Central Committee and State Council, Targets for doing a better job in birth planning work), in Population Yearbook of China Editorial Committee (ed.), *Zhongguo Renkou Nianjian (1985)* (Population Yearbook of China, 1985). Beijing: Zhongguo Shehui Kexue Chubanshe, pp. 45–48.

Chen Muhua. 1979 "Shixian sige xiandaihua, bixu you jihua de kongzhi renkou zengzhang" (Realization of the four modernizations requires the planned control of population growth), *Renmin Ribao*, 11 August, p. 2.

———. 1981. "Fazhan renkou kexue wei kongzhi renkou zengzhang mubiao fuwu" (Develop population science to serve the goal of controlling population growth), *Renkou Yanjiu* 3: 1–7.

Chen Pi-chao and Adrienne Kols. 1982. "Population and birth planning in the People's Republic of China," *Population Reports* (Series J, no. 25): J577–J618.

Chu Junhong. 2001. "Prenatal sex determination and sex-selective abortion in rural central China," *Population and Development Review* 27(2): 259–282.

Cheng, L. and A. So. 1983. "The reestablishment of sociology in the PRC: Toward the sinification of Marxian sociology," *Annual Review of Sociology* 9: 471–498.

Cohen, Joel E. 1990 "Review, *Population System Control* by Song Jian and Yu Jingyuan," *SIAM Review* 32(3): 494–500.

———. 1995. *How Many People Can the Earth Support?* New York: W. W. Norton.

Cole, H. S. D., Christopher Freeman, Marie Jahoda, and K. L. R. Pavitt (eds.). 1973. *Models of Doom: A Critique of the Limits to Growth*. New York: Universe.

Davis, Deborah S. and Julia S. Sensenbrenner. 2000. "Commercializing childhood: Parental purchases for Shanghai's only child," in Deborah S. Davis (ed.), *The Consumer Revolution in Urban China*. Berkeley: University of California Press, pp. 54–79.

Dean, Mitchell. 1999. *Governmentality: Power and Rule in Modern Society*. London: Sage.

Deng Xiaoping. 1984 [1979]. "Uphold the four cardinal principles," in *Selected Works of Deng Xiaoping (1975–1982)*. Beijing: Foreign Languages Press, pp. 166–191.

Editorial Board (*Bianjibu*). 1980. "Jiji kaizhan renkou xueke de yanjiu gongzuo jiasu peiyang renkouxue de zhuanmen rencai—Zuotanhui jiyao" (Energetically unfold research work in the field of demography and accelerate training of demographic professionals—Main points of workshop), *Renkou Yanjiu* 2: 1–2, 8.

Feigenbaum, Evan A. 2003. *China's Techno-Warriors: National Security and Strategic Competition from the Nuclear to the Information Age*. Stanford: Stanford University Press.

Foucault, Michel. 1978. *History of Sexuality: An Introduction*, Vol. 1. New York: Vintage.

———. 1991 "Governmentality," in Burchell, Gordon, and Miller (eds.), pp. 87–104.

Goldman, Merle. 1981. *China's Intellectuals: Advise and Dissent*. Cambridge: Harvard University Press.

———. 1994. *Sowing the Seeds of Democracy in China: Political Reform in the Deng Xiaoping Era*. Cambridge: Harvard University Press.

Goldsmith, Edward, Robert Allen, Michael Allaby, John Davoll, and Sam Lawrence. 1972. *Blueprint for Survival*. Boston: Houghton Mifflin.

Government Work Report. 1985 [1979]. "Diwujie quanguo renmin daibiao dahui, di'erci huiyi zhengfu gongzuo baogao" (Government work report of the second session of the Fifth National People's Congress), in Zhongguo Shehui Kexueyuan Renkou Yanjiu Zhongzin (ed.), *Zhongguo Renkou Nianjian, 1985* (Almanac of China's Population, 1985). Beijing: Zhongguo Shehui Kexue Chubanshe, p. 25.

