5 *Utilization of scientists and engineers in China*

Although it is clear that the "supply" side of the science and technology (S&T) talent equation is an important component of a nation's innovation capacity and potential, it also is the case that sheer numbers of scientists and engineers is not an adequate proxy for innovative performance and economic contribution. The effective use and deployment of the S&T talent pool is the major factor which truly shapes, as well as yields, meaningful innovative outcomes. Having described the characteristics of China's human resources in science and technology (HRST) and the educational pipeline through which China's S&T workforce has been produced, the purpose of this chapter is to highlight and evaluate how effectively the Chinese S&T workforce has been utilized.

The chapter first lays out how intellectuals, of whom scientists and engineers are an important component, as a social class have evolved in contemporary China. This analysis is followed by a review of the core political and modernization issues involved in the Chinese Communist Party (CCP) policies toward intellectuals in general, and scientists and engineers in particular, since 1949; the attitudes and actions of the CCP have been the major determinant of how Chinese scientists and engineers are treated both politically and economically. The various components of the professional lives and careers of China's high-end talent pool – from job assignments and promotion to career mobility and performance rewards – are discussed. The chapter also looks at the growing impact of entrepreneurship and commerce, especially within China's high-technology sector, and its effect on the utilization of the S&T workforce; in the era of reform and open-door, and the onset of the knowledge-based economy, there are many new imperatives and opportunities driving the individual behavior and attitudes of Chinese scientists and engineers.

When thinking about *utilization* of the S&T workforce, key questions which come to mind are: whether these scientists and engineers

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are deployed effectively; whether they perform well once at work; and whether they are satisfied with the environment in which they work. The chapter will discuss each of these issues.

Although enhancing income is not the sole driver and motivator of the bulk of the talent pool, it clearly does have a growing influence on career choices, including the critical decision about whether to stay abroad or return to China after foreign education. The last section of the chapter is therefore devoted to an examination of wage trends and compensation issues related to Chinese scientists and engineers. "On the table," from both a policy and management point of view, is a series of emerging questions about the evolving structure of the local labor market, the degree to which there actually *is* a functioning labor market in China, the seemingly growing role of nationalism in post-Deng Xiaoping China versus the 1950s, and the extent to which the Chinese S&T community, taken as a whole, is appropriately utilized and deployed to meet the expectations of the country's leadership in terms of overall performance and substantive contributions to the nation's economic prosperity, national technological strength, and international image and prestige.

Scholar-officials, intellectuals, cadre, and *jibie*

The "science and engineering" professions are relatively new to China. Historically, intellectuals occupied a very high position in the Chinese society: scholars, farmers, artisans, and merchants (*shi, nong, gong, shang*), ranked in that order, were the key four pre-modern Chinese social groups (Bodde, 1991: 203–12; Wortzel, 1987: 15–17). More accurately, "scholars" were scholar-officials, or gentry (*shishen*), who had a good command of the Confucian classics and passed an imperial civil service examination (*keju kaoshi*) at various levels to be appointed as government officials. As a distinct social group in imperial China, scholar-officials dominated the broad array of social and economic affairs, receiving an assortment of political, economic, and social privileges and powers, and basically lead a rather well-off, high status mode of life (Chang, 1955).

That tradition remained in place for several centuries, although *keju kaoshi* was abolished in 1905 and the Qing dynasty was replaced by a republic in 1911. During the nationalist (Kuomintang) government era, intellectuals with advanced education, especially returnees from overseas, were highly respected and promoted to important positions in education, economy, and even politics. One example was that of the National Defense Planning Commission (*guofang sheji weiyuanhui*) and its successor, the National Resources Committee (*ziyuan weiyuanhui*), which recruited the geologist Weng Wenhao, the economist Qian Changzhao, and the mining expert Sun Yueqi, all foreign-trained, to direct the nation's research, planning, and managerial bureaucracy. Weng, not politically ambitious, was even appointed premier (Kirby, 1989).

It was under communist leadership that Chinese intellectuals were considered to pose difficult ideological problems for the regime (to be discussed in the next section). According to Mao Zedong's standard, anyone with a high school education could be called an "intellectual" (*zhishi fenzi*), with those having more education being "big" (*da*) intellectuals and the less educated "small" (*xiao*) intellectuals (Ogden, 1992: 295). In the 1950s, the term "high-ranking intellectuals" (*gaoji zhishi fenzi*) was coined to refer to some 100 000 Chinese professors, senior researchers, senior medical doctors, and so on, with at least a college education. Currently, "intellectuals" are those with education at college-level and above (Li, 1993: 27–30), which is similar to the definition of HRST if the education received is in an S&T-related field. But before 1978, when the reform and open-door policies were initiated, knowledge and education were secondary in China, so that no matter how important they were in the nation's economic, political, and cultural affairs, intellectuals remained only a marginalized social "stratum" (*jieceng*) under the leading class (*jieji*) of workers and peasants, and could not be an independent class on their own (Kelly, 1990). In the words of Mao Zedong, intellectuals were just "hairs attached to the skin" – their social status was attached to the "skin" of the stratified structure of contemporary Chinese society.

With the inception of the communist regime, intellectuals scattered among various professions, including science, engineering, agriculture, medicine, and teaching among others, were classified into the ranks of cadre (*ganbu*), whose salary and benefits, for most of the history of the People's Republic of China, were associated with their work-grade (*jibie*). This elaborate system categorized and encompassed almost every employee at a state-owned work unit (*danwei*), either within an enterprise (*qiye*) or a public institution (*shiye*), denoting with clarity their position in a hierarchy of job-related rewards, income levels, prestige, privileges, and authority. Within it, cadres were assigned to one of 30 grades, with Grade 1 for state president and vice president, and Grade 26 for the lowliest cadre; there were 12 grades for professors, whereas engineers had eight grades, among others, with adjustments for a region's hardship and cost of living (Kraus, 1981: 31–4).

Because cadres were at the center of the *jibie* system, those in other *jibie* had to find an equivalent rank within the cadre *jibie*, which in turn determined their political status and material and non-material benefits.[1] For example, a Grade 8 professor was equivalent to a Grade 17 *ganbu*, which simply but importantly meant that a Grade 8 professor had similar benefits to those enjoyed by a Grade 17 *ganbu* (Chen, 2006: 82–3). Similarly, new graduates from a four-year undergraduate program entered the rank of *ganbu* at Grade 21, and earned a monthly salary of RMB (*reminbi*) 62 if they worked in Beijing, or slightly higher in Shanghai, regardless of whether they were engineers or college lecturers. This linkage between the status of a Chinese professional and the classification within an official *jibie*, which did not necessarily bring with it further privileges, special treatment, economic benefits, or power associated with the *jibie*, is known as "official-centeredness" (*guanbenwei*) (Lü, 2000: 244; Zhong, 2003: 99). Although the *jibie* system no longer operates in its original way, in its current form, the official-centerness correlates a member (*yuanshi*) of the Chinese Academy of Science (CAS) and the Chinese Academy of Engineering (CAE), respectively, to a vice minister in the government hierarchy, an advisor of doctoral students, a bureau chief, a professor, a division director, and so on. Intellectuals remain quite agitated about this system as formal membership of either the CAS or the CAE is viewed as a prestigious academic honor, while a professorship is a professional-educational rank, with both having nothing to do with their "official" title. The appearance of some sort of "relationship" or a correlation between holders of such an academic honor or achievement-oriented rank with holders of office not only strengthens the official-centeredness of the Chinese

[1] Benefits were not the right term; "treatment" (*daiyu*) is probably a more accurate description as they include both material and non-material components with the latter sometimes more significant than the former.

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personnel system but also seems to depreciate the value and prestige of members of the CAS and the CAE (Cao, 2004a).

CCP policy toward intellectuals

Policies regarding the utilization of intellectuals, including scientists and engineers, and, correspondingly, the social status accorded them have evolved and indeed changed considerably during the history of the People's Republic of China. Relations between the political leadership and the intellectual community have centered on four major issues.

First, since the construction of a modernizing, harmonious, and innovation-oriented society relies on the technical intelligentsia, the CCP has adopted a largely utilitarian policy toward intellectuals in general, and scientists and engineers in particular. Upon taking power in 1949, the CCP faced the immediate challenge of revitalizing the national economy, so the services of Chinese intellectuals at home and abroad were sorely needed. In the mid-1950s, simultaneously complacent about China's completion of the transition to socialism and concerned about the country's continued economic backwardness, the CCP held a conference on intellectuals, during which the then premier, Zhou Enlai, spoke at length about the party's views toward intellectuals and advocated a "blooming and contending" policy, calling on intellectuals to help the party eliminate bureaucratism, factionalism, and subjectivism. In the early 1960s, when an economic crisis emerged after the Anti-Rightist Campaign and the failures of the Great Leap Forward, the party modified its policies toward intellectuals by recalling scientists and engineers and even former "rightists" to key positions in research and education. The CCP convened another conference on intellectuals in Guangzhou in 1962 to reverse the anti-intellectual trend that had prevailed since 1957. As a result, natural scientists enjoyed a measure of prestige and respect between 1962 and the start of the Cultural Revolution, the research environment was far less politicized, and the amount of time scientists spent attending political meetings was limited to one day a working week at most (Nie, 1988: 722–3). In the aftermath of the Cultural Revolution, in order to win back trust from the intellectual community and to mobilize its members to the fullest possible extent, the leadership held a national science conference in 1978, during which the just

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rehabilitated Deng Xiaoping gave a very upbeat speech celebrating the role of scientists in society. He made it clear that S&T is the principal "productive force" underlying the four modernizations and that scientists form "part of the working class" and are not somehow politically suspect as they had been since the Anti-Rightist Campaign. The party once again withdrew from its overly dominant position, granting scientists greater freedom within their areas of professional competence. In 2000, Jiang Zemin, then CCP General Secretary and Chinese President, put forward the "Three Represents" theory – the CCP represents the development trends of advanced productive forces; the orientations of an advanced culture; and the fundamental interests of the overwhelming majority of the people of China. Various efforts were made to co-opt intellectuals, who, apparently, were viewed as a component within the "advanced productive forces."

At each of the above-mentioned moments, the party typically became more receptive to the ideas and opinions of intellectuals, and natural scientists and technologists in particular; the CCP loosened its control over institutions of learning and allowed scientists to enjoy a certain degree of freedom in their exercise of academic autonomy and maintenance of authority in teaching and research. Renowned intellectuals were appointed to quasi-political positions such as deputies of the People's Congress and members of the People's Political Consultative Conference at national and regional levels. The party even made great efforts to recruit scientists and engineers into its ranks in the mid-1950s and again after the Cultural Revolution, which more or less signified its pragmatic approach to achieving goals during those periods. There is no doubt that intellectuals as a whole have benefited the most from the reform and open-door policies launched under Deng Xiaoping (to be discussed). In fact, the party has offered economic incentives, academic "reputation," political access, and even well-paid government positions, while standing to benefit from their advice and support (Pei, 2006: 89–92).

Second, the utilitarian policy emerged from the party's distrust of Chinese intellectuals. This may seem like an odd perspective, but as the party has reflected on the cost of periodic attacks on intellectuals it has come to recognize the high price that has been paid in terms of the country's economic well-being and technological progress. For a long time intellectuals were not considered part of the working class, China's leading class, but as a part of the despised bourgeois social group. It was not until January 1956 that the CCP began to address this issue in a special conference on intellectuals. In his 1956 keynote speech, Premier Zhou Enlai explained the party view that the overwhelming majority of intellectuals had become government workers in the cause of socialism and that they were already part of the working class. In the early 1960s, while intellectuals as a whole had not recovered from the bitterness of the Anti-Rightist Campaign, Zhou Enlai reiterated at the 1962 Guangzhou conference that the overwhelming majority of intellectuals worked enthusiastically for socialism, accepted party leadership, and were ready to go on remodeling themselves so as to become working class and thus they should not be regarded as bourgeois. Also at the conference Vice Premier Chen Yi declared boldly, "China needs intellectuals, and needs scientists. For all these years, they have been unfairly treated. They should be restored to the position they deserve." He encouraged intellectuals to take off the hat of "bourgeois intellectuals" and put on the crown of "intellectuals of the working class" (*tuomao jiamian*) (Nie, 1988: 722–3).

Nonetheless, during the Cultural Revolution, intellectuals were denounced sharply as the "stinking number nine" (*chou laojiu*) at the bottom of the barrel as social outcasts after landlords, rich peasants, counter-revolutionaries, bad elements, rightists, traitors, spies, and capitalist roaders (leaders who took the capitalist road). In addition, China's political leadership has always perceived any appeal from the Chinese intellectual community, in particular in the form of pleas for greater freedom and autonomy, as threatening to the legitimacy and authority of the regime; as a result, the CCP has felt it necessary to exercise a heavy political hand. This explains why the "blooming and contending" period turned into a retaliatory strike intended to suppress intellectuals; the party could not accept the claims of intellectuals that only experts were capable of properly governing research establishments and only professors were qualified to run the country's colleges (*zhuanjia zhi suo, jiaoshou zhi xiao*). This also helps to explain why even during the reform era of the 1980s, when intellectuals advocated that they should be able to make their own decisions relating to their work and thus required more freedom and autonomy, that such advocacy was regarded as a serious threat to the CCP monopoly on S&T practices.

The party fought back on several occasions, with the Campaign Against Spiritual Pollution in 1983, the Anti-Bourgeois-Liberalization

Campaign in 1987, and the suppression of the pro-democracy movement in 1989 (Goldman, 1994: 256–360; Meisner, 1996: 349–467). Ironically, however, despite the paranoia that seems attached to these actions, the CCP has needed to move in the direction demanded by the intellectual community as well as the imperatives of its modernization goals. Without the contributions of Chinese intellectuals, continued technological progress and economic prosperity could not be ensured, which actually presents a potentially bigger threat to the regime's claims of legitimacy.

Third, the utilitarian value of Chinese intellectuals determined that they should be "united with, educated, and remolded," as the CCP Central Committee defined in the Fourteen Articles on Scientific Work in 1961, so that existing prejudices against intellectuals could be dispelled (Nie, 1988: 719). To "unite" meant that the party was interested in utilizing the expertise of intellectuals, who were, in the meantime, required to be "educated" or to "educate" themselves through engaging in ideological reform and in the study of communist ideology, Marxism–Leninism–Mao Zedong Thought in particular, and to "remold" their bourgeois ideas. Thus, Chinese intellectuals had not only witnessed and participated in, but have also become targets of, political campaigns – from the thought-reform movement in late 1951, the Anti-Rightist Campaign in 1957, and the Cultural Revolution to various campaigns in the 1980s, in which they had been attacked and mobilized to have their bourgeois ideology transformed. For better or worse, most Chinese intellectuals had decided to retreat from taking a pro-active, highly visible stance, by pulling their heads in. Only during the most recent period has the theme of "uniting with, educating, and remolding" undergone a fundamental change.[2] Nevertheless, education focussing on communist ideology still is required for college students. In the aftermath of the 1989 Tiananmen Square crackdown it became mandatory that those newly admitted into colleges should spend their first year in military camps to enhance patriotism and prevent them from following the footprints of their predecessors; this routine still operates, despite a shorter period.

Ultimately, the party's expectation is that intellectuals will become "both red and expert" (*you hong you zhuan,*) and that they will

[2] Nie Rongzhen pointed out, "Now that intellectuals are part of the working people, we should no longer use the slogan of 'uniting with, educating and remolding' intellectuals" (Nie, 1988: 719).

maintain their loyalty and support for the CCP. Here, "redness" means possession of political consciousness in adhering to revolutionary lines and implementing party policies, while "whiteness" is used to denote bourgeois, or counter-revolutionary, ideology (Ogden, 1992: 293). The "red versus expert" issue remained a source of great frustration for many Chinese intellectuals from the late 1950s to the 1980s. In order to conquer "whiteness," and eventually become "red experts," intellectuals were subjected to long and difficult processes of "political re-education" and "ideological reform" through attending endless political study sessions, undergoing frequent criticism and self-criticism, and doing manual labor at factories and farms. More often than not the party used the terms "red" and "white" at will, depending on the prevailing emphasis: *virtuocracy* or *meritocracy*. At one time, the party proclaimed that intellectuals were "red" because of their devotion of expertise to China's socialist construction; at another, the CCP articulated a need to take away "white flags" and establish "red flags;" that is, to criticize bourgeois intellectuals and nurture revolutionary intellectuals (Wang, 1994: 237–40).

In the prevailing anti-intellectualism situation found after the 1957 Anti-Rightist Campaign, Nie Rongzhen, who was then Vice Premier and Commissioner of both the State Science and Technology Commission (SSTC) and the National Defense Science and Technology Commission (NDSTC), led an effort, in 1961, to draft "The Fourteen Articles on Scientific Work" (Nie, 1988: 720). The document defined two criteria for being a "red" scientist – supporting the CCP and socialism and using knowledge in the service of socialism. Accordingly, a scientist who had fulfilled these two criteria might be regarded as having become basically "red;" as for those scientists trained prior to 1949 the party only required that they be patriotic and willing to cooperate with the CCP. The document also suggested abolishing the term "white expert," because ambiguous linkage of the concepts of "expertise" and "whiteness" dampened the enthusiasm of those intellectuals who worked diligently in their fields (Yao *et al*., 1994: 102–3). At the 1978 national conference on science, the first after the Cultural Revolution, Deng Xiaoping, then just rehabilitated, clarified the "red and white" issue by pointing out that working devotedly for socialist scientific enterprises and making contributions to them is a sign of being an expert as well as being "red" (Deng Xiaoping, [1978] 1987: 46). The "Three Represents" theory put forth by former CCP

General Secretary Jiang Zemin also acknowledges the redness of Chinese intellectuals.

Because of the four issues involved in the interaction between the CCP and intellectuals – the utilitarian values of intellectuals; their class characteristics; the "uniting with, educating, and remolding intellectuals" policy; and the "red and expert" requirement, Chinese intellectuals have experienced a sort of "emotional rollercoaster," fluctuating between the highs of high-level recognition and effective utilization and the lows of harsh treatment (Williams, 1999: 83). Now, while giving the highest priority to the development of S&T and initiating the "rejuvenating the nation with science, technology, and education" (*kejiao xingguo*) and the "empowering the nation through talent" (*rencai qiangguo*) strategies, the party has reaffirmed the utilitarian values of intellectuals in general, and technical professionals in particular; increasingly intellectuals are recognized and appreciated for their roles in society and contributions to the economy. The occupational prestige of scientists and engineers has been among the highest, comparable with that in developed countries. For example, the 2003 survey on Chinese public attitudes toward S&T showed that scientists, physicians, and engineers received higher occupational prestige scores, ranking second, third, and seventh out of the 14 occupations identified (the first was teachers) (MOST, 2005: 131). It is against this background that one may examine the utilization of scientists and engineers – a strategically important intellectual stratum that both the party and the state must rely on to achieve the nation's ambitious economic goals and technological objectives.