———. 1985 [1980]. "Diwujie quanguo renmin daibiao dahui, disanci huiyi zhengfu gongzuo baogao" (Government work report of the third session of the Fifth National People's Congress), in Zhongguo Shehui Kexueyuan Renkou Yanjiu Zhongxin (ed.), *Zhongguo Renkou Nianjian, 1985* (Almanac of China's Population, 1985). Beijing: Zhongguo Shehui Kexue Chubanshe, p. 26.

Greenhalgh, Susan. 1986. "Shifts in China's population policy, 1984–86: Views from the central, provincial, and local levels," *Population and Development Review* 12(3): 491–515.

———. 1990 "Population studies in China: Privileged past, anxious future," *The Australian Journal of Chinese Affairs* 24 (July): 357–384.

———. 2003. "Planned births, unplanned persons: 'Population' in the making of Chinese modernity," *American Ethnologist* 30(2): 1–20.

———. In progress. *Governing by Numbers: Population Science in the Making of Modern China*. University of California Press.

Greenhalgh, Susan and Edwin A. Winckler. 2001. *Chinese State Birth Planning in the 1990s and Beyond*. Washington, DC: Resource Information Center, Immigration and Naturalization Service, US Department of Justice.

Gui Shixun. 1983. "Diqijiang: Weilai renkou ziran biandong yao youliyu shehui de fazhan" (Seventh lecture: The natural growth of the population in the future must be beneficial to societal development), *Shehui* 4: 61–65.

Hacking, Ian. 1982. "Biopower and the avalanche of printed numbers," *Humanities in Society* 5(3–4): 279–295.

———. 1986. "Making up people," in Thomas C. Heller, Morton Sosna, and David E. Wellbery (eds.), *Reconstructing Individualism: Autonomy, Individuality, and the Self in Western Thought*. Stanford: Stanford University Press, pp. 222–236.

———. 1990. *The Taming of Chance*. Cambridge: Cambridge University Press.

———. 1991. "How should we do the history of statistics?" in Burchell, Gordon, and Miller (eds.), pp. 181–197.

———. 1999. *The Social Construction of What?* Cambridge, MA: Harvard University Press.

Horn, David G. 1994. *Social Bodies: Science, Reproduction, and Italian Modernity*. Princeton: Princeton University Press.

Hua Guofeng. 1985 [1978]. "Shuji guashi, quandang dongshou, jinyibu gaohao jihua

shengyu" (With party secretaries in command, all party members [should] join the effort to do a better job in birth planning), in Population Yearbook of China Editorial Committee (ed.), *Zhongguo Renkou Nianjian (1985)* (Population Yearbook of China, 1985. Beijing: Zhongguo Shehui Kexue Chubanshe), pp. 20–22. Orig. publ. in *Renmin Ribao*, 8 July 1978.

Hua Shiping. 1995. *Scientism and Humanism: Two Cultures in Post-Mao China (1978–1989)*. Albany: State University of New York Press.

Huang Shu-tse. 1974. "China's views on major issues of world population," *Peking Review* 35 (30 August): 5–9.

IF [Interview file],11/13/85,BJ Interview with Chinese population specialist, Beijing.

IF,11/18/85,BJ Interview with Chinese population specialist, Beijing.

IF,11/22/85,TJ Interview with Chinese population specialist, Tianjin.

IF,12/2/85,SH Interview with Chinese population specialist, Shanghai.

IF,12/3/85,SH Interview with Chinese population specialist, Shanghai.

IF,12/3/86,XA Interview with Chinese population specialist, Xi'an.

IF,10/12/87,TY Interview with Chinese population specialist, Taiyuan.

IF,1/22/99,NY Interview with Chinese population specialist, New York.

IF,11/16/99,BJ Interview with Chinese population specialist, Beijing.

IF,11/23/99,BJ Interview with Chinese population specialist, Beijing.

Johnson, Kay, Huang Banghan, and Wang Liyao. 1998. "Infant abandonment and adoption in China," *Population and Development Review* 24(3): 469–510.

Kang Mingcun, Pang Shugui, and Gu Zushan. 1981 "Dui Xinjiang Shehezi Diqu dusheng zinu xingbie bili diaocha" (A survey of the sex ratio of single children in the Shihezi district of Xinjiang), *Renkou Yanjiu* 4: 43–45.