Job assignment, promotion, mobility, and reward

Under the planned economy, policies concerning the recruitment of science and engineering personnel and their job assignments, as well as promotion and rewards, underwent several changes, though their essence was retained for most of the Maoist period and beyond. During that time, Chinese students not only received free higher education, but also had their jobs secured through a very structured job assignment system (*fenpei*). Indeed, graduates from Chinese tertiary institutions of learning had to fulfill an obligation for the education they received. In this way, they not only worked where they were directed by the state, but also entered a social structure in which a single, bureaucratic framework defined desirable positions in various state-owned institutions and enterprises. They were willing to accept their job assignments because they received stable employment and lifetime job security, the possibility of climbing the cadre ladder, and assorted benefits such as subsidized housing, healthcare, and education for their children, among others. Nevertheless, in many ways, they were often coerced into accepting the options they were given because they were neither allowed nor able to make their own job choices (Davis, 2000). In some cases, husbands and wives were separated because the job system did not pay special deference to the needs of the family. Of course, preferable jobs usually went to the children of politically privileged groups – cadres and party members – because the CCP, through its organizational departments at different levels, maintained firm control of job assignments. As a result, while the Maoist policies on higher education and job assignment were intended to prevent urban bourgeois parents from passing their favored social status on to their children, these policies had the unintended consequence of being utilized by the so-called "new" preferred groups to achieve the same "old" purpose.[3]

Taking into consideration a student's political loyalty, academic credentials, and recommendations from a university (with possible

[3] This is ironic because, in the 1960s and 1970s, Chinese policies regarding so-called "manpower planning" were moving in directions advocated by many key international development agencies. At the time, in many Third World countries, too much money was being spent on educating an elite while the rest of the population was being neglected. Moreover, the education policies in place were indeed focussed on the "ivory tower" of high-end intellectuals and there was too little investment in the basic technical skills and know-how needed to operate the economy at a very basic level. The Chinese-announced emphasis on vocational and mass education was, therefore, not out of step with efforts being made to move many developing nations in the same direction. Unfortunately, as suggested above, over time a serious gap between theory and practice emerged in China, as education for the political elites never really took a back seat to more practical education in trades and basic technologies. Of course, one could cite the "*xiafang*" (sending to the countryside) policies adopted during the Cultural Revolution to bring intellectuals into closer contact with the masses as evidence that the Maoist system was committed to breaking down the ivory tower mentality that prevailed at the time. Although true, and very damaging in terms of its long-term economic consequences, it also is the case that the old system was never dismantled to the point of altering the traditional philosophical foundations of intellectuals as a group.

involvement of professors), unified job assignment to a specific *danwei* – a university, a research institute, an enterprise, or a government agency – as well as the location of the specific *danwei* might or might not be what the individual in question personally desired. Usually, the nation's actual or perceived need rather than a graduate's academic achievement and preference carried more weight in the assignment process. Although there were cases in which job assignments were made outside the specialized skills or training of graduates, in many instances the assignment was "rational" in so far as it did attempt to match a student's field of study, broadly defined, to a specific job. In this way, particular assignments met the interests of both students and *danwei*. For example, a student majoring in chemical engineering might be assigned to a factory to solve its pollution problem, to a research institute to develop new polymers, or to a college to teach introductory chemistry. In other words, at least in theory, the job assignment system represented a bridge between the demands of the economy and the supply side of the education system.

More important, however, a specific job assignment was meant to be permanent, thus determining a student's career prospects. Usually, when an individual started a job they could envision their career path and map all the way until their time of retirement. Given the very low level of job mobility in China at that time, other than the reassignment by the state, if a student did not like the *danwei* or the job, or they did not perform well in the particular job assigned, there really was no institutional mechanism for them to transfer to another *danwei* or job. Until recently, household registration, or residence permit system (*hukou*), further prevented Chinese from migrating not only from rural to urban areas but also from one city to another; the personal dossier (*dang'an*) of an individual, which contained lifelong personal information – from family background, educational attainment, employment history, and political attitude – was controlled by the party branch of an employee's *danwei*, and without formal endorsement there was almost no way to initiate a job change. Meanwhile, the rigidity of the system also meant that *danwei* often had no way of hiring an employee directly, not to mention letting them go. Therefore, many of China's scientists and engineers found themselves underemployed or misemployed; it was often the case that their skills and talents or specialized training could not be leveraged in an optimal fashion.

At present, along with free higher education, the job assignment system has been dismantled except in a few select cases in which students are admitted to a particular *danwei* of importance to the nation, which pays for their study and thus those students are required to work for that particular *danwei*. For example, universities usually enroll some students designated for the military and national defense S&T sector. On one hand, graduates now have an opportunity to choose their job and their own future, and to move to another *danwei* if they do not like the one they have selected. In addition, enterprises and institutions have become more selective in hiring as they seek candidates who not only have excellent potential, but also are willing to grow with them and rise through the ranks. On the other hand, not only does a student have to take on the burden of paying for their education today, but, as Chinese universities have churned out more graduates in recent years, job-hunting has also become more competitive. As graduates are attracted to those jobs with higher pay and brighter career prospects, many positions which do not provide these immediate benefits remain in desperate need of key talent; organizations continue to have increasing difficulty competing for, recruiting, and retaining qualified employees. To some extent, foreign-invested enterprises (FIEs) in China have an advantage over domestic institutions and enterprises, as evidenced by the increasing numbers of scientists and engineers working for them (see Table 3.8), as do some non-state-owned domestic enterprises. Of course, the decision to work for a foreign firm that pays more and offers more job perks does represent a rational response to real market forces. Nonetheless, in many sectors market forces have yet to kick in fully in terms of fostering appropriate wage adjustments and changes in benefits packages to accord with the recruitment challenges that continue to exist throughout the Chinese economy, especially outside the three most-preferred job locations: Beijing, Shanghai, and Guangzhou/Shenzhen.

With a science and engineering bachelor's degree, a graduate used to start as an assistant engineer at an enterprise, a research assistant at a research institute, or as an assistant lecturer at a university. But nowadays, the minimum requirement for employment at institutions of learning is a master's degree and a doctorate for new faculty at CAS institutes and leading Chinese universities. The inflation of credentials in employment occurs not only because jobs require more advanced knowledge to perform them effectively, but also because more students with higher level education are available for them as a result of the expansion of higher education (see Chapter 4).

Maoist China was characterized by egalitarianism, under which most employees were paid at relatively low wage rates. The salary structure reflected this stress on egalitarianism; since employment was for a lifetime, there was a belief that job security offset any unfairness in the system in terms of those who worked harder or contributed more than others. The cradle-to-grave employment guarantee also carried with it benefits ranging from subsidized apartments, healthcare, education for children, and retirement pensions to soap and toilet paper. Promotion was expected every several years and was mainly based on seniority – age and years of experience, but not necessarily on achievement and performance. Promotion was also gradual with differences between grades (*jibie*) in terms of salary being incremental and small. This emphasis on egalitarianism became the underpinning of what eventually came to be called the "iron rice-bowl" (*tie fanwan*) or was vividly described as "every one eating from the same big bowl" (*chi daguofan*); again, the system helped to provide employment stability and security, but it constrained individualism, discouraged competition, limited creativity and initiative-taking, and did not promote entrepreneurship.

Currently, with the "big rice-bowl" having been smashed with the advance of the reform programs under Deng Xiaoping, pay differentials within and across *danwei*, sectors, and ownership structure have become much more significant and promotions more meritocratic. Many foreign and local human resources consultancy firms have been called into enterprises in China, domestic as well as foreign-invested, to restructure the personnel system and create new, performance linked compensation schemes. Entire new job definitions have been developed to ensure that job responsibilities are clearly defined and that performance criteria are unambiguously spelled out. Interestingly, while employment in FIEs may seem attractive in the current economic environment, it also is the case that the competitive pay positions associated with them or non-government entities simply do not provide the same safety net as employment at state-owned *danwei* used to offer. As a result, for many employees, job security has become a real and serious concern. Not only have workers from state-owned enterprises been laid off, professors at universities and senior scientists at research institutes face the possibility of termination for poor performance as tenure is not guaranteed. For example, in implementing the Knowledge Innovation Program, the CAS has streamlined its research institutes according to fields of study to reduce redundancy and raise efficiency; some research personnel have been discharged because of fit and performance issues. The CAS also pioneered the separation of professional rank and appointment, which means that even someone who is qualified to be a senior scientist is not necessarily sure that he or she will receive such an appointment (Suttmeier *et al.*, 2006).

As mentioned, job mobility was almost impossible during the Maoist period and its immediate aftermath. Institutionally, as noted, *hukou* and *dang'an* were barriers that banned scientists and engineers from changing jobs. Worse, the "big rice-bowl" mentality of egalitarianism discouraged them from actively looking for new positions where they could utilize their expertise better and more effectively. Consequently, according to the SSTC, the predecessor of the Ministry of Science and Technology (MOST), only 2% of scientists and engineers changed *danwei* in 1983, and 4% did so in 1985. Likening the immobility of S&T personnel to "a pool of stagnant water," China's scientific leadership vowed to find solutions (Saich, 1989: 126–35). The reform of China's S&T system, which started in the spring of 1985, encouraged and facilitated the mobility of scientific and engineering personnel, especially from institutions of learning to enterprises. Since this represented a major break – not only from the prevailing practices that had become highly institutionalized in China since 1949 but also with the political control of scientific personnel that the CCP had held through the job assignment system – it took many years to overcome a variety of key obstacles and make job mobility for scientists and engineers, and for employees as a whole, possible and easier.[4] Nowadays, more and more Chinese do not believe in working for the same *danwei* for their whole life and they change jobs more frequently, for pay increases as well as career opportunities. Scientists and engineers are no exception.

As described in Chapter 3, since 1999 China has reconstructed its research sector by enterprising a significant number of applied

[4] In theory, the CCP, through its organization department at various levels, still controls *dang'an* of all cadres, according to the principle of "the party administers cadres."

Table 5.1 ***Mobility structure at China's research and development (R&D) institutes (1998–2005) (%)***

	1998	1999	2000	2001	2002	2003	2004	2005
Moving in from:								
Enterprises	17.2	15.0	13.1	13.2	12.4	11.4	9.3	8.5
Institutions of higher education	47.0	51.4	47.4	41.2	51.7	55.0	59.0	60.5
R&D institutes	7.2	9.0	13.7	15.4	13.5	12.0	9.0	7.9
Overseas	0.5	0.5	0.9	0.9	1.3	1.8	1.7	1.1
Moving to:								
Government	14.8	10.0	12.3	15.8	18.9	19.5	22.2	22.4
Enterprises	51.5	51.6	41.0	34.1	36.7	36.4	36.7	32.5
Overseas	13.8	14.2	16.5	12.0	14.9	11.8	8.2	9.1

Source: **Ministry of Science and Technology,** 2007: 64–5.

research-oriented R&D institutes. In 1998, China had some 590 000 S&T personnel working at 5778 R&D institutes; by 2003, both the numbers of S&T personnel and the number of R&D institutes decreased to some 410 000 and 4169, respectively (MOST, 2005: 45), as a result of the restructuring. R&D institutes have started to see a net increase in employment after several years of decline, mainly from new graduates who are not only younger but also highly educated. In addition to retirements, many S&T personnel have moved from R&D institutes to enterprises, government agencies, and overseas positions, in that order (MOST, 2007: 62–7) (Table 5.1).

Of course, accompanying job mobility is the high turnover rate that exists in all facets of China's labor market. Fears that new, skilled employees will move on within two to three years for better pay, among others, have jettisoned the efforts of the Chinese government to encourage enterprises and R&D institutes to provide more professional training and skills development. Many chief executive officers (CEOs) inside Chinese companies, for example, have refrained from supporting this type of professional cultivation because they feel that such "investments" will be wasted. This is one of the reasons why many enterprise CEOs in China have been criticized for short-term thinking. As the situation suggests, however, when examined in the context of high staff turnover, and from a business and management perspective, this type of thinking may not be totally illogical.

Finally, to encourage sustained high levels of performance, the Chinese government has established a series of science awards to reward scientists and engineers for their achievements and to stimulate their further pursuit of excellence. The nature of these rewards has evolved as well. The 1956 Natural Science Award, China's first, was largely politically motivated. One of the first-class awards went to the aerodynamics scientist Qian Xuesen for his book, *Engineering Cybernetics*, which, according to the initial stipulation, could not be considered as it was published abroad and the award was supposed to target achievements made within China. A special case, however, was made for Qian, who returned from the USA in 1955. Measured by quality, his work no doubt well deserved an award; the decision to reward him, however; was used as a political gesture to lure more returnees (Li, 1995). No more awards were given until 1982 when the reward system was resumed and later was extended from national to provincial and municipal levels. For many years, rewarding scientists by way of such awards was surprisingly linked to increases in their income and improvements in their living conditions; the awards themselves carried token monetary value, but entitled recipients to other material benefits from the *danwei*, such as housing and promotion. They served as a form of bonus to scientists at a time when there were no other ways to do so. As a result, institutions at all levels were empowered to present awards to outstanding technical personnel. Because of these unintended consequences, the reward system was somewhat abused. In 2000, the state decided to abolish all awards at provincial and municipal levels, and consolidated three national science awards – a natural science award, an award for inventions, and an award for the promotion of S&T progress – which are given annually. In the meantime the government established a national superior science and technology prize, which carries a monetary value of RMB 1 million; the prize rewards two Chinese scientists who have made tremendous contributions to national basic and applied scientific research every year.

High-tech entrepreneurship

The reform of China's S&T system in the mid-1980s, mentioned above, also aimed at improving links between research and the

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economy through technology transfer from institutions of learning to enterprises and more directly through pro-active technical entrepreneurship on the part of the country's S&T talent pool. The earliest expressions of this new emphasis on technical entrepreneurship appeared in Zhongguancun.

Located north-west of Beijing, the capital of China, Zhongguancun is no doubt the nation's most talent-intensive region; it is home to Beijing University, Qinghua University, some 60 institutions of higher education, and more than 200 research institutes affiliated to the CAS, government ministries, and the Beijing municipality. As early as 1980, inspired by the entrepreneurship of the Silicon Valley, Chen Chunxian, a nuclear fusion physicist from the CAS Institute of Physics, founded the first S&T enterprise in Zhongguancun. Back then a significant number of scientists and engineers made great efforts to seek outside support for applied research and development work that could directly benefit the economy and meet market needs. For example, technological findings from the CAS were turned to marketable products by more than one-third of the firms along the so-called "Electronics Street" (*Dianzi Yitiaojie*) in Zhongguancun, including the New Technology Company, a spin-off of the CAS Institute of Computing Technology and the forerunner of Lenovo. Founder, another successful Chinese start-up, was a spin-off from Beijing University, whose Chinese electronic publishing systems have come to dominate the world's Chinese publishing market (Lu, 2000). These companies promoted technology transfer from universities and research institutes and created a series of products with market potential and competitive edge. As a whole, in its initial development Zhongguancun saw a celebration of S&T start-ups not witnessed before in China's history. Those involved in such "risky" business ventures were said to "jump into the sea" (*xiahai*), highlighting the fact that many of these entrepreneurs were willing to give up secure positions within state-owned or state-run organizations for the chance to run their own companies.[5]

The "Electronics Street" evolved into the Beijing Experimental Zone of New Technology and Industrial Development in 1988 and

[5] The term, *xiahai*, carried a negative connotation when it was first used, meaning "to give up a respectful profession for a disdained one" such as acting and business. In its current usage, it means to jump on the bandwagon of money-making.

became the Zhongguancun Science Park in 1994. Moreover, the Zhongguancun model has stimulated enthusiasm for the rest of the nation to pursue high-technology entrepreneurship. Thus far, 53 science parks have been established at national level, and more at provincial level, where scientists and engineers have seen their initiatives and talents tapped and used to their full extent (Cao, 2004c).

Of course, the emergence of the Zhongguancun area was not without its challenges. Under former CCP Party Secretary Zhao Ziyang, the Zhongguancun "experiment" was monitored and reviewed carefully by the Chinese leadership, primarily because no one knew how it would evolve over time; nor did the leadership fully grasp the consequences of unleashing this type of entrepreneurial energy. The entire experiment almost met its demise after the June 4 Tiananmen Square event in 1989. Evidence began to appear that several local firms from within the zone had supplied funds and support to the Chinese students who were demonstrating in the square. Foremost among these firms was said to be Stone (*Sitong*), which was headed by successful entrepreneur Wan Runnan. Stone, with the help of some technology imported from a Japanese firm, had developed a Chinese printer that was proving to be popular in the local marketplace. When CCP officials discovered Wan's alleged role in the Tiananmen Square events, the entire Zhongguancun experiment was placed in jeopardy as party officials contemplated what to do about the future of Zhongguancun and whether further entrepreneurship should be encouraged. Many of the entrepreneurs were scientists and engineers who had left the security of state institutions to drive forward China's technological edge. Fortunately, even though many CCP members were skeptical, the decision was made to retain the Zhongguancun experiment, and today it is an area of Beijing that is thriving and represents one of the cutting edge areas of Chinese technological advance (Kennedy, 1997).

Entering the era of a knowledge-based economy, high-technology entrepreneurship has become a new fashion among China's young scientific professionals, many of whom are S&T students, especially computer and information technology, and have overseas study and work and entrepreneurship experience. Such companies as Sina, Sohu, Netease, Alibaba, Shanda, and Baidu, among others, have replaced Lenovo, Stone, and Founder as new symbols in this next wave of entrepreneurship and they are not confined to Zhongguancun any more. Listing some of these high-technology enterprises on the domestic and especially overseas stockmarkets has made their founders and core employees – many educated in the field of science and engineering themselves – into millionaires and even billionaires. These scientist-and-engineer-turned entrepreneurs have started to appear on the Chinese "richest lists," although non-high-technology entrepreneurs, especially real-estate developers, still dominate such lists. These companies may not pay their employees and even executives high salaries compared with their counterparts in the West (Kanellos, 2007), but they promote stock options and other incentives as a means to attract, retain, motivate, and compensate those who have accepted the risks associated with ventures whose longevity and survival are often uncertain even under the best of circumstances.

As mentioned, China has also attracted a significant amount of foreign direct investment, which has moved up the value chain from the labor-intensive manufacturing of toys, clothing, and furniture to more technology-intensive and R&D-intensive high-technology products, from computers and telecommunications equipment to semiconductors. China's coming of age as a new base for R&D endeavors by MNCs has created additional channels of opportunity for the utilization of Chinese technical talent. Some foreign firms, such as Intel, for example, have actually become the source of funds to enable some start-up enterprises to get off the ground. In the late 1990s, Intel created a new-venture fund in China to support the development of Chinese-language content products and software as a means of sparking the growth and expansion of personal computer sales, especially among Chinese consumers. Similarly, IDC, a Massachusetts-based information company that has made major investments in Chinese-language information technology-(IT-) related publications, established a similar fund focused on enabling local high technology start-ups to grow their businesses. Finally, the world of US venture capital has now found its footing in China and is gaining traction in identifying new business venture opportunities among the newest wave of Chinese technology entrepreneurs. Many of these firms have deployed ethnic Chinese staff, many with MBA degrees from some of the best business schools in Europe and the USA, to help build relationships and identify emerging investment opportunities. This all suggests that we have only seen the tip of the iceberg in terms of new career paths for scientists and engineers who are willing to bypass traditional career opportunities and explore the notion of starting and running their own businesses. In addition, this all supports the notion that continues to gain currency in China and is popular among returnees – "it is better to be the head of the chicken than the tail of the ox."

In many ways, the emergence of this new class of "technological entrepreneurs" represents the cutting edge of China's new industrial architecture. The future face of the Chinese economy, and the key source of China's evolving competitive advantage, will increasingly come from this new stratum in the economy. And, moreover, it will likely spearhead the transition to the knowledge economy that Chinese leaders are determined to nuture over the coming years.

Career prospect of young scientists

It is known that many of the most creative advances come from young researchers, and thus having a generation of young scientists and engineers in the pipeline is vital to a country's scientific enterprise. Fortunately, as mentioned in Chapter 3, China's S&T workforce, even at the leadership level, is not only well educated, but is also getting younger with a group of 45-year-olds becoming the core of the talent pool. Given the generation gap wrought by the Cultural Revolution and the "brain drain," young Chinese scientists shoulder more than their counterparts elsewhere, who have a historical responsibility for receiving the baton from the older generation and passing it along to the younger one. Over the years, the Chinese government and various S&T and educational institutions have initiated various programs to nurture leaders of Chinese science, and have made great efforts to lure young and outstanding scientists from overseas. The Cheung Kong Scholar Program under the Ministry of Education, the One Hundred Talent Program at the CAS, and the National Science Fund for Outstanding Young Scientists at the National Natural Science Foundation of China are such programs. As will be discussed in Chapter 6, many returnees have not yet established themselves, therefore, support from these programs has had an effect on them launching a successful career in China and becoming leaders within China's scientific community (Cao & Suttmeier, 2001).