Kwakernaak, Huibert. 1977. "Application of control theory to population policy," in A. V. Balakrishnan and M. Thoma (eds.), *Lecture Notes in Control and Information Sciences*. Berlin: Springer-Verlag, pp. 359–378.

Kwok, D. W. Y. 1965. *Scientism in Chinese Thought, 1900–1950*. New Haven: Yale University Press.

Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers Through Society*. Cambridge, MA: Harvard University Press.

Latour, Bruno and Steve Woolgar. 1979. *Laboratory Life: The Social Construction of Scientific Facts*. Beverly Hills: Sage.

Lavely, William. 1997. "Unintended consequences of China's birth planning policy," paper presented at Conference on Unintended Social Consequences of Chinese Economic Reform, Harvard University, 24 May.

———. 2001. "First impressions from the 2000 census of China," *Population and Development Review* 27(4): 755–769.

Lee, James Z. and Wang Feng. 1999. *One Quarter of Humanity: Malthusian Mythology and Chinese Realities*. Cambridge, MA: Harvard University Press.

Li Cheng and Lynn T. White, III. 1991. "China's technocratic movement and the world economic herald," *Modern China* 17(3): 342–388.

Li Xiaorong. 1996. "License to coerce: Violence against women, state responsibility, and legal failures in China's family planning program," *Yale Journal of Law and Feminism* 8: 145–191.

Li Xiuzhen. 1980. "Dangqian jihua shenggyu gongzuo de xingshi he renwu" (The situation and duties of birth planning work today), *Renkou Yanjiu* 1: 3–5, 47.

Liang Zhongtang. 1985 [1979]. "Dui woguo jinhou ji shi nian renkou fazhan zhanlue de jidian yijian" (Several opinions about the strategy for China's population development in the next few decades), in Liang Zhongtang, *Lun woguo renkou fazhan zhanlue* (On China's population development strategy). Taiyuan: Shanxi People's Press, pp. 1–16.

Lilienfeld, Robert. 1975. "Systems theory as an ideology," *Social Research* 42(4): 637–660.

Lin, Cyril Chihren. 1981. "The reinstatement of economics in China today," *China Quarterly* 85 (March): 1–48.

Liu Zheng. 1980. "Laogu shuli you jihua kongzhi renkou zengzhang de zhanlue sixiang" (Firmly establish a strategic concept for controlling population growth in a planned way), *Renmin Ribao*, 25 February, p. 5.

———. 1981. "Population planning and demographic theory," in Liu Zheng, Song Jian et al. (eds.), *China's Population: Problems and Prospects*. Beijing: New World Press, pp. 1–24.

Liu Zheng et al. 1977. *Renkou Lilun* (Population theory). Beijing: Shangwu Yinshu Guan.

Liu Zheng, Wu Cangping, and Lin Fude. 1980. "Dui kongzhi woguo renkou zengzhang de wudian jianyi" (Five proposals for controlling China's population growth), *Renkou Yanjiu* 3: 1–5.

Ludz, Peter C. 1975. "Marxism and systems theory in a bureaucratic society," *Social Research* 42(4): 661–674.

Luke, Nancy and Susan Cotts Watkins. 2002. "Reactions of developing-country elites to international population policy," *Population and Development Review* 28(4): 707–733.

Lynch, Michael and Steve Woolgar (eds.). 1990. *Representation in Scientific Practice*. Cambridge, MA: MIT Press.

Meadows, Donella H., Dennis L. Meadows, Jørgen Randers, and William W. Behrens, III. 1974. *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*, 2nd ed. New York: Universe.

Mesarovic, Mihajlo and Eduard Pestel. 1974. *Mankind at the Turning Point: The Second Report to the Club of Rome*. New York: E. P. Dutton & Co.

Miller, H. Lyman. 1996. *Science and Dissent in Post-Mao China: The Politics of Knowledge*. Seattle: University of Washington Press.