However, given the limited number of scientists included in these programs, their experiences may not be representative. China's doctoral programs produced a record high number of PhDs in science and engineering in 2006, and the pipeline of students studying science and engineering at doctoral level has been filled. To China, the availability of a large number of young scientists willing to work very hard for relatively little financial compensation compared with other professions (to be discussed in the next section) is an asset that could contribute to China's scientific enterprise. Some observers believe that China's major competitive weapon will be its ability to move from an economic model, driven by cheap labor and cheap foreign capital, to a knowledge economy, driven by inexpensively generated intellectual know-how (Stevenson-Yang & DeWoskin, 2005). But, as prospective scientists, newly minted PhDs are certainly concerned about the availability of funding for their careers. Indeed, there is little doubt that the way Chinese young scientists are utilized and the nature of the environment in which they work are critical to maintaining the momentum for China's future development in S&T. In particular, their treatment in obtaining support for their research, promotion, and compensation to some extent will determine whether a scientific career is appealing for future bright students and whether science is a career path for those who are active in the workforce. Data about the number of young scientists receiving grants from the NSFC, China's major funding agency for basic research and applied-oriented basic research, represents a useful proxy of understanding their utilization (Table 5.2).

Among various types of funding at the NSFC, in 2006, general programs (*mianshang xiangmu*) supported projects with an average of RMB260 000 (US$33 000) for three years and projects receiving support under key programs (*zhongdian xiangmu*), involving participants from more than one institution, received average grants of RMB1.5 million (US $188 000) for four years. Apparently, grantees of the general program were, on average, 41.15 years old in 2006 compared with 43.28 years old in 2001, while those supported by the key program have also witnessed a drop in their average age from 52 years old in 2001 to 49 years old in 2006.

In 2001, about a quarter of the general grants went to scientists aged 35 years and younger, at which age they likely had just received their PhDs; by 2006, the grants going to that age group increased to about 30 percent, although the big-money key programs have experienced no percentage change for the same age group of principal investigators in between.

If in 2001 the 31- and 50-year-old age groups accounted for some 70% of general program grants; in 2006 scientists at these ages were

Table 5.2 (a) *Age profile of recipients of general programs at the National Natural Science Foundation of China (persons, %)*

			Age group (years)											Average age (years)
Year		Total	25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71	
2001	N	4 435	4	212	858	1 331	604	341	238	398	326	95	28	43.28
	%	100.00	0.09	4.78	19.35	30.01	13.62	7.69	5.37	8.97	7.35	2.14	0.63	
2002	N	5 808	2	335	1 080	1 795	843	590	261	419	334	113	36	42.57
	%	100.00	0.03	5.77	18.60	30.91	14.51	10.16	4.49	7.21	5.75	1.95	0.62	
2003	N	6 359	2	401	1 282	1 842	1 044	731	303	381	240	103	30	41.83
	%	100.00	0.03	6.31	20.16	28.97	16.42	11.50	4.76	5.99	3.77	1.62	0.47	
2004	N	7 711	1	513	1 542	1 849	1 734	939	380	360	247	111	35	41.73
	%	100.00	0.01	6.65	20.00	23.98	22.49	12.18	4.93	4.67	3.20	1.44	0.45	
2005	N	9 111	3	582	1 906	2 010	2 368	1 047	422	343	275	116	39	41.49
	%	100.00	0.03	6.39	20.92	22.06	25.99	11.49	4.63	3.76	3.02	1.27	0.43	
2006	N	10 271	5	725	2 312	1 939	2 906	1 106	558	327	239	114	40	41.15
	%	100.00	0.05	7.06	22.51	18.88	28.29	10.77	5.43	3.18	2.33	1.11	0.39	

Table 5.2 (b) *Age profile of recipients of key programs at the National Natural Science Foundation of China*

Year	Total		Age group (years)											Average age (years)
			25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71	
2001	N	124	0	0	2	23	26	7	13	13	26	12	2	51.88
	%	100.00	0.00	0.00	1.61	18.55	20.97	5.65	10.48	10.48	20.97	9.68	1.61	
2002	N	208	0	0	8	48	28	28	11	21	35	23	6	51.12
	%	100.00	0.00	0.00	3.85	23.08	13.46	13.46	5.29	10.10	16.83	11.06	2.88	
2003	N	252	0	1	3	52	43	41	15	27	39	22	9	51.08
	%	100.00	0.00	0.40	1.19	20.63	17.06	16.27	5.95	10.71	15.48	8.73	3.57	
2004	N	224	0	0	6	40	52	48	11	22	21	13	11	49.58
	%	100.00	0.00	0.00	2.68	17.86	23.21	21.43	4.91	9.82	9.38	5.80	4.91	
2005	N	303	0	0	5	40	94	61	21	33	18	21	10	49.35
	%	100.00	0.00	0.00	1.65	13.20	31.02	20.13	6.93	10.89	5.94	6.93	3.30	
2006	N	277	0	0	6	26	99	58	22	19	24	15	8	49.08
	%	100.00	0.00	0.00	2.17	9.39	35.74	20.94	7.94	6.86	8.66	5.42	2.89	

Source: www.nsfc.gov.cn (accessed on October 2, 2007).

awarded 80% of such grants. Likewise, in the competition for key program project support, the same age groups of principal investigators had seen the portion receiving grants increase from some 55% in 2001 to almost three-quarters (75%) in 2006. In particular, while the age groups of 41–45 and 61–65 seemed to stand out in 2001 in terms of receiving grants from key programs, five years later, those aged between 41 and 50, the so-called "middle-aged scientists," became important recipients of the key program support – gobbling up more than half of the larger grants. Although we do not know how likely a young scientist compared with an older one is to win an NSFC grant, we may conclude that there has been a trend in so far as younger and younger scientists are receiving larger and larger shares of NSFC grant monies.

Utilization and income of scientists and engineers

In discussing the utilization of scientists and engineers, we cannot ignore the issue of compensation, even though salary rates alone are not an accurate measure of the real value of scientists and engineers as a whole. Compensation trends in China seem to reflect the country's growing integration into the global talent pool, especially among the high-end component of the Chinese talent pool.

In pre-reform China, intellectuals as a whole received a salary higher than that of manual laborers, although it was lower compared with wage levels before 1949 when the People's Republic was established (Chen, 2004). Indeed, high-ranking intellectuals (*gaoji zhishi fenzi*) were in the highest income bracket in China and enjoyed favorable treatment in housing, healthcare, and other benefits (Cheng, 1965: 149–54). Scientists and engineers were especially privileged, enjoying not only higher social and political status but also material benefits associated with that status. Even in the early 1960s, when the country experienced extreme economic difficulties in the aftermath of the Great Leap Forward, and both staples and scarce consumer goods were rationed, those involved in strategic weapons programs, many being very senior in the scientific community and returnees from the West, were given special treatment (Nie, 1988). This is one of the reasons why intellectuals were attacked severely during the Cultural Revolution. Nevertheless, despite being attacked, being sent to factories and the countryside, losing many of their privileges, and having their salaries cut, they still were better off than factory workers economically. College graduates, including those "worker–peasant–soldier students" (*gongnongbing xueyuan*), still earned a salary similar to their predecessors before the Cultural Revolution, which was higher than most others. What frustrated intellectuals the most was that their knowledge was not appreciated and utilized, and that their loyalty was called into question simply because they were honest (and perhaps courageous) enough to state their opinions about what was right or wrong with the regime.

In the aftermath of the Cultural Revolution, the four modernizations drive, launched in 1978, called for the respect of knowledge and talented people. Leaders such as Deng Xiaoping, after traveling abroad to places such as Japan and the USA, recognized just how far behind the rest of the world China had fallen economically and technologically. A major commitment from the highest echelons of the Chinese leadership was made to close the prevailing gap as quickly as possible. Chinese intellectuals saw their "damaged" images cleaned and their political and social status restored. However, higher social prestige was not translated into decent economic benefits during the early reform era; in reality, intellectuals were disappointed by their inability to cash in on the regime's new reforms and open-door policy. Ironically, the early beneficiaries of market-oriented reform, between the late 1970s and the early 1990s, were private entrepreneurs (*getihu*) who became prosperous or rich first by taking advantage of loopholes in the law and engaging in activities, some of which, from the perspective of the twenty-first century, might be considered to be dishonest, unethical, and illicit, if not illegal. This was the new era of Deng Xiaoping and the most popular notion was "to get rich is glorious." This resulted in an "inversion of intellectuals and manual laborers in income" (*nao ti daogua*). There was a frequently quoted saying, "those who made atomic bombs earn less than those peddling tea-leaf-soaked eggs on the street, and those who perform surgery earn less than hair-cutters" (*zao yuanzidan buru mai chayedan, na shoushudao buru na titoudao*),[6] implying that compared with other social groups that benefited more from the reforms initiatives, scientists, surgeons, and intellectuals as a whole earned an income in

[6] In Chinese, *dan* in *yuanzidan* and *chayedan* share the same pronunciation, while *dao* is knife of different types in *shoushudao* and *titoudao*.

reverse proportion to their contribution to society. In fact, one of the reasons why intellectuals supported the pro-democracy movement in 1989 was that they felt poorly treated, underpaid, and burdened with difficult living conditions (Miller, 1996).

Intellectuals were also constrained by the cultural tradition (and constraint) of despising money and business. In the mid-1980s, the reform of the S&T management system aimed at not only strengthening the linkage of research and the economy and raising the efficiency of scientific research, but also holding the scientific workforce accountable for results. Consequently, many scientists and engineers had to find funding for their research themselves and to become involved in technology-transfer activities from which they may gain some money to supplement their salary. Quite a number of scientists and engineers from state-owned enterprises and institutions had to "moonlight" at township and village enterprises at weekends, thus receiving the name of "Saturday engineers."[7] In fact, one of the reasons why intellectuals supported the pro-democracy movement in 1989 was that they felt poorly treated, underpaid, and burdened with difficult living conditions (Miller, 1996).

Nevertheless, one of the major sources of difficulty experienced by the more entrepreneurial of these scientists and engineers was the uncertainty surrounding the rules about what they were or were not allowed to do to earn extra income. Several engineers, who ventured out as "consultants" to various localities to assist township and municipal governments address a range of technical problems and issues, soon found themselves in political hot water when they requested payment for their services. Some were reprimanded for violating socialist principles, while others received even harsher treatment when their attempts to secure payment were met with claims of extortion or bribery. There also were several instances where engineers tied their compensation to actual performance and results – a type of "success fee" – only to find that after actually solving one problem or another, their expectations about receiving substantial compensation were deemed unreasonable and underhanded by local officials. In such cases, the engineers were

[7] Such moonlighting activities often created problems within the *danwei* as these scientists and engineers could potentially use their facilities and research. Some had their payments confiscated or even were charged with corruption and theft of state property.

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threatened with imprisonment or substantial fines if they demanded any more than just a token payment for their services. Many simply walked away highly discouraged as well as extremely frustrated about the lack of legal support for actions that had been encouraged by the central government in Beijing.

A series of salary reforms were carried out in the 1980s and 1990s to correct the shortcomings of the compensation system for China's scientific and technical community (Cooke, 2004). These reforms were also a response to the realization that the country was suffering from a shortage of talented personnel; economic hardship had driven many young qualified academics to leave for better life and career opportunities overseas. This situation gradually led to a "war for talent." The impact of this intensified competition for brainpower may be seen in the changes that were introduced across many Chinese institutions of learning; they included increases in salaries and other benefits. The 1985 salary reform, for example, stipulated that an individual's salary be composed of three parts: a basic component, a seniority component, and a component associated with the position held. One of the considerations in the S&T reforms was to allow scientists and engineers to transfer technology and to set up high- and new-technology companies as a way of supplementing their income. In 1986, the government authorized universities, research institutes, hospitals, and other *danwei* to appoint and promote professionals, with those appointed and promoted receiving a salary increase. By 1992, out of the 23 million professionals, 5.42 million had reached senior ranks (Chen, 2004: 229–45). The government further allowed scientists and engineers to have concurrent positions by legitimating the "Saturday engineer" phenomenon, and to receive part of their income from consulting and technology-transfer. Some provinces started to reward scientists and engineers who had made tremendous contributions to the local economy with passenger cars, houses, and bonuses as high as half a million RMB.

Institutions of learning have also experimented with new incentives to entice and retain excellent scholars. In 1997, for example, Qinghua University started to offer a special stipend to some of its faculty members. In 1999, when the 985 Program was initiated, Beijing and Qinghua universities used part of these government funds to raise the salaries of their faculty members and recruit new professors from overseas. At Fudan University in Shanghai, under a similar scheme, faculty members received an annual stipend ranging from RMB10 000 to RMB200 000 depending upon their appointments. As mentioned in Chapter 2, the Cheung Kong Scholar Program, launched in 1998, mandates that its recipients receive a stipend of RMB100 000 from the Ministry of Education, on top of their regular salary and other benefits, including housing, from the universities where the endowed professors work. The One Hundred Talent Program at the CAS awards a grant of RMB2 million, which includes a housing allowance and a salary component. Universities have also improved living conditions for their faculty members, especially those young and newly recruited, by turning crowded dormitories (*tongzilou*), a kind of building with a long corridor through the middle of each floor lined by small rooms on either side and without private kitchens or lavatories, into truly liveable apartments. In fact, incentives provided at institutional level were sometimes significantly higher than those provided by the programs mentioned above; today, talented professors and scientists can negotiate their salary, housing, research grant, and other fringe benefits directly with their potential employers.

Non-state employers, such as FIEs and especially MNCs, have entered the competition for Chinese talent as well. Those scientists and engineers and other professionals employed by MNCs have seen their salaries and benefits increase several times higher than their counterparts at domestic institutions and enterprises. In fact, according to estimates by the Department of Organization of the CCP Central Committee, employees at China's non-state sector have reached 50 million and growing, including not only workers, peasants, cadres, but also an increasing number of professionals (*People's Daily*, June 11, 2007: 10). Apparently, professionals within the non-state sector have found their knowledge and skills better utilized and better compensated than their counterparts at state-owned enterprises and institutions.

Gradually, scientists and engineers have seen the gap between higher social status and lower material rewards largely disappear. Moreover, since the late 1990s, they have taken important positions and enjoyed not only significant social status but also higher incomes and other privileges, comparable with their predecessors during the pre-Cultural Revolution era and their counterparts in other countries. It appears that today's intellectuals no longer carry the "better performance with cheap compensation" (*jialian wumei*) image of the 1980s. Most intellectuals feel that their overall income level allows them to maintain a high standard of living and are optimistic about their future status with the nation's active promotion of an innovation strategy. The drive to foster the emergence of an innovation-focussed economy has created the conditions for a more symbiotic relationship between the S&T talent community and the Chinese government. With support for innovation at its apex, there is now a sense that the troubles experienced by intellectuals in the past will not re-appear in the near future, especially as the Chinese leadership is heavily dependent on the S&T talent pool to help facilitate the transition to a new economic and technological foundation for future growth and development.

Income of scientific workforce in the reform era

There is no precise information available on the income of Chinese scientists and engineers, nor is there accurate information on the income of Chinese professionals and those who are counted as HRST. The closest systematic information is annual wage by sectors, which shows how employees in the research sector – scientific research and technical services between 1978 and 2002, and scientific research, technical service, and geological prospecting thereafter (Table 5.3) – have fared relative to those in other sectors. It should be noted that although this is not necessarily the most accurate indicator, it does serve as a useful proxy of the group's income in so far as what is reported here is the average of all the employees in each of the respective sectors of the economy.

In 1978 when the reform and open-door initiative started, employees in the scientific research and technical services sector, on average, earned RMB669 (US $398 at the exchange rate of US $1 = RMB1.68) a year, ranked sixth among all sectors, lagging behind those in production and the supply of electricity, gas, and water (RMB850), construction (RMB714), geological prospecting and water conservancy (RMB708), transportation, storage, post and telecommunications (RMB694), and mining and quarrying (RMB674). In the years to follow, along with all employees, those in the scientific research and technical services sector saw their wages increase. However, their rank remained where it was in 1978.

The year 1992 seems to be a watershed; it was at this time that China's then paramount leader, Deng Xiaoping, toured Southern

Table 5.3 (a) *Average wage of Chinese employees by sector (RMB, 1978–2002)*

Year	National	Farming, forestry, animal husbandry, and fishery	Mining and quarrying	Manufacturing	Production and supply of electricity, gas, and water	Construction	Geological prospecting and water conservancy	Transport, storage, post, and telecom-munication	Wholesale and retail trade and catering
1978	615	470	676	597	850	714	708	694	551
1980	762	616	854	752	1 035	855	895	832	692
1985	1 148	878	1 324	1 112	1 239	1 362	1 406	1 275	1 007
1989	1 935	1 389	2 378	1 900	2 241	2 166	2 199	2 197	1 660
1990	2 140	1 541	2 718	2 073	2 656	2 384	2 465	2 426	1 818
1991	2 340	1 652	2 942	2 289	2 922	2 649	2 707	2 686	1 981
1992	2 711	1 828	3 209	2 635	3 392	3 066	3 222	3 114	2 204
1993	3 371	2 042	3 711	3 348	4 319	3 779	3 717	4 273	2 679
1994	4 538	2 819	4 679	4 283	6 155	4 894	5 450	5 690	3 537
1995	5 500	3 522	5 757	5 169	7 843	5 785	5 962	6 948	4 248
1996	6 210	4 050	6 482	5 642	8 816	6 249	6 581	7 870	4 661
1997	6 470	4 311	6 833	5 933	9 649	6 655	7 160	8 600	4 845
1998	7 479	4 528	7 242	7 064	10 478	7 456	7 951	9 808	5 865
1999	8 346	4 832	7 521	7 794	11 513	7 982	8 821	10 991	6 417
2000	9 371	5 184	8 340	8 750	12 830	8 735	9 622	12 319	7 190
2001	10 870	5 741	9 586	9 774	14 590	9 484	10 957	14 167	8 192
2002	12 422	6 398	11 017	11 001	16 440	10 279	12 303	16 044	9 398

Table 5.3 (a) *(cont.)*

Year	Finance and insurance	Real estate	Social services	Healthcare, sports, and social welfare	Education, culture and arts, radio, film, and television	Scientific research and polytechnic services	Government agencies, party agencies, and social organizations	Others
1978	610	548	392	573	545	669	655	
1980	720	694	475	718	700	851	800	
1985	1 154	1 028	777	1 124	1 166	1 272	1 127	
1989	1867	1 925	1 926	1 959	1 883	2 118	1 874	
1990	2 097	2 243	2 170	2 209	2 117	2 403	2 113	
1991	2 255	2 507	2 431	2 370	2 243	2 573	2 275	
1992	2 829	3 106	2 844	2 812	2 715	3 115	2 768	
1993	3 740	4 320	3 588	3 413	3 278	3 904	3 505	3 371
1994	6 712	6 288	5 026	5 126	4 923	6 162	4 962	5 213
1995	7 376	7 330	5 982	5 860	5 435	6 846	5 526	6 295
1996	8 406	8 337	6 778	6 790	6 144	8 048	6 340	7 184
1997	9 734	9 190	7 553	7 599	6 759	9 049	6 981	6 838
1998	10 633	10 302	8 333	8 493	7 474	10 241	7 773	8 481
1999	12 046	11 505	9 263	9 664	8 510	11 601	8 978	10 068
2000	13 478	12 616	10 339	10 930	9 482	13 620	10 043	11 098
2001	16 277	14 096	11 869	12 933	11 452	16 437	12 142	12 590
2002	19 135	15 501	13 499	14 795	13 290	19 113	13 975	14 215

Table 5.3 (b) *Average wage of Chinese employees by sector (RMB, 2003–2006)*

Year	National	Agriculture, forestry, animal husbandry, and fishery	Mining	Manufacturing	Production and supply of electricity, gas, and water	Construction	Transport, storage, and post
2003	14 040	6 969	13 682	12 496	18 752	11 478	15 973
2004	16 024	7 611	16 874	14 033	21 805	12 770	18 381
2005	18 364	8 309	20 626	15 757	25 073	14 338	21 352
2006	21 001	9 430	24 335	17 966	28 765	16 406	24 623

Year	Information transmission, computer service, and software	Wholesale and retail	Hotels and catering service	Financial intermediation	Real estate	Leasing and business service	Scientific research, technical service, and geological prospecting
2003	32 244	10 939	11 083	22 457	17 182	16 501	20 636
2004	34 988	12 923	12 535	26 982	18 712	18 131	23 593
2005	40 558	15 241	13 857	32 228	20 581	20 992	27 434
2006	44 763	17 736	15 206	39 280	22 578	23 648	31 909

Table 5.3 (b) *(cont.)*

Year	Management of water conservancy and public facilities	Service to household and other services	Education	Health, social security, and social welfare	Culture, sports, and entertainment	Public management and social organizations
2003	12 095	12 900	14 399	16 352	17 268	15 533
2004	13 336	14 152	16 277	18 617	20 730	17 609
2005	14 753	16 642	18 470	21 048	22 885	20 505
2006	16 140	18 935	21 134	23 898	26 126	22 883

Source: National Bureau of Statistics, various years.