Naughton, Barry. 1995. *Growing Out of the Plan: Chinese Economic Reform, 1978–1993*. Cambridge: Cambridge University Press.

Nordhaus, William D. 1973. "World dynamics: Measurement without data," *The Economic Journal* 83(332): 1156–1183.

O'Neill, Brian. 2001. "Cassandra/cornucopian debate," in Neil J. Smelser and Paul B. Baltes (eds.), *International Encyclopedia of the Social and Behavioral Sciences*. Oxford: Elsevier.

Peng Xizhe and Guo Zhigang (eds.). 2000. *The Changing Population of China*. Oxford: Blackwell.

"People's Republic of China law on population and birth planning." 2002. *Population and Development Review* 28(3): 579–585.

Pickering, Andrew (ed.). 1992. *Science as Practice and Culture*. Chicago: University of Chicago Press.

———. 1995. *The Mangle of Practice: Time, Agency, and Science*. Chicago: University of Chicago Press.

Rabinow, Paul. 1989. *French Modern: Norms and Forms of the Social Environment*. Chicago: University of Chicago Press.

———. 2002. "Midst anthropology's problems," *Cultural Anthropology* 17(2): 135–149.

Rose, Nikolas. 1999. *Powers of Freedom: Reframing Political Thought*. Cambridge: Cambridge University Press.

Rossi, Alice S. (ed.). 1985. *Sociology and Anthropology in the People's Republic of China: Report of a Delegation Visit, February–March 1984*. Washington, DC: National Academy Press.

Simon, Denis Fred and Merle Goldman (eds.). 1989. *Science and Technology in Post-Mao China*. Cambridge, MA: Harvard University Press.

Song Jian. 1999 [1980]. "Cong xiandai kexue kan renkou wenti" (Population problems from the perspective of modern science), in Song Jian, *Song Jian kexue lunwen xuanji* (Selected scientific papers of Song Jian). Beijing: Kexue Chuban She, pp. 549–554. Orig. publ. in *Guangming Ribao*, 3 October 1980.

———. 1981. "Population development—Goals and plans," in Liu Zheng, Song Jian et al. (eds.), *China's Population: Problems and Prospects*. Beijing: New World Press, pp. 25–31.

———. 1986. "Systems science and China's economic reforms," in Yang Jiachi (ed.), *Control Science and Technology for Development (CSTD'85)*. Oxford: Pergamon, pp. 1–8.

———. 1999 [1995]. "System science and policy-making," in Song Jian, *Song Jian kexue lunwen xuanji* (Selected scientific papers of Song Jian). Beijing: Kexue Chuban She, pp. 534–538. Originally presented at International Conference on Control and Information, 1995.

Song Jian and Li Guangyuan. 1980. "Renkou fazhan wenti de dingliang yanjiu" (Quantitative research on the problem of population development), *Jingji Yanjiu* 2: 60–67.

Song Jian, Tian Xueyuan, Li Guangyuan, and Yu Jingyuan. 1980. "Concerning the issue of our country's objective in population development," *Renmin Ribao* (People's Daily), 7 March, p. 5. In *Joint Publications Research Service* 75524, 18 April 1980: 35–38.

Song Jian, Chi-Hsien Tuan, and Jing-Yuan Yu. 1985. *Population Control in China: Theory and Applications*. New York: Praeger.

Song Jian and Yu Jingyuan. 1985. *Renkou Kongzhilun* (Population control theory). Beijing: Kexue Chuban She.

Song Jian, Yu Jingyuan, and Li Guangyuan. 1999 [1980]. "Guanyu woguo renkou fazhan de dingliang yanjiu baogao" (A report on quantitative research on the question of China's population development), in Song Jian, *Song Jian kexue lunwen xuanji* (Selected scientific papers of Song Jian). Beijing: Kexue Chuban She, pp. 540–545. Originally published in *Shijie Jingji Diaoyan*, no. 5, 31 January 1980.