China to revitalize the reform agenda that had been halted after the 1989 Tiananmen Square crackdown. In that year, the annual wage for employees in the scientific research and technical service sector ranked fifth at RMB3115 (US $565 at the exchange rate of US $1 = RMB5.51). Ten years later, in 2002, that sector moved to the second spot, in terms of wages by employment sectors, with an average annual salary of RMB19 113 (US $2308 at the exchange rate of US $1 = RMB8.28), slightly less than finance and insurance's RMB19 135 (in fact, between 1999 and 2002, these two sectors ranked first alternatively on the sector salary list).

In 2003, China changed the way of reporting its national employee wage statistics, not only combining "scientific research and technical service" with "geological prospecting," into "scientific research, technical service, and geological prospecting," but also adding a new sector – "information transmission, computer services, and software" ("information sector" for short). The latter, which presumably employs a significant number of computer scientists and software engineers, was the sector offering the highest salaries – RMB44 763 (US $5616 at the exchange rate of US $1 = RMB7.97), on average, in 2006, followed by finance (RMB39 280 or US $4928) and research (RMB31 909 or US $4004). More noticeably, wages in the sectors of information and research increased along with an increase in employment, and at a pace that has been faster than the national average, especially in the research sector. This is in contrast to the perception that with more graduates entering the job market every year and competition for jobs becoming increasingly intense, salaries for many technical and professional positions would be lower or at least flat.[8] This seems to suggest that scientists and engineers may finally benefit more, if not most, from the reform and open-door policies. Continuous investment in education and scientific research over the past ten years has led to significant changes in the lives of those working in scientific and technical fields.

Within the research sector, which by definition is composed of research and experimental development, professional technical

[8] This was what happened in the USA in the 1970s when so many Americans had been getting college degrees that the relative wages of white-collar professionals had started to fall. Consequently, it no longer paid to go to college (Freeman, 1976).

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services, services of science and technology exchanges and promotion, and geological prospecting, the S&T workforce includes not only scientists and engineers, but also skilled technicians and other staff. In addition, other sectors also employ scientists and engineers; their wage information is included in these sectors rather than in the research sector. Nevertheless, the research sector, by its nature, appears most likely to employ a higher percentage of scientists and engineers who surely have above-average earning power in the current economic environment. That said, however, because they are deployed across a broad spectrum of the Chinese economy as a whole, the wage rates reported here likely understate the salaries earned specifically by scientists and engineers.

Many of the most competitive pay positions are associated with non-state sectors, most likely FIEs; their employees tend to make more money than their counterparts at state-owned institutions and enterprises in all sectors except higher education and healthcare, where the state still dominates and even monopolizes (Table 5.4). In 2006, state-owned employees earned more than the national average wage and non-state-owned employees, but in the information and research sectors, state-owned employees earned about two-thirds or one-quarter less than non-state employees. In particular, a non-state-owned employee in computer services earned as much as RMB66 749 (US $8375) in 2006. Over the years, the number of non-state-owned employees has closed in on and finally surpassed state-owned employment in the information sector in 2006, although state-owned *danwei* are still the main employers in scientific research with six times more employees than in non-state-owned enterprises.

Again, it is important to recognize that salaries, as reported, represent the average for a sector so that the scientific workforce is quite likely to earn more, sometimes several times more, than has been suggested here. It is reported, for example, that about 40 percent of intellectuals earn an annual salary of more than RMB100 000 (*Nanfang Daily*, January 18, 2003). According to a survey conducted among intellectuals in Shanghai, Guangzhou, and Nanjing, in early 2006, college professors on average earned RMB70 000–100 000 annually (*Outlook Dongfang Weekly*, January 4, 2006).

Over the years, the research sector and the new information sector have been better off when comparing their employees' earnings with the national average. Between the late 1970s and the early 1990s, the

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Table 5.4 *Average wage in the information and research sectors, by ownership (RMB, 2003–2006)*

	2003			2004			2005			2006		
Sector	Average	State-owned	Others	Average	State-owned	Others	Average	State-owned	Others	Average	State-owned	Others
National	14 040	14 577	14 574	16 024	16 729	16 259	18 364	19 313	18 244	21 001	22 112	20 755
Information transfer, computer services, and Software	32 244	26 572	42 867	34 988	29 131	44 683	40 558	31 654	50 509	44 763	34 328	55 135
Telecoms and other information transfer services	30 481	27 096	41 715	32 264	29 458	40 414	36 941	31 590	46 863	40 242	33 947	50 240
Computer services	41 722	14 470	55 406	47 725	22 898	60 701	52 637	32 545	58 470	60 749	41 894	66 327
Software industry	36 873	22 568	38 981	42 835	26 995	44 321	52 784	33 897	54 038	59 385	43 385	60 512
Scientific research, technical service, and geological perambulation	20 636	19 975	26 061	23 593	22 976	29 346	27 434	26 309	35 154	31 909	30 459	41 003
Research and experimental development	22 391	22 307	27 057	25 052	24 851	29 987	29 054	28 597	36 366	33 497	33 065	38 814
Professional technique services	22 046	21 111	26 211	25 349	24 922	28 255	29 460	28 727	33 170	34 723	33 310	41 000
Services of science and technology exchanges and promotion	16 877	15 190	25 981	19 923	18 204	29 852	23 574	19 860	38 608	27 045	23 602	40 372
Geologic prospecting	15 277	15 111	21 427	18 458	17 729	46 494	21 366	20 576	58 293	24 971	24 131	58 046

Source: National Bureau of Statistics, various years.

relative earning power of the research sector was only 1.1, which means that salaries of its employees were 10 percent more than the national average. Later on, the relative earning power of the research sector jumped to around 1.5, while that of the information sector has been over 2.0 since the sector has been treated as a separate item.

Geographically, Beijing, Shanghai, Tianjin, Jiangsu, Zhejiang, and Guangdong are the provinces and municipalities where booming economies have provided employees with a premium salary in almost all sectors (Table 5.5).[9] Employees in the information sector do extremely well in Beijing and Shanghai, and in 2006 saw their salary to be 1.8 times more than the national average in this sector; those in Zhejiang earned 27% more than the national average. For the research sector, Beijing and Shanghai continue to stand out, with employees making 50% more than the national average in 2006, followed by Guangdong and Tianjin. But even in these regions, several non-S&T-related sectors fared better than or as well as the information and research sectors, including finance and public management and social organization. Indeed, civil service, which includes employment in public management and social organization, has become one of the hottest job choices for Chinese graduates, including S&T majors, as such employment not only means a safe job, but also provides good healthcare, a good retirement program and pension, and other such benefits. The earning power of civil service employees in Beijing, Shanghai, and Zhejiang is significantly higher. This explains why, in 2005, about 540 000 people took the civil servant examination, roughly a 16-fold increase over those who took it in 2001 (Fan, 2007).

In addition to the wages paid by employers, Chinese professionals, especially high-ranking ones, also receive various benefits – some intrinsic – from the state and other sources because of official-centeredness, which relates professional title to the *jibie* of a civil servant in terms of benefits. In science and engineering, as mentioned, a member (*yuanshi*) of the CAS or the CAE is entitled to a stipend from the state, though a meager RMB200, life-time employment, and other benefits from regional governments or the institution to which they are affiliated; they also receive de facto privileges equivalent to a

[9] The exceptions are Tibet, Qinghai, and Ningxia, three autonomous regions dominated by minorities, which are most likely receiving favorable treatment and subsidies from central government.