Su Renyu and Yinghang Kou. 1978. "Control of population growth and the acceleration of agricultural development: Village population survey, Wuwei County, Gansu Province" (in Chinese), in *Papers of the First National Annual Conference on the Science of Population Theory*, Institute of Population Research, People's University of China. Beijing: People's University of China, pp. 190–196.

Suttmeier, Richard P. 1980. *Science, Technology and China's Drive for Modernization*. Stanford: Hoover Institution Press.

———. 1989. "Science, technology, and China's political future—A framework for analysis," in Simon and Goldman (eds.), pp. 375–396.

Tian Xueyuan. 1985 [1979]. "Kongzhi renkou cujin sihua" (Control population to advance the four modernizations), in Tian Xueyuan, *Tian Xueyuan Wenji* (Collected papers of Tian Xueyuan). Beijing: Zhongguo Jingji Chubanshe, pp. 10–16. Originally published in *Tianjin Ribao*, 11 September 1979.

———. 1985 [1981]. "Sanshi nian lai Zhongguo renkou de fazhan" (The last thirty years of population development in China), in Tian Xueyuan, *Tian Xueyuan Wenji* (Collected papers of Tian Xueyuan). Beijing: Zhongguo Jingji Chubanshe, pp. 75–89. Originally published in *Zhongguo Keji Shi Liao*, September 1981.

Tien, H. Yuan. 1973. *China's Population Struggle: Demographic Decisions of the People's Republic, 1949–1969*. Columbus: Ohio State University Press.

——— (ed.). 1980. *Population Theory in China*. White Plains: M. E. Sharpe.

———. 1981. "Demography in China: From zero to now," *Population Index* 47(4): 683–710.

———. 1991. *China's Strategic Demographic Initiative*. New York: Praeger.

Xinhua. 1979. "NPC deputies discuss population growth control," Broadcast, 29 January. In *FBIS, China: Political, Sociological, and Military* 73,903 (25 July): 132–134.

Wang Nairong and Yang Kuixing. 1980. "Renzhen yanjiu woguo sige xiandaihua suo mianlin de renkou lilun he shiji wenti" (Earnestly study the problems of population theory and reality facing China's four modernizations), *Renkou Yanjiu* 1: 48–53.

Watkins, Susan Cotts. 2000. "Local and foreign models of reproduction in Nyanza Province, Kenya, 1930–1998," *Population and Development Review* 26(4): 725–759.

Wilmoth, John R. and Patrick Ball. 1992. "The population debate in American popular magazines," *Population and Development Review* 18(4): 631–668.

Winckler, Edwin A. 2002. "Chinese reproductive policy at the turn of the millennium: Dynamic stability," *Population and Development Review* 28(3): 379–418.

Yu Zhenping. 1980. "Scientists predict various rates of future population growth," Xinhua Domestic Service in Chinese, 13 February, in *FBIS, PRC National Affairs*: L11–L13.

Zeng Yi et al. 1993. "Causes and implications of the recent increase in the reported sex ratio at birth in China," *Population and Development Review* 19(2): 283–302.

Zha Ruichuan. 1980. "Renkou lilun yanjiu jinyibu kaizhan" (Population theory research is further developing), *Renkou Yanjiu* 1: 45–47.

Zhang Longxi. 1998. *Mighty Opposites: From Dichotomies to Differences in the Comparative Study of China*. Stanford: Stanford University Press.

Zhang Xuexin. 1984. "Gaodeng xuexiao renkouxue de xiankuang he chushi" (Present situation and trend of demography in institutions of higher education), *Renkou Yanjiu* 5: 22–24, 17.

Zhao Ziyang. 1985 [1981]. "Dangqian de jingji xingshi he jinhou jingji jianshe de fangzhen" (The present economic situation and the principles for future economic construction), in Zhongguo Shehui Kexueyuan Renkou Yanjiu Zhongxin (ed.), *Zhongguo Renkou Nianjian, 1985* (Almanac of China's Population, 1985). Beijing: Zhongguo Shehui Kexue Chubanshe, p. 33.

Zhu Chuzhu et al. 1997. *The Dual Effects of the Family Planning Program on Chinese Women*. Xi'an: Xi'an Jiaotong University Press.