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Table 5.5 *Average wage of Chinese employees, by region and select sectors (RMB, 2006)*

	Average	Information transmission, computer service and software	Financial intermediation	Real estate	Scientific research, technical service, and geological prospecting	Education	Health, social security, and social welfare	Public management and social organization
National	21 001	44 763	39 280	22 578	31 909	21 134	23 898	22 883
Beijing	40 117	81 851	113 092	32 275	54 231	42 565	48 167	48 714
Tianjin	28 682	43 366	59 796	27 939	44 993	29 512	31 299	32 660
Hebei	16 590	27 394	25 081	15 927	26 102	16 117	16 878	15 973
Shanxi	18 300	22 586	24 628	12 092	19 316	17 726	15 582	16 565
Inner Mongolia	18 469	26 139	24 889	15 197	23 772	21 393	20 510	20 553
Liaoning	19 624	39 741	32 284	16 912	26 823	20 473	20 639	21 708
Jilin	16 583	26 807	22 747	14 762	20 046	17 901	15 483	17 364
Heilongjiang	16 505	32 926	26 793	14 666	22 517	19 545	18 426	19 541
Shanghai	41 188	83 525	69 043	48 420	48 234	40 263	45 267	43 118
Jiangsu	23 782	44 202	43 495	28 444	37 155	25 647	29 394	35 469
Zhejiang	27 820	57 027	59 910	30 069	40 894	39 224	42 016	46 770
Anhui	17 949	25 695	25 532	17 229	21 198	17 599	17 667	18 831
Fujian	19 318	40 817	42 359	21 588	27 701	21 933	24 076	24 645
Jiangxi	15 590	21 810	25 069	13 934	20 592	16 156	18 377	16 195
Shandong	19 228	36 522	33 304	19 241	26 986	21 877	22 950	21 584

Table 5.5 (*cont.*)

	Average	Information transmission, computer service and software	Financial intermediation	Real estate	Scientific research, technical service, and geological prospecting	Education	Health, social security, and social welfare	Public management and social organization
Henan	16 981	24 436	26 988	15 658	22 713	17 213	17 180	16 238
Hubei	16 048	30 328	23 619	16 925	24 693	17 078	17 733	19 436
Hunan	17 850	32 178	25 966	17 831	21 655	18 688	22 124	17 991
Guangdong	26 186	53 121	55 508	26 286	46 587	26 706	33 319	35 142
Guangxi	18 064	30 940	29 576	16 551	22 498	17 039	20 690	20 330
Hainan	15 890	43 621	34 209	16 503	16 651	20 808	20 711	21 161
Chongqing	19 215	34 996	39 755	18 053	27 525	19 133	22 228	22 640
Sichuan	17 852	34 048	31 503	16 993	30 164	16 552	21 436	19 705
Guizhou	16 815	24 067	29 549	12 039	20 411	16 719	18 834	17 750
Yunnan	18 711	27 880	28 797	14 346	21 122	18 666	19 912	18 257
Tibet	31 518	66 882	60 018	34 793	34 625	30 062	32 065	34 234
Shaanxi	16 918	38 484	26 917	17 920	23 705	17 232	16 383	14 446
Gansu	17 246	16 866	19 826	12 239	20 403	18 997	17 491	17 824
Qinghai	22 679	33 080	27 321	12 959	35 352	24 417	24 564	24 163
Ningxia	21 239	35 662	37 628	15 625	22 670	21 026	18 662	20 191
Xinjiang	17 819	28 513	28 647	15 425	21 220	19 663	20 053	20 356

Source: National Bureau of Statistics, 2007: 173–5.

vice minister or vice governor in terms of housing, medical care, and transportation. Professors and other intellectuals at similar ranks enjoy a lesser, but nonetheless still significant, benefits package. Experts designated at national and provincial levels receive special stipends or monthly salary supplements. In 2004, for example, those experts receiving special stipends at the national level reached 145 000 or about 8 percent of senior professionals. In addition, many college professors in Shanghai, Guangzhou, and Nanjing engage in extra teaching outside their home institutions to make extra income (*Outlook Dongfang Weekly*, January 4, 2006). Researchers also earn extra money by publishing in journals catalogued by the *Science Citation Index* (SCI) at a couple of hundreds to hundreds of thousands of RMB depending upon where they publish their work.

Satisfaction of S&T workers

Income aside, self-assessment by scientists and engineers is probably a better way to measure the utilization of their expertise. According to a survey of 7000 S&T workers by the China Association for Science and Technology (CAST), the umbrella organization of Chinese S&T societies, in 2003, less than half of respondents were "very much" and "somewhat satisfied" with their jobs and only 13.8% were "not satisfied" with their job; satisfaction was higher for those in the East and with higher professional ranks. Among them, 6.7% indicated that their ability was fully utilized, another one-third had 80% of their ability utilized, 43.9% saw 50–80% of their expertise utilized, with the rest less than 50% of their ability utilized (CAST Research Team on Survey of Chinese S&T Workers, 2004b: 24–5 and 132). That is, there is still room for improvement to satisfy S&T workers and better utilize their expertise. A similar survey of over 5000 S&T workers at non-state-owned enterprises and institutions by the CAST in 2002 also found that employees wanted their working environment improved and, not surprisingly, their level of satisfaction with the job was correlated to their income (CAST Research Team on Survey of Chinese S&T Workers 2004a: 19–20).

For those working at state-owned institutions, close to 90% of respondents to the CAST survey of S&T workers in 2003 claimed to have smooth relations with members of research teams, which may contribute significantly to their job satisfaction (CAST Research Team on Survey of Chinese S&T Workers, 2004b: 122). Nevertheless, as will be discussed in Chapter 6, the Chinese scientists with domestic doctoral degrees felt that they had been treated unequally compared with those trained overseas.

S&T workers were not so satisfied with the research environment in which they work (CAST Research Team on Survey of Chinese S&T Workers, 2004b: 94). One of their concerns was increasing incidents of misconduct in research. One-third of the S&T workers surveyed had noticed such incidents and an equal percentage of respondents thought the situation "very serious" and "somewhat serious" (CAST Research Team on Survey of Chinese S&T Workers, 2004b: 133). Pressure to perform is surely one of the reasons that have contributed to the rise of misconduct and fraud in science as significant investment in scientific enterprise in recent years has not yielded equally significant achievements. According to surveys, on average, Chinese S&T workers in both state-owned and non-state sectors work 46 hours a week with some individual's working week lasting for more than 60 hours; and usually, the higher the educational attainment, the longer the working week (CAST Research Team on Survey of Chinese S&T Workers, 2004a: 19; CAST Research Team on Survey of Chinese S&T Workers, 2004b: 25–6).

Conclusion

This chapter has discussed various issues involved in the utilization of scientists and engineers in China. Scientists and engineers are part of China's vast community of intellectuals, which, as a social group, has experienced a variety of ups and downs in terms of status, stature, and political standing between 1949 and the present period. Although often mistrusting intellectuals as a group, and periodically uncertain of the loyalties of even top scientists and engineers, the CCP has also been pragmatic toward intellectuals in general, and scientists and engineers in particular, by giving them autonomy in their areas of expertise as long as they do not go beyond certain "politically defined" boundaries. The once very powerful job assignment system has disappeared as market reforms have proceeded, and consequently college graduates have more freedom to choose where they want to work and work satisfactorily. Job mobility has become a reality with more S&T personnel moving from R&D institutes to enterprises, which has made it possible to further strengthen the role of enterprises in China's national innovation system. Young scientists have seen increasing opportunities in terms of receiving grants from the NSFC, China's leading funding agency for scientific research, thus making scientific research as a career option more attractive to young scientists at the onset of their professional lives. The development of China's high-technology industry has also opened more opportunities for S&T personnel, especially those with entrepreneurial aspirations who have the willingness to start their own businesses and assume the risks associated with pursuing that course of careers.

More importantly, Chinese scientists and engineers have seen not only their social status, but also their income raised. As a proxy for the S&T workforce, wages of employees in S&T-related sectors such as scientific research and information technology have outperformed those in other sectors; in fact, R&D and information services have become among the top-paying fields in recent years. On average, in 2006, a software engineer earned twice as much as an average Chinese employee and a researcher one and half times as much. If they happened to be in Beijing and Shanghai and/or employed by an FIE, they would do even better. On one hand, this phenomenon reflects the sustained attractiveness of the S&T professions, which, along with the increasing share of young scientists being supported for their research at the NSFC, sends a clear and strong, positive signal to those who are interested in pursuing a technical career in China. On the other, it may reflect the paucity of talented and qualified scientists and engineers in China, which could be a problem as demand for such individuals is increasing steadily. If the latter is the case, the implications are clear: China's higher educational system needs to do a better job – turning out not only more but also more employable graduates to meet increasing demands across all sectors of the economy. The issues of demand and supply of S&T talent are discussed more fully in Chapter 7.

Finally, to more fully understand the issues surrounding utilization of China's scientific and technical talent, it is necessary to examine the question from within the context of its evolving political, economic, and national security environment. As the regime has become more self-confident, especially in the aftermath of the 2008 Olympics, and as the imperatives of technological advance have grown in importance, the place and position of the S&T community have changed in positive ways from the situation that existed during the Maoist period. These changes, for the most part, reflect the changing agenda of the Chinese leadership – both the party and the state – as well as the different challenges which face the regime today versus those of its predecessors. The Maoist political agenda was of paramount importance during its heyday of the 1950s to the mid-1970s; the regime also felt under siege from within and without. Paranoia and xenophobia were at an all time high during this period, and thus produced policies and actions that clearly saw the S&T community as potentially threatening to regime legitimacy at various points in time. Yet, even during this period, the demands of national security made it necessary to adopt much of an inclusive set of policies toward scientists and engineers to help drive China's advanced weapons programs.

The agenda of the Chinese leadership under President Hu Jintao and Premier Wen Jiabao, although no less challenging in many respects, reflects a rather different set of issues and concerns. No doubt, there remain major apprehensions about maintaining the authority and legitimacy of the CCP. That recognized, it also must be acknowledged that the complexion of the leadership itself has evolved, with more and more scientific and technical personnel in positions of authority, and growing numbers of overseas-trained individuals becoming national- and local-level leaders. Most important, the situation within the Chinese economy commands a new set of skills and talents to move to the next phase of China's modernization drive. As the focus of the 15-year S&T Medium- to Long-Term Plan (MLP) suggests, moving toward a knowledge-centered, innovation-driven economy is no longer simply desirable for China, it has now become a strategic imperative because of the huge environmental damage wreaked upon the country from the growth approach of the last two-plus decades. The Chinese leadership recognizes, as do many foreign observers, that China must wean itself from an economic model that depends so heavily on fossil fuels, heavy inputs of natural resources, and cheap labor to produce adequate levels of economic growth. The new innovation-driven economy that is being touted as the key to China's future requires a highly qualified, highly mobilized, and highly supportive S&T community at the center of the efforts to guide China on its future growth path. This suggests that there will need to be an even closer, more intimate relationship between the political leadership and the S&T talent pool. This all bodes well for the utilization of China's steadily growing S&T community, as this is the time and place in China's modern history for them to showcase their capabilities and resourcefulness. Not only are the Chinese people watching, but so is the rest of the world